2014 Spring Meeting Lille, France – May 26th - 30th

SYMPOSIUM J

Laser interaction with advanced materials: fundamentals and applications

Symposium Organizers:

Chantal Boulmer-Leborgne, University of Orleans, France

Rosalia Serna, Instituto de Optica, CSIC, Madrid, Spain

Maria Pervolaraki, Univ. of Cyprus, Nicosia, Cyprus

Florenta Costache, Fraunhofer Institute for Photonic Micro-systems, Dresden, Germany

Nadezhda Bulgakova, Institute of Thermophysics SB RAS, Novosibirsk, Russia

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Published in Applied Surface Science (APSUSC) - Elsevier

PROGRAM VIEW : 2014 Spring
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Symposium : J

Laser interaction with advanced materials: fundamentals and applications

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Fundamentals of laser-mater interaction (I) : Ch. Boulmer-Leborgne

09:00 **Large-scale atomistic simulations of the structural transformations and microstructure development in short pulse laser processing of metals (Invited)**

Authors : Leonid V. Zhigilei, Chengping Wu, Eaman T. Karim, Maxim Shugaev
Affiliations : University of Virginia, Department of Materials Science and Engineering

Resume : The microscopic mechanisms responsible for the material ejection and surface modification in short-pulse laser processing of metal targets are investigated in a series of large-scale massively parallel atomistic simulations. The simulations are performed with a computational model that combines the classical molecular dynamic method with a continuum description of the laser excitation of conduction band electrons, electron-phonon coupling and electron heat conduction. The results of the simulations reveal a complex picture of highly non-equilibrium processes responsible for material modification and/or ejection in response to the fast laser energy deposition. The extreme heating and cooling rates realized in short pulse laser processing are defining the kinetics of the melting and resolidification processes and are responsible for the generation of unusual microstructure of the surface region. The resolidification, in particular, is controlled by the competition between the epitaxial regrowth of the substrate and nucleation of crystallites within the undercooled melted region, leading to the formation of nanocrystalline surface structure with a high density of stacking faults, twins, dislocations and point defects. The results of the simulations are related to the available experimental data and the implications of the computational predictions for practical applications are discussed.

J.I 1

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09:30 **Modelling and probing femtosecond laser pulse interaction with materials: melting of gold nanofilms**

Authors : S. L. Daraszewicz 2, Y. Giret 1,2, N. Naruse 1, Y. Murooka 2, J. Yang 1, D. M. Duffy 2, A. L. Shluger 2, and K. Tanimura 1
Affiliations : 1 The Institute of Scientific and Industrial Research (ISIR), Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan, 2 London Centre for Nanotechnology, Department of Physics and Astronomy, University College London (UCL), Gower Street, WC1E 6BT, London, UK

Resume : Understanding of the fundamentals of femtosecond laser pulse interaction with materials and describing the dynamics of atoms induced by laser excitation is an essential step in future structure and function control of nanomaterials. We present state-of-the-art ultrafast electron diffraction (UED) measurements probing the structural evolution of melting processes of gold nanofilms. We quantitatively combine our measurements with the two-temperature molecular dynamics (2T-MD) modelling directly revealing the atomistic dynamics of gold nanofilms during a photo-induced solid-to-liquid phase transition. The equivalent spatiotemporal scales of the experiment and the simulation, which encompasses both ultrafast changes in the interatomic potential and the electron-phonon relaxation process, have enabled direct insight into the atomistic mechanism behind the temporal evolution of the Bragg peaks. We used a wide range of laser fluences and observed transition between slow heterogeneous melting, rapid homogeneous melting and ultrafast non-thermal melting at very high fluence, where electronic excitation effects on the interatomic potential are non-negligible. We discuss the latter case in terms of a

J.I 2

shift of equilibrium lattice volume leading to rapid surface expansion accompanied by bond softening. An excellent agreement between 2T-MD and experiments enables us to elucidate the atomistic behaviour of the melting dynamics on a sub-picosecond timescale.

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09:45 **Generation of femtosecond second-harmonic pulses from Archimedean nanospirals** J.I 3

Authors : Roderick Davidson, Jed Ziegler, Sergey Avanesyan and Richard Haglund
Affiliations : Vanderbilt University, Nashville, TN 37235 USA

Resume : The second-order susceptibility in non-centrosymmetric crystals produces frequency mixing, sum-frequency and harmonic generation, and optical rectification. However, in these materials, efficient generation of second-order nonlinear effects requires that the fundamental incident and the nonlinear outgoing waves must be phase matched through a macroscopic volume of material, typically on the order of cubic millimeters. The enhanced electric field at plasmonic resonances in asymmetric nanoscale antennas can lead to efficient harmonic generation, especially when the plasmonic geometry is asymmetric on either inter-particle or intra-particle levels. The Archimedean nanospiral offers a unique geometrical asymmetry for second-harmonic generation (SHG) because the SHG results neither from arranging centrosymmetric nanoparticles in asymmetric groupings, nor from non-centrosymmetric nanoparticles that retain a local axis of symmetry. Here we report high SHG conversion efficiencies (3·10-8) from arrays of lithographically fabricated, sub-wavelength-dimension nanospirals, using transform-limited 15 fs pulses at a wavelength of 800 nm. The nanospirals are stable under average power loadings up to 300 μW per nanoparticle even without protective dielectric coating. The nanospirals also respond selectively to linear and circular polarization states of incident light and exhibit conversion among polarization states. These experiments show that the intrinsic asymmetry and two-dimensio

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10:00 **Control of local energy deposition inside dielectrics and semiconductors using long-wavelength femtosecond lasers** J.I 4

Authors : A. Mouskeftaras (1), S. Leyder (1), R. Clady (1), P. Delaporte (1), W. Marine (2), A. Rode (3), M. Sentis (1), O. Utéza (1), D. Grojo (1)
Affiliations : (1) Aix-Marseille University, CNRS, LP3 UMR 7341, F-13288, Marseille, France ; (2) Aix-Marseille University, CNRS, CINAM UMR7325, F-13288 Marseille, France ; (3) Laser Physics Centre, The Australian National University, Canberra, ACT 0200, Australia

Resume : Using tightly focused femtosecond laser pulses with wavelengths in the range 1200–2200 nm, we reveal major differences between bulk dielectrics and semiconductors in strong field ionization regimes. By measuring the wavelength dependence of nonlinear absorption, we gauge the photoionization mechanisms for various materials. We find the signature of the tunnel ionization for all tested dielectrics. Interestingly, this indicates that long-wavelengths can open up an alternative to pulse shortening for ultraprecision applications. However, a strong wavelength-dependence associated with multiphoton ionization persists for semiconductors. The measurements are in accordance with Keldysh's predictions. Another major difference between dielectrics and semiconductors is observed in the material modification regimes. 3D femtosecond laser micromachining promotes a wide range of applications inside dielectrics. However, the extension of these technologies to semiconductors remains today a challenge because their intrinsic properties prevent efficient energy confinement in the bulk. Concentrating on silicon, we perform a pump-probe shadowgraphy experiment at 1300-nm wavelength. We image in this way the local energy deposition inside the material. This allows us to investigate propagation effects due to low threshold for self-focusing in silicon and potential factors that prevent bulk micromachining.

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10:15 **Coffee Break**

Fundamentals of laser-mater interaction (II) : F. Costache

10:45 **Experimental investigation of femtosecond laser induced modification of dielectric materials (Invited)** J.II 1

Authors : Stéphane Guizard

Affiliations : Laboratoire des Solides Irradiés, CEA-CNRS, Ecole Polytechique, 91128 Palaiseau

Resume : Laser processing and machining of dielectrics is a growing field, involving increasingly complex laser temporal and spatial pulse shaping. Predicting and modeling the optimum pulse characteristic for a given application requires a detailed knowledge of all the elementary events involved during the interaction. To understand and observe these physical mechanisms in detail, we carry out time resolved experiments, using spectral interferometry as a probe. Thus we can measure in real time the excitation density achieved in the solid and the following relaxation of excited carriers. Since many processes (non-linear excitation, impact ionization, modification of pulse shape and propagation) arise during the pump laser pulse itself, usual pump-probe experiments as not capable to distinguish and directly observe them. To encompass this difficulty, we used a flexible double pump scheme, allowing modulating the excitation density and carrier healing steps. We have been able to derive the following conclusions: - The appropriate criteria to determine the ablation or damage threshold is the amount of deposited energy in the solid, not the density of carriers. The latter, measured at breakdown threshold, decreases with increasing pulse duration. - We report the first direct observation of laser induced impact ionization/avalanche. This phenomena is a hypothesis in a huge number of publication, but was never demonstrated. More important, we show that it is not connected to the optical breakdown, occurring far above the threshold for damage/ablation. Finally, the most interesting result is that it does not take place in all materials. The possible reason for this selective occurrence of impact ionization will be discussed.

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11:15 **Ablation of metals by extreme-ultraviolet pulsed laser** J.II 2

Authors : J. Lancok, P. Pira, T. Burian, L. Juha, L. Vyšín, Z. Zelinger, J. Wild
Affiliations : Institute of Physics of the Academy of Sciences of the Czech Republic,v.v.i., Na Slovance 2, 182 21 Praha 8, Czech Republic; Faculty of Mathematics and Physics, Charles University, V Holesovickach 2, 180 00 Praha 8, Czech Republic; J. Heyrovský Institute of Physical Chemistry of the Academy of Sciences of the Czech Republic, v. v. i., Dolejškova 2155/3, 182 23 Praha 8, Czech Republic

Resume : Properties of a plasma plume formed on metallic thin films and bulk target irradiated by the focused beam of an extreme-ultraviolet (XUV) capillary-discharge laser were investigated Ablation (and desorption) behaviour of different metals with different physical properties such as Ti, Al, Ag, , Ir, Pd, Pt, Pb and Bi will be reported. For ablation the XUV capillary discharge laser operated at 46.9 nm was used. Langmuir probe was used to determine an electron temperature and plasma density. Although the temperatures seem to be comparable with values obtained in plasmas produced by conventional, long-wavelength lasers, the density is significantly lower. A higher recombination rate in the photoionized plasma could be responsible for the reduced density. The possibilities of metals layer by pulsed XUV laser deposition will be discussed.

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11:30 **Study of dynamic strength properties of polycrystalline and single crystal synthetic diamond under the action of picosecond laser pulses** J.II 3

Authors : K. V. Khishchenko,[1] S. A. Abrosimov,[2] A. P. Bazhulin,[2] A. P. Bolshakov,[2] V. E. Fortov,[1] A. A. Khomich,[2] V. I. Konov,[2] I. K. Krasyuk,[2] P. P. Pashinin,[2] V. G. Ralchenko,[2] A. Yu. Semenov,[2] D. N. Sovyk,[2] I. A. Stuchebryukhov[2]
Affiliations : [1]Joint Institute for High Temperatures RAS; [2]General Physics Institute RAS, Moscow, Russia

Resume : Experimental-theoretical study of dynamic strength properties of polycrystalline CVD diamond and single crystal HPHT diamond under the action of 70 ps laser pulses is presented. The targets were irradiated at Kamerton-T facility with second harmonics of Nd:YAG laser (wavelength 527 nm, pulse energy 2.5 J) at intensities up to 20 TW/cm² to obtain the ablation pressure of 0.66 TPa and the strain rate up to 100/μs. The spall (tensile) strength of 16.5 GPa is evaluated that is about 24% of theoretical estimation of maximum dynamic strength of diamond. Raman spectroscopy revealed small presence of graphite phase in spallation debris that indicates a surface diamond-to-graphite transformation during the material fracture.

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11:45 **Observation of ultrafast electro-optic effect and transient Newton rings at the surface of LiNbO3 irradiated with fs laser pulses** J.II 4

Authors : Mario Garcia-Lechuga, Javier Hernandez-Rueda, Jan Siegel, Javier Solis
Affiliations : Laser Processing Group, Instituto de Óptica, CSIC, Serrano 121, 28006 Madrid, Spain

Resume : Lithium niobate (LiNbO3) is a crystalline dielectric widely used in photonics and integrated optics due to its electro-optic, piezoelectric, photorefractive and nonlinear optical properties. In this work, we analyze the interaction of single fs laser pulses with un-doped LiNbO3 by fs-resolved microscopy as well as different post-irradiation characterization techniques. After gentle focusing, fs laser pulses (800 nm, 120 fs) are used to irradiate the sample surface while its reflectivity is imaged using either 400 or 800 nm illumination probe-pulses. Experiments are carried in the vicinity of the ablation fluence threshold. Time-resolved images show a characteristic modulation of the reflectivity of the irradiated surface well before the development of a dense electron plasma in approx.1 ps. Additionally, the spatial spread of the sub-picosecond reflectivity changes is larger than the size of the final ablated crater. These features are consistent with a modulation of the reflectivity in the sub-ps scale by electro-optic effect. For longer time delays (hundreds of ps) transient Newton rings develop at the surface. Although long since observed in fs-laser irradiated semiconductors and metals, these transient features, associated to the special optical properties of the expanding material, are reported for the first time in a dielectric material.

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12:00 **Lunch**

Laser-induced nanoparticle generation : N. Bulgakova

14:00 **Understanding Nanoparticle and Nanostructure Generation by Laser (Invited)**

Authors : Tatiana E. Itina
Affiliations : Hubert Curien Laboratory, Bât. F, 18 rue Benoît Lauras, 42000 Saint-Etienne, France

Resume : During last decade, laser-based synthesis of nanoparticles and nanostructures has attracted particular attention [1]. Nanoparticles demonstrate unique plasmonic and/or photoluminescent properties, as well as a capacity of field amplification. These effects are essential in many promising applications, such as imaging, sensors, photodynamic therapy, etc. Many of medical applications require the absence of any toxicity and/or of the incompatibility with biological tissues. Nanoparticle and nanostructure generation by laser ablation provides possibilities to respect such strict requirements [2]. This study is aimed at the better understanding of the mechanisms involved in nanoparticle formation by laser ablation and at the possibilities of the process optimization. For this, we carry out very detailed simulation based on combined numerical methods. In particular, we focus our attention on the role of laser parameters and ambient environment in both target decomposition and following laser plume dynamics. The obtained results are also used to explain several promising experiments where nanoparticles and nanostructures are obtained with unique properties that are impossible to reproduce by other methods. [1] D. B. Geohegan et al., Appl.Phys. Lett. 72, 2987 (1998) [2] S. Besner et al., Appl. Phys. A 93, 955-959 (2008)

J.III 1

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14:30 **Femtosecond laser fragmentation for controllable synthesis of nanomaterials**

Authors : Ksenia Maximova, Andrei Kabashin
Affiliations : Aix Marseille Université, CNRS, LP3 UMR 7341, 13288, Marseille, France

Resume : Nanoparticles are widely used for various applications, and for most of them, including photovoltaics, catalysis, Raman spectroscopy, bioimaging and therapy, the purity of the nanomaterials is a crucial factor. Conventional chemical ways of the nanoparticles fabrication are connected with the contamination of the material with non-reacted starting reagents, by-products and surfactants; therefore they often demand long and sophisticated purification procedures. As a clean and "green" alternative to chemical synthesis, nanoparticles generation by laser ablation and laser fragmentation has recently been proposed. This technique includes the laser irradiation of the colloids, prepared either by the laser ablation of the solid target in liquid, or by the suspension of mechanically milled particles. As this method requires only bulk starting material and an appropriate solvent, it yields in pure particles with bare surface. Regardless the absence of any ligands and surfactants, laser-synthesized nanoparticles are extremely stable. As the nanoparticles mean size is a key factor for their properties, the control over it is desirable. In the most cases, it is effectuated by the addition of ligands and surfactants that subverts

J.III 2

the advantages of particles' bare surface. We propose a fully-physical approach to tuning the particles size acting only through the physical parameters of the system. This method allows us to control the particles size while keeping their unique clean surface.

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14:45 **Nanoparticle plume dynamics in femtosecond laser ablation of metals**

Authors : G. O'Connell, T. Donnelly, J. G. Lunney
Affiliations : School of Physics and CRANN, Trinity College Dublin, Dublin, Ireland

Resume : We describe the results of some recent experiments on femtosecond laser ablation of various metals, including gold, silver, aluminium and tin. Laser irradiation using 130 fs pulses was carried out in vacuum at a laser fluence ~1 J cm-2. We have studied the dynamics of both the plasma and nanoparticle ablation plumes using Langmuir probe, optical emission spectroscopy and time-resolved optical absorption. We have measured the number and energy distribution of the ions in the plasma flow and have measured the temporal variation of temperature and density of the nanoparticle plume from absolutely calibrated emission spectra. We describe a time-resolving optical absorption setup which was used to measure, on-the-fly, the nanoparticle plume density with both temporal and spatial resolution. The partition of material between atoms, ions and nanoparticles for each material was estimated

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15:00 **Spatio-temporal characterization of laser plasma plume: applications of nanoparticles formation in the ambient air**

Authors : Marie Girault, Jean-Marie Jouvard, Luc Lavisse (1), Hamadi Farida (2), François-Xavier Ouf (3)
Affiliations : 1-Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB), UMR 6303 CNRS-Université de Bourgogne, 1 Allée des Granges Forestier F-71100 Chalon-sur-Saône, France ; 2- Laboratoire d'Interaction Laser-Matière, Centre de Développement des Technologies Avancées, Houch-Oukil, B.P. 17, Baba Hassen, Alger, Algérie ; 3-Institut de Radioprotection et de Sûreté Nucléaire (IRSN), Saclay, BP 68, F-91192 Gif-sur-Yvette cedex, France

Resume : Irradiation of a metallic surface by a pulse Nd:YAG laser source can lead to the formation of a thin liquid layer at the material surface, then the formation of plasma for pulse durations shorter than several tens of nanoseconds. At the end of interaction, the plasma cools down and expands at supersonic speeds in ambient air. Under some temperature and pressure conditions, the plasma condenses and aggregates in order to form liquid micrometric and nanometric particles, named nuclei. The interaction taking place in air, particles are target oxides. Our project is based on the study of mechanisms of nanoparticles formation. A preliminary experimental study leaded to the characterization of particles produced by laser treatment. Particles were collected after laser shot to be analyzed. Moreover, Small Angle X-Rays Scattering (SAXS) was used to probe in-situ the formation of nanoparticles in the plasma plume, in order to determine its sizes, its morphology and its density. Nanoparticles formation has been also localized in the plasma plume. These experimental observations have been compared to numerical simulations in order to understand the origin of nanoparticles formation in air. So as to optimize the simulation conditions of laser-matter interaction and plasma expansion in air, a physical analysis of plasma is realized by emission spectroscopy and by fast photography. Our objective is to obtain a spatio-temporal characterization of temperature and electronic density gradients.

J.III 4

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15:15 **Ultrashort laser ablation of fullerite in liquid media**

Authors : A. De Bonis1, M. Curcio1, A. Galasso1, J.V. Rau2 , A. Santagata3, R. Teghil1
Affiliations : 1 Dipartimento di Scienze, Università della Basilicata, Viale dell'ateneo Lucano, 10 – 85100 Potenza, Italy; 2 CNR - ISM, Via del Fosso del Cavaliere, 100 – 00133 Roma, Italy; 3 CNR – ISM UOS Tito, C.da Santa Lojia, Zona Industriale Tito Scalo - 85010 Tito (PZ) – Italy

Resume : The Laser ablation in liquid is a technique attracting a growing interest in the scientific and technological communities due to the possibility of obtaining stable nanoparticles in liquid media [1]. In particular the ablation of carbon based targets is of particular importance due to the possibility to obtain different carbon allotropes by varying the experimental parameters [2]. We have investigated the ablation of a fullerite target in different media (water and H2O2) by two femtosecond laser sources (Nd:glass 527nm, 250fs and 10 Hz and Ti:sapphire 800nm, 100fs and 1kHz). The aim of this study was to compare the effect of different parameters (wavelength, repetition frequency and liquid media) on the physical and chemical processes involved during the ablation and,

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consequently, on the obtained nanoparticles properties. The ablation process has been studied both by shadowgraphic technique and optical emission spectroscopy. The obtained products have been characterized by transmission electron and scanning electron microscopies, by X-ray photoelectron and micro-Raman spectroscopies and X-ray diffraction. [1] V. Amendola, M. Meneghetti, Phys. Chem. Chem. Phys, 15, 3027, 2013. [2] G.W. Yang, Progress in Materials Science, 52, 648, 2007

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15:30 **Coffee Break**

Laser-induced nanoparticle formation and manipulation : T. Itina

16:00 **Plasmonic Ag nanoparticles by visible laser annealing for applications in flexible, organic electronic devices**

Authors : S. Kassavetis1, S. Kaziannis2, M. Beliatis3, D. Kutsarov3, N. Pliatsikas1,4, C. Kosmidis2, S.R.P. Silva3, S. Logothetidis4, E. Lidorikis1, P. Patsalas4
Affiliations : 1. University of Ioannina, Department of Materials Science and Engineering, GR-45110 Ioannina, Greece; 2. University of Ioannina, Department of Physics, GR-45110 Ioannina, Greece; 3. University of Surrey, Advanced Technology Institute, Nanoelectronics Center, Guildford GU2 7XH, Surrey, United Kingdom; 4. Aristotle University of Thessaloniki, Department of Physics, GR-54124 Thessaloniki, Greece

Resume : Incorporation of plasmonic metal nanoparticles (NPs) in the layers of an organic optoelectronic device contributes to the optimization of their performance, e.g. enhancement of the power conversion efficiency in the case of solar cells. This work focuses on the fabrication of silver NPs on top of the electrode surface (ITO and PEDOT:PSS), grown on glass and flexible PET substrates, via laser annealing (LA) of the Ag with the 532 nm beam of Nd:YAG laser (5 ns pulse duration). The goal is to control the NPs size and spatial distribution and to tailor the Localized Surface Plasmon Resonance (LSPR) through process parameters. For the fabrication of the NPs, 5-10 nm thick Ag layer was grown on top of the electrodes via DC sputtering. Real-time optical absorption measurements were used to monitor the formation of the NPs and the LSPR variation vs. the number of pulses (the laser exposure time). For the ITO/Glass, Atomic Force Microscopy and Variable Angle Spectroscopic Ellipsometry characterization showed: i) fabrication of Ag NPs for laser fluence (f) in the range 11-50 mJ/cm2, ii) ablation of the Ag layer for f≥75 mJ/cm2, and iii) dependence of the LSPR to the f. In the case of the flexible PET substrate, the LA also led to the fabrication of Ag NPs on the electrode surface, without causing any undesirable effects to transparency of the ITO/PET. Furthermore, the ablation of the Ag layer from the ITO/PET surface started at lower f compared to the ITO/Glass.

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16:15 **Formation of plasmonic colloidal silver for flexible and printed electronics using laser ablation**

Authors : S. Kassavetis1, S. Kaziannis2, N. Pliatsikas1,3, A. Karanastasis1, A. Avgeropoulos1, N. Zafeiropoulos1, C. Kosmidis2, E. Lidorikis1, and P. Patsalas3
Affiliations : 1University of Ioannina, Department of Materials Science and Engineering, 45110 Ioannina, Greece; 2University of Ioannina, Department of Physics, 45110 Ioannina, Greece; 3Aristotle University of Thessaloniki, Department of Physics, 54124 Thessaloniki, Greece

Resume : Laser Ablation (LA) in liquids has been used for the production of various nanoparticles (NPs); among them, Ag NPs in aquatic solutions (usually produced by fs LA) have attracted exceptional interest due to its strong plasmonic response. However, the emerging technologies of flexible and printed electronics require the implementation of volatile solvents such as toluene and chloroform, and additives such as Poly-vinyl-pyrrolidone (PVP), which can actively interact with the laser beam resulting in photo-activated isomerization reactions. In this work, we present a comprehensive study of LA of Ag in toluene and chloroform, with and without PVP, and we consider a wide range of LA parameters such as the laser wavelength (1064, 532, 355 nm), the pulse duration (35 ps and 5 ns), the pulse power (0.3-10 mJ), the number of pulses and the concentration of PVP. In addition, we consider a secondary laser beam for the refinement of the NPs size distribution. The optical properties of the NPs were evaluated by optical transmittance measurements in the Visible-UV

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spectral ranges, while the NPs size distribution was evaluated by Dynamic Light Scattering. The morphology of the NPs and the formation of aggregates were investigated by Scanning and High-Resolution Transmission Electron Microscopy. Finally, the surface functionalization of the NPs, as well as the formation of organic aggregates, as a result of the isomerization reactions, was studied by X-Ray Photoelectron Spectroscopy.

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16:30 **Laser-induced agglomeration of gold nanoparticles dispersed in a liquid**

Authors : P.G. Kuzmin, G.A Shafeev, A.A. Serkov, N.A. Kirichenko, M.E. Scherbina
Affiliations : Wave Research Center of A.M. Prokhorov General Physics Institute of the Russian Academy of Sciences, 38, Vavilov street, 119991, Moscow, Russian Federation

Resume : Evolution of size distribution function, morphology, and extinction spectra of gold nanoparticles dispersed in liquids under picosecond laser exposure are studied both experimentally and theoretically. Characterization of nanoparticles is carried out by means of optical absorption spectroscopy, transmission electron microscopy and size-measuring disc centrifuge. Modeling of the evolution of size distribution function of particles is performed on the basis of numerical solution of kinetic equation for distribution function which takes into account the splitting and aggregation of particles into fragments of different sizes. It is shown that in case of high concentrations of nanoparticles (above 10^18 particles per ml) the process of laser fragmentation which is typical of nanosecond laser exposure [1] turns into laser-induced agglomeration, which leads to the shift of size distribution function to larger sizes. The evolution of the size distribution function with laser exposure time is monitored and compared to modeling results. [1] N A Kirichenko, I A Sukhov, G A Shafeev, M E Shcherbina, "Evolution of the distribution function of Au nanoparticles in a liquid under the action of laser radiation", QUANTUM ELECTRON, 2012, 42 (2), 175–180.

J.IV 3

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16:45 **Controlling size and distribution of noble metal nanoparticles embedded in Al2O3**

Authors : M. Lambert (1), C. Kaan Akkan (2), A. May (1), N. Agarwal (1), C. Aktas (1)
Affiliations : (1) Leibniz Institute for New Materials, CVD/Biosurfaces, Saarbrucken, Germany (2) Institute of Biomedical Engineering, Boğazi?i University, Istanbul, Turkey

Resume : Controlling the particle size distribution and particle size of embedded nanoparticles in either dielectric or ceramic materials is a key factor for designing advanced materials. The most common way to produce these materials is alternate-target-PLD where a rotating composite target made of sectors of two or more materials is used. This method does not offer the possibility to control these factors very easily. Therefore a new method to synthesize Al2O3 with embedded nanoparticles has been designed. Co-Sputtering of Au and Al2O3 using Electron Beam Evaporation for Au and PLD for the Al2O3 component yielded into Au nanoparticles embedded in solid Al2O3. Particle size and distribution could be controlled by changing the evaporation properties in relation to the laser energy on the Al2O3 target. To further improve and simplify the process, a new two-beam PLD method was designed to ablate Ag and Al2O3 at the same time. Using a self-constructed optical setup and a newly designed composite target, it was possible to change the ratio of laser energy on Ag and Al2O3 to obtain different sizes of the embedded Ag particles which could be shown with TEM analysis. Scratch resistance and stability of the coating can also be achieved. Due to its simplicity this method looks very promising. Further research will aim towards the effect of substrate temperature on the particle formation and the design of new, more complex materials such as ternary alloys embedded in dielectric matrices.

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17:00 **Laser processing of ceramic substrates modified by deposition of metals and oxides**

Authors : V. Rico-Gavira,1J. Gil-Rostra, 1 F. Yubero,1 J.P. Espinós,1 A.R. González-Elipe,1 R. Lahoz,2 F. Rey-García,2 G. F. de la Fuente2
Affiliations : 1.- Instituto de Ciencia de Materiales de Sevilla (CSIC-Univ. Sevilla). Avda. Américo Vespucio 49. 41092 Sevilla. Spain. 2.- Instituto de Ciencia de Materiales de Aragón (CSIC-Univ. Zaragoza). María de Luna, 3. 50018 Zaragoza. Spain

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Resume : This work reports the room temperature laser processing of white porcelain ceramic tiles with the purpose of coloring their surface. The method involves the evaporation on their surface of very small amounts of copper metal or a mixed oxide of copper in silicon oxide. Avoiding formation of a mirror film in the former case is a prerequisite for its successful laser treatment. For this purpose, copper is evaporated at glancing angles to form small aggregates that

depict plasmon resonance absorption, before their percolation threshold to form a continuous mirror-like surface. The Cu-Si mixed oxide films were deposited by magnetron sputtering. In both cases, irradiating the modified surface with a near-IR emitting Laser leads to the development of a relatively large variation of colors, ranging from blue through green to yellow. Analysis of these surfaces with UV-vis absorption spectroscopy, XPS and SIMS demonstrate that each color can be associated with a different chemical and agglomeration state of copper in the modified surfaces. The developed technology can be of general use with other metals and ceramic substrates to produce different types of colors and other surface functionalities.

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17:15 **Nanosecond (ns) laser manipulation of glass containing silver ions: influence of the wavelength, the energy deposited and the silver ion concentrations**

Authors : Mohamed Cherif Sow, Jean Philippe Blondeau
Affiliations : Laboratoire CEMHTI, UPR 3079 CNRS, Orleans, France

Resume : Interaction of pulsed laser with glass surface is widely studied [1, 2]. It?s well-known that ns laser interaction lead to crack formation on the glass surface or to a thin layer removal from the glass surface through the sputtering process. These two phenomenons are related to the deposited energy. Photoinduced effects of direct ns laser exposure on metal doped glasses are not yet well known, even if many experimental results have been obtained [3, 4]. Thus, further experimental and theoretical results are needed for a well-understand of the photoinduced mechanism by ns laser on glass. In this work, we focused on the experimental study of nanosecond laser interaction with silver exchanged glasses (witch contain only silver ions). Samples were prepared from soda-lime float glasses by Ag -Na ion exchange technique in a mixed melt of AgNO3 and NaNO3. Different concentrations of Ag have been obtained at the glass surface by changing the ion exchange duration. Direct nanosecond-written lines or spots have been inscribed on the glass surface. Three wavelengths in UV, Visible and IR have been used. Optical microscopy (OM), Scanning Electron Microscopy (SEM), profilometry and absorption spectroscopy have been used to characterize the nanoparticles (NPs) initiation, growth and morphology near the glass surface after ns laser exposure. The first aim of this work is to investigate the effect of different irradiation wavelengths. The second aim of our work is to study the influence of silver ion concentrations on the photoinduced phenomena. According to our knowledge, the influence of these two parameters has not been explained whereas the influences of energy density, pulses duration are now well known. At this point of our work, we have shown, as expected, that ns laser cause glass surface damage or ablation, depending on deposited energy. The assignment of the removal material to silver nanoparticles and/or pieces of glass needs further experiments. We also show that silver NPs are formed mainly around the laser spot when the exposed area is bleaching according to deposited energy. Some of these NPs are not strongly linked to the glass surface and could be removed from it, simply by cleaning the glass surface with a simple tissue. Actually, no influence of silver ion concentrations has been observed, but it is worth to notice that it still seems that higher silver ion concentrations are not necessary to silver NPs formation but lead to glass deterioration. The study of the influence of the wavelength being in progress. In the near future, we expect to analyze the removal material from the interaction zone with SEM analysis in order to know the ratio of silver nanoparticles and glass. One of the potential applications of this study is the direct locally writing of waveguide inside transparent materials with controlled ablation. [1] M. R. Kasaai , V. Kacham, F. Theberge, S. L. Chin, Journal of Non-Crystalline Solids 319 (2003) 129?135. [2] T. Shinona, M. Tsukamoto, S. Maruyama, N. Matsushita, T. Wada, X. Wang, H. Honda, M. Fujita, N. Abe 38 (2009) 81. [3] J. Zhanga, W. Dongb, J. Shenga, J. Zhenga, J. Lia, L. Qiaoa, L. Jiang, Journal of Crystal Growth 310 (2008) 234?239. [4] J. Sheng, J. Zheng, J. Zhang, C. Zhou, L. Jiang, Physica B 387 (2007) 32?35.

J.IV 6

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17:30 **Low-order harmonic generation from atoms and nanoaggregates in ZnS laser ablation plasmas**

Authors : Mohamed Oujja, Antonio Benítez-Cañete, Ignacio Lopez-Quintas, Margarita Martín, R. de Nalda, Marta Castillejo*
Affiliations : Instituto de Química Física Rocasolano, CSIC, Serrano 119, 28006 Madrid, Spain

J.IV 7

Resume : Clusters and nanoparticles produced by laser ablation of solid targets are being studied as optical nonlinear media for generation of short wavelength coherent radiation. Harmonic generation of a driving laser propagating through

a laser ablation plasma in an orthogonal configuration also serves for the diagnosis of multicomponent plumes. Here we report on the generation of low-order harmonics of the fundamental radiation of a Nd:YAG laser (1064 nm, 15 ns, 0.5 TW/cm2) in a ZnS laser plume created by ablation with another Nd:YAG laser (1064 nm, 7 ns). Odd harmonics up to the 9th order (118.2 nm) have been observed with distinct spatiotemporal characteristics, which were determined by varying the delay between the ablation and driving pulses and by spatially scanning the plasma with the focused driving beam. At short distances from the target (≤ 1 mm) the harmonic intensity displays two temporal components peaked at ≈ 250 nanoseconds and ≈ 10 microseconds, with relative intensity favoring the latter for higher harmonic orders. While the first component is spatially confined in the direction normal to the target, the second one is more intense in the lateral regions of the plume. These results are discussed in reference to the nonlinear optical behavior of plume atoms and nanoaggregates and their differing spatiotemporal distribution within the ablation plasma, and provide a scenario for measuring the nonlinear optical response of clusters and nanoparticles in the gas phase.

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PROGRAM VIEW : 2014 Spring
MY PROGRAM : 2014 Spring

Symposium : J

Laser interaction with advanced materials: fundamentals and applications

26 May 2014 | **27 May 2014** | 28 May 2014 | 29 May 2014 | 30 May 2014

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start at	Subject	Num.
	Advanced materials prepared by PLD, MAPLE and LIFT (I) : M. Pervolaraki	
08:30	**MICROBIAL COLONIZATION OF BIOPOLYMERIC THIN FILMS CONTAINING NATURAL COMPOUNDS AND ANTIBIOTICS FABRICATED BY MAPLE (Invited)** **Authors :** R. Cristescu1, G. Dorcioman1, C. Popescu1, C. Nita1, A. Visan1, G. Socol1, I.N. Mihailescu1, D. Mihaiescu2, A. Grumezescu2, M. Enculescu3, C. Chifiriuc4, R. J. Narayan5, and D. B. Chrisey6 **Affiliations :** 1National Institute for Lasers, Plasma & Radiation Physics, Lasers Department, P.O. Box MG-36, Bucharest-Magurele, Romania 2Faculty of Applied Chemistry and Materials Science, "Politehnica" University of Bucharest, 1–7 Polizu Street, 011061 Bucharest, Romania 3National Institute of Materials Physics, P.O. Box MG-7, Bucharest-Magurele, Romania 4Faculty of Biology, University of Bucharest, Microbiology Immunology Department, 77206-Bucharest, Romania 5Biomedical Engineering, University of North Carolina, Chapel Hill, NC, USA 6Department of Physics and Engineering Physics, Tulane University, New Orleans, LA, USA **Resume :** Although a large variety of antimicrobial agents are currently available, they are often rendered ineffective by the ability of many types of microorganisms to develop genetic resistance and to grow in multicellular structures known as biofilms. Of the various strategies to inhibit microbial biofilms, use of bioactive surfaces that are resistant to microbial colonization is the most promising approach. In this respect, we have prepared thin composite biopolymeric films containing either natural (flavonoid) or synthetic (antibiotic) bioactive substances by means of a matrix assisted pulsed laser evaporation (MAPLE) approach that involves use of a pulsed KrF* excimer laser source (λ = 248 nm, τ = 25 ns, ν = 10 Hz). Chemical bonding in the films was evaluated using Fourier transform infrared (FTIR) spectroscopy. An assay to assess the antimicrobial performance of MAPLE-modified surfaces was performed by spectrophotometric counting of viable cells. As revealed by scanning electron microscopy, the MAPLE technique did not affect the surface properties of the deposited materials for biomedical applications. The flavonoid-containing thin films showed increased resistance to microbial colonization, highlighting their potential to be used for the design of anti-biofilm surfaces. Since these bioactive substance-containing composites do not contain antimicrobial agents, there is lower risk of the development of microbial resistance.	J.V 1
	add to my program (close full abstract)	
09:00	**Towards paper-based point-of-care diagnostics fabricated by Laser Induced Forward Transfer** **Authors :** Ioannis N. Katis (a), Judith A. Holloway (b), Jens Madsen (b), Saul N. Faust (b), Spiros D. Garbis (c), Peter J.S. Smith (d), David Voegeli (e), Dan L. Bader (e), Robert W. Eason (a), Collin L. Sones (a) **Affiliations :** a Optoelectronics Research Centre, University of Southampton, Highfield, Southampton, U.K. SO17 1BJ.; b Clinical and Experimental Science, Faculty of Medicine and Institute for Life Sciences, University of Southampton and NIHR Wellcome Trust Clinical Research Facility and Respiratory Biomedical Research Unit, University Hospital Southampton NHS Foundation Trust, Southampton UK; c Institute for Life Sciences, Centre for Proteomic Research, and Cancer Sciences & Clinical and Experimental Medicine, University of Southampton, Highfield Campus, Southampton, UK.; d Institute for Life Sciences and Centre for Biological Sciences ; e Faculty of Health Sciences, University of Southampton, Highfield, Southampton SO17 1BJ, UK ;	J.V 2

Resume : We report the Laser Induced Forward Transfer (LIFT) of antibodies from a liquid donor film onto paper receivers for application as point-of-care (POC) diagnostic sensors. Paper was chosen as the ideal receiver due to its inherent biocompatibility, wicking properties, wide availability and price, all of which make it an efficient and suitable platform for POC diagnostic sensors. A modified LIFT procedure, referred to as Dynamic Release Layer (DRL-LIFT), has been employed to ensure the viability of the biomolecules post-transfer. The laser used was a KrF excimer operating at 248 nm with a repetition rate of 1 Hz, pulse duration of ~10 ns, and delivering a maximum energy of ~400 mJ per pulse. Both enzyme-tagged and untagged IgG antibodies were LIFT-printed. The functionality and immunological reactivity of the LIFT-printed antibodies was confirmed by developing and demonstrating an Enzyme Linked Immunosorbent Assay and establishing the standard calibration curve for the LIFT-printed pixels. Additionally, it was shown that the localisation of the LIFT-printed pixels and immobilisation of the antibodies, a pre-requisite for paper-based diagnostic devices, was maintained throughout the wet-bench process which further justifies the spatial patterning ability of LIFT. This work demonstrates that LIFT is a technique capable of transferring antibodies onto a paper substrate accurately, reproducibly and with minimal loss of biochemical viability.

add to my program **(close full abstract)**

09:15 **Ag conductive ink printing through LIFT technique**

Authors : C. Florian, F. Caballero-Lucas, J.M. Fernández-Pradas, J.L. Morenza, P. Serra
Affiliations : Departament de Física Aplicada i Òptica, Universitat de Barcelona, Barcelona, Spain Martí i Franquès 1, E-08028.

Resume : Laser induced forward transfer (LIFT) technique has been used to transfer successfully a wide variety of materials. One of its advantages over other printing techniques relies in the possibility to work with different viscosities, allowing the transferring of liquids, pastes and solids with high spatial resolution. Furthermore, it is possible to print continuous lines of material by changing the printing distance between consecutive pixels. The fabrication of electronic organic devices requires the printing of fine conductive lines. In this work, the printing of pixels and lines through LIFT on receptor substrates used in the fabrication of electronic organic devices is presented. The transferred liquids were dispersions of Ag nanoparticles with different concentrations using glycerol and sodium dodecyl sulfate surfactant. An Yb:YKW pulsed laser was used in air environment at room temperature. The laser had a wavelength of 1027 nm and the pulse duration was 450 fs. Morphology characterization of the transferred material was made for wet and dried samples after a heat treatment. Printed single pixels have circular morphology with diameters of 40 μm before and after the drying process. Printed lines present continuity for various overlap values depending on the transferred solution. Ag concentration in the printed features appears homogeneous after drying.

J.V 3

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09:30 **Towards controlled growth of nanostructured Zn1-xCoxS via double-pulse fs-Pulsed Laser Deposition**

Authors : Ignacio Lopez-Quintas 1, Vincen Loriot 1 2, David Ávila-Brande 3, Jesús G. Izquierdo 4, Esther Rebollar 1, Luis Bañares 4, Marta Castillejo 1, Rebeca de Nalda 1, Margarita Martín 1
Affiliations : 1 Instituto de Química Física Rocasolano, CSIC Madrid, Spain; 2 Institut Lumière Matière, UMR5306 Université Lyon 1-CNRS, Villeurbanne, France (present address); 3 Departamento de Química Inorgánica I, Facultad de Ciencias Químicas, UCM, Madrid, Spain; 4 CLUR-Departamento de Química Física I, Facultad de Ciencias Químicas, UCM, Madrid Spain

Resume : Previous studies on the ultrafast laser ablation dynamics of ZnS/Co targets indicate that some degree of control over the plasma composition can be achieved using a double-pulse femtosecond ablation scheme in a pump-probe configuration in the near-infrared region. Different temporal behaviour for different species was found, opening the possibility to control the plasma composition and subsequently serving to tailor the properties of deposits obtained by pulsed laser deposition. In this work, we studied the effect of the delay between pump and probe pulses and their relative energies on the outcome of the deposition process. Deposits from targets containing 2% and 10% of Co obtained at different combinations of delays and relative energies were analyzed. Their thickness, measured in situ by studying changes in the reflectance of the material and ex situ by Atomic Force Microscopy, is found to be much higher for the combination of pump and probe pulses delayed in the

J.V 4

range of 1-300 ps region than for two individual uncoupled pulses. The Co/Zn ratio of the deposits, obtained under the above pump-probe double pulse ablation scheme, was analyzed by Scanning and Transmission Electron Microscopy coupled to Energy Dispersive X-ray Spectroscopy. Possibilities for the controlled synthesis of Zn1-xCoxS materials with this double pulse approach will be discussed.

add to my program (close full abstract)

09:45 **PLD of metallic coatings via a dynamic prism configuration**

Authors : F. Cambronero(1), F. Rey-García(1), C. Bao-Varela(1), L. C. Estepa(2), R. Lahoz(2), L. A. Angurel(2), G. F. de la Fuente(2)
Affiliations : 1. Micro-optics & GRIN Optics UA (USC-CSIC), University of Santiago de Compostela, Spain; 2. ICMA (CSIC-Univ. Zaragoza), Spain.

Resume : Pulsed Laser Deposition provides a useful technique to enhance the durability, strength, hygroscopic, anticorrosive, antibacterial, aesthetic, optical or magnetic properties via surface modification and functionalization of a large number of glass, ceramic, polymeric and metallic materials. PLD processes are carried out in an ample variety of geometrical configurations. This work presents a PLD process based on a dynamic prism system configuration, in which the laser beam of a nanosecond pulsed Nd:YVO4 laser (Powerline E, Rofin) emitting at a wavelength of 1064 nm is scanned and focused through two prisms into a metal target placed inside a vacuum chamber. The second prism is located on a platform that allows the displacement of the laser beam along the target surface. To develop this technique, metal targets of aluminium and brass were irradiated under high vacuum conditions in order to coat commercial glass substrates placed in parallel at a defined distance. The coatings obtained were studied by SEM, Confocal Microscopy and AFM to elucidate their microstructure and surface roughness. In addition, Spectroscopy and electrical transport measurements were performed in order to associate the physical properties of these coatings with their composition and the processing conditions imposed. Work supported by projects MAT2010-18519, DGA-T87, EU LIFE11ENV/ES/000560 CERAMGLASS) and CDTI- 220/01117.

J.V 5

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10:00 **Cofee Break**

Advanced materials prepared by PLD, MAPLE and LIFT (II) : R.Serna

10:30 **Large enhancement in photoluminescence of ZnO grown on strain relaxed nanoporous GaN template by pulsed laser deposition**

Authors : Jie Tang, 1,2 Liyuan Deng, 1 I P Seetoh,1,4 K K Ansah-Antwi, 1 T. Venkatesan,1,2 Soo Jin Chua1,2,3,4
Affiliations : 1. Electrical and Computer Engineering, National University of Singapore, Singapore 117576 2. NUSNNI-Nanocore, National University of Singapore, Singapore 117576 3. Institute of Materials and Research Engineering, Agency for Science, Technology and Research, 3 Research Link, Singapore 117602 4. Singapore-MIT Alliance, National University of Singapore, 4 Engineering Drive 3, Singapore 117576, Singapore

Resume : ZnO possesses the advantages of large bandgap (3.37 eV) and large exciton binding energy (60 meV), high transparency in the visible wavelength range, high conductivity as well as piezoelectric and magnetic properties, enabling its application in multi-functional devices as diverse as solar cells, UV LEDs, nanogenerators, gas sensors, and thin film transistors. To achieve good device performance, it is crucial to obtain high-quality ZnO crystals by growing on lattice-matched substrates. However, ZnO films grown on normal substrates like sapphire or Si experience huge strains. It has been shown that ZnO grown on GaN template, which was formed on sapphire substrate, is a promising way as the lattice mismatch of GaN and ZnO is very small (~1.8 %). It is also possible to obtain heterojuction devices with ZnO grown on GaN template, making it a more attractive approach. However, due to the thermal and lattice mismatch between GaN film and sapphire substrate, the GaN template itself is under stain, which will results in poor crystal quality and higher defects density of ZnO films grown on it. In this work, we have grown ZnO on stain-relaxed nanoporous GaN template and achieved large enhancement in photoluminescence (PL). The porous GaN template was prepared by electrochemical etching in HF and KOH solutions and ZnO film was deposited using pulsed laser deposition (PLD). The ZnO film grown on nanoporous GaN

J.VI 1

exhibits up to 8 fold enhancement in compared to that on planar GaN template. The samples are further examined under Raman, AFM and XRD to investigate the enhancement mechanism. The higher PL intensity of ZnO on nanoporous GaN is attributed to improved material quality with reduction in dislocation and relaxation of compressive stress, which is evidenced by redshift of E2 phonon peak of ZnO on porous GaN with respect to that on planar GaN. The demonstrated high quality ZnO grown on nanoporous GaN template will benefit ZnO related optoelectronic devices.

add to my program (close full abstract)

10:45 **Pure and Rare-Earth Doped Gallium Lanthanum Sulphide Amorphous Thin Films Grown by Pulsed Laser Deposition in Various Temporal Regimes**

Authors : G. Dascalu1, O. G. Pompilian2, I. Mihaila1, S. Gurlui1, P. Hawlova3, P. Nemec3, V. Nazabal4, C. Focsa2

Affiliations : 1) Faculty of Physics, University "Alexandru Ioan Cuza", 700506 Iasi, Romania 2) Laboratoire de Physique des Lasers, Atomes et Molécules, Université Lille 1, 59655 Villeneuve d'Ascq cedex, France 3) Faculty of Chemical Technology, University of Pardubice, Studentska 573, 53210 Pardubice, Czech Republic 4) Institut des Sciences Chimiques de Rennes, Université de Rennes 1, Campus de Beaulieu, 35042 Rennes cedex, France

Resume : Amorphous chalcogenide thin films are of high current interest for technological applications as optical storage media or waveguides for photonic integrated circuits. During the last decades, the Pulsed Laser Deposition (PLD) technique has become a method of choice in producing such films in laboratory. Using bulk targets of pure and rare-earth (Er, Pr) doped Gallium Lanthanum Sulphide (GLS) we have deposited chalcogenide thin films on Si and SiO2 substrates in a vacuum chamber using nanosecond, picosecond and femtosecond ablation. Several tens of samples have been deposited in different conditions, in order to study the influence of various parameters, as laser wavelength and pulse width, fluence, target – substrate distance, background pressure etc. The produced samples have been characterized by contact profilometry, Raman spectroscopy, time-of-flight secondary ion mass spectrometry (TOF-SIMS), variable-angle spectroscopic ellipsometry (VASE), optical transmission, X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX). We will present the main conclusions of this systematic study, with special focus on some peculiar effects observed in the morphology, structure, composition and optical properties of the deposited thin films.

J.VI 2

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11:00 **Growth of tailored oxide heterostructures by pulsed laser deposition and studies of their electronic structure and electrical transport characteristics**

Authors : Pramod Kumar, P.P.S. Bhadauria, Anurag Gupta, Prabir Pal, Ajay Shukla, Anjana Dogra and R. C. Budhani

Affiliations : CSIR, National Physical Laboratory, Dr. K.S. Krishnan Marg, New Delhi-100012

Resume : With the advancements in thin film growth technology, it is possible to make epitaxial film of tailored heterostructures with in-situ diagnostic tool such as reflection high energy electron diffraction (RHEED). Molecular beam epitaxy (MBE) and pulsed laser deposition (PLD) are most widely used techniques to fabricate smooth, stoichiometric and epitaxial thin films of various compounds. In the present work, we report the fabrication of 6 and 20 unit cell (uc) thick films of various composition of LaAl1-xCrxO3 (x = 0, 0.2, 0.4, 0.6, 0.8, 1.0) on TiO2 terminated SrTiO3 single crystal substrate by using PLD. The unit cell growth of these samples has been monitored by in-situ RHEED. We observe clean oscillations in RHEED intensity as a function of growth which not only confirms the perfect layer by layer growth of films but also compliments the smooth and two dimensional growth. The electrical transport of these samples measured down to 2K shows enhancement in sheet resistance and suppression in sheet electron density with the increase in Cr content. The enhancement of the sheet resistance is attributed to the suppression of polar catastrophe with addition of Cr. Electronic structure of interface in (6 uc) LaAl1-xCrxO3/SrTiO3 samples has been studied using X-ray photoemission spectroscopy (XPS) and ultraviolet photoemission spectroscopy (UPS). The XPS and UPS valence band (VB) shows that the in-gap spectral weight (distributed around 1 eV below Fermi level) decreases with increasing Cr concentration and disappears for highest Cr content. Such tailoring of conducting interface with correlated metal like Cr may pave the way for understanding of the electronic phenomena seen in such interfaces.

J.VI 3

add to my program (close full abstract)

11:15 **Pulsed laser deposition of novel CBN (CaxBa1-xNb2O6) thin films for high performance electro-optic devices**

Authors : S. Vigne, N. Hossain, F. Fesharaki, K. Wu, J. Margot, M. Chaker
Affiliations : INRS-EMT, 1650 Boulevard Lionel Boulet, Varennes, QC J3X 1S2, Canada ; INRS-EMT, 1650 Boulevard Lionel Boulet, Varennes, QC J3X 1S2, Canada ; Poly-Grames Research Center, Ecole Polytechnique de Montreal, QC H3T 1J4, Canada ; Departement de Physique, Universite de Montreal, C.P.6128, Succ. Centre-ville, QC H3C 3J7, Canada ; INRS-EMT, 1650 Boulevard Lionel Boulet, Varennes, QC J3X 1S2, Canada

Resume : Pulsed Laser Deposition (PLD) is a reliable technique to grow very high quality epitaxial thin films on appropriate substrates due to PLD's ability to retain the target's stoichiometry and relative easiness. We successfully used PLD to grow high quality novel calcium barium niobate, CBN (CaxBa1-xNb2O6) epitaxial thin films on various substrates. The unique electro-optic (EO) properties (EO coefficient of 130pm/V) and high Curie temperature (above 250° C) of CBN have made it an excellent candidate to develop integrated electro-optic devices with outstanding performance. Growth on Magnesium oxide (MgO), Platinum coated MgO and silicon substrates is shown and opens the way towards the deep study of this new material's properties and optimization for the development of high performance electro-optic devices. In this work, we show the optimization of growth conditions of CBN thin films on MgO, Pt-coated MgO and Si substrates. High crystallinity and promising material quality is shown for all the CBN thin films grown under optimized conditions. The dielectric and optical properties of CBN are studied in the context of reaching to an electro-optic device. The patterning of CBN is investigated towards the large scale integration of high performance CBN EO devices on a single chip. Finally, a CBN waveguide was fabricated (as a building block of EO device) and promising EO material properties are demonstrated towards the development of high performance novel CBN based EO devices.

J.VI 4

add to my program (close full abstract)

11:30 **Potassium niobates thin films synthesized by pulsed laser deposition: relationships between deposition conditions, morphologies and structure**

Authors : A. Waroquet, V. Demange, S. Députier, M. Guilloux-Viry
Affiliations : Institut des Sciences Chimiques de Rennes – UMR 6226 Campus scientifique de Beaulieu 263, Avenue du Général Leclerc 35042 Rennes Cedex, France

Resume : In recent years, potassium niobates have been studied because of their interesting electronic, optical and photocatalysis properties[1-3]. Present research is focused on thin films of the K-Nb-O system on (100) oriented strontium titanate substrate synthesized by pulsed laser deposition. Depending on the composition of the target, pseudo-cubic KNbO3, orthorhombic K4Nb6O17 and K4Nb6O17.3H2O, tetragonal tungsten bronze (TTB) K6Nb10.88O30, triclinic K3Nb7O19 and orthorhombic KNb3O8 phases have been successfully grown as either single or multi-phased samples. X-ray diffraction analysis revealed that all the phases, excepted K3Nb7O19, present an epitaxial growth. Scanning electron microscopy showed that the films are made of small crystals and that the morphologies of these last ones reflect their crystalline structure: cubes for the pseudo-cubic phase, plates for the orthorhombic phases and rods for the tetragonal one. Epitaxy relationships will be presented in connection with the morphology of the crystals constitutive of the films. A study of the influence of the annealing temperature has revealed a temperature dependence of the growth of the TTB phase. First results of the luminescence and photocatalysis properties of the potassium niobates single-phased thin films will be presented. [1] B.T. Matthias and J.P Remeika, Phys. Rev., 1951. 82, p. 727-729. [2] G. Zhang et al., J. Alloys Compd., 2006. 425, p. 76-80. [3] G. Zhang et al., Chem. Eng. J., 2006. 123, p. 59-64.

J.VI 5

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11:45 **Synthesis of lead –free (Ba1−xCax)(ZryTi1−y)O3 thin films by laser ablation and their functional properties**

Authors : N. D. Scarisoreanu1, A. Andrei1, V. Ion1, R. Birjega1, L.Nedelcu2, A. Moldovan2, F. Craciun3 and M. Dinescu1
Affiliations : 1. NILPRP, P.O. Box MG-16, RO-77125, Bucharest, Romania, 2 .NIMP-National Institute of Materials Physics, 077125 Bucharest-Magurele, Romania, 3. CNR-Istituto dei Sistemi Complessi, Area della Ricerca Roma-Tor Vergata, Via del Fosso del Cavaliere 100, I-00133, Rome, Italy

J.VI 6

Resume : Having the goal to replace lead-based materials in different electronic devices, recent studies have demonstrated the possibility to obtain lead-free (Ba1−xCax)(ZryTi1−y)O3 (BCZT) ferroelectric bulk materials with very high dielectric permittivity, piezoelectric coefficients and electromechanical strain. Depending on the amount of A-site (Ca2+) and B-site (Ti4+) isovalent

substitutions, different properties can be obtained, ranging from normal ferroelectrics up to relaxor ferroelectrics. In this study was reported the growth by pulsed laser deposition (PLD) and by pulsed laser deposition assisted by radiofrequency discharge (PLD-RF) of BCZT thin films with different compositions around MPB. Pure perovskite structures have been obtained. The films deposited on Pt/Si substrates are polycrystalline and show (110) and (111) orientation, while films deposited on (100) Nb:SrTiO3 are epitaxial. The piezoelectric properties have been measured by piezoresponse force microscopy. Using spectro-ellipsometry (SE) technique, a high refractive index and low extinction coefficient for a large spectrum of wavelength (n>2 and k<10-4 for near UV-VIS-near IR) was found. Dielectric measurements carried out at different temperature and frequency values evidenced the phase transitions. Excellent dielectric properties (relative permittivity of about 2000 and tangent loss ~ 3%) have been measured at room temperature.

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12:00 **Lunch**

Pulsed laser depositon: materials and processes : C. Focsa

14:00 **Ag and Sb doped thin films of thermoelectric PbTe material deposited by multi-target ArF PLD**

Authors : E. Cappelli1*, A. Bellucci1, L. Medici2, A. Mezzi3 , S. Kaciulis3 and D.M. Trucchi1
Affiliations : 1CNR-IMIP, Montelibretti, via Salaria Km 29.3, P.O.B. 10, 00016 Rome, Italy. 2CNR-IMAA, 85050 Tito Scalo, Potenza, Italy. 3CNR-ISMN, Montelibretti, via Salaria Km 29.3, P.O.B. 10, 00016 Rome

Resume : It has been evaluated the ability of a deposition system, consisting of pulsed ArF laser ablation from rotating targets, to grow thin films of PbTe high temperature thermoelectric material, and to obtain a uniform and controlled Ag and Sb doping, through the entire thickness of the film, using a multi-target system in vacuum. The substrate used was technical alumina. The substrate temperature effect on various structural parameters and the physical-chemical and electronic properties was evaluated in the range RT-400 ° C. The stoichiometry and the distribution of the dopants, over the whole thickness of the samples deposited, have been studied by XPS (X-ray photoelectron spectroscopy) and corresponding depth profiles. The structure of the film was analysed by grazing incidence X ray diffraction (GI-XRD) . The Scherrer analysis for dimensions of crystallites shows the presence of nano-structures, to be of the order of 30-35 nm. Electrical resistivity of the samples, has been studied by the four point probe method. From conductivity values and Seebeck parameter determination, the power factors of deposited films was calculated. All data obtained resulted to be of magnitude comparable with the values obtained on the corresponding bulk materials .

J.VII 1

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14:15 **Pulsed Laser Deposition of monocristalline copper films on MgO (111) substrates.**

Authors : F. Aweke (1), J. Hulik (1), F. le Normand (1), F. Antoni (1), C. Speisser (1), D. Muller (1), G. Morvan (2)
Affiliations : (1) ICube-Laboratoire des Sciences de l'Ingénieur, de l'Informatique et de l'Imagerie, Université de Strasbourg-CNRS, 23, rue du Loess, 67037 STRASBOURG Cedex, France (2) LHyGeS-Laboratoire d'Hydrologie et de Géochimie de Strasbourg, UMR7517 CNRS/EOST/UdS, 1, rueBlessig 67084 STRASBOURG Cedex, France. (*) Presenting author

Resume : Pulse Laser Deposition of Cu (111) films on MgO(111) transparent substrates is achieved at low temperatures (100-150°C). An excimer ArF (193 nm) pulsed (20 ns) laser beam is focused to a pure copper target under vacuum (10-7 mbar) with a fluence of 10 J/cm². These thin layers are prepared for growth of graphene at low temperatures by carbon implantation into copper followed by annealing. Therefore four requirements must be fulfilled for these films: 1) high crystallinity to get uniform carbon segregation; 2) low thickness to perform low energy carbon implantation and 3) low temperature and 4) large scale synthesis. XRD, electron diffraction (EBSD), channeling Rutherford backscattering, SEM, AFM, XPS are used to study the growth and structure of the copper films. Nucleation of dense oriented copper nuclei are obtained followed by rapid coalescence to form epitaxial Cu(111)/MgO(111) films. We

J.VII 2

have studied growth parameters like the temperature, the laser fluence, the working pressure in order to reduce the thickness of the Cu(111) films below 300 nm and to avoid the formation of twin boundaries. Results concerning the carbon implantation into these films and the thermal annealing will be also presented.

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14:30 **Laser synthesis of nanometric iron oxide films for thermo sensors and thermo converters**

Authors : 1 S.A.Mulenko, 1 E.V.Moroz, 2 N.T.Gorbachuk, 3 N.Stefan, I.N.Mihailesku
Affiliations : 1 Institute for Metal Physics NAS of Ukraine, 36, Academician Vernadsky Blvd, UA-03142, Kiev-142, Ukraine 2 Kiev State University of Technology and Design, UA-03011, Kiev-11, Ukraine 3 National Institute for Laser, Plasma and Radiation Physics, PO Box MG-54, RO-77125, Magurele, Romania

Resume : Ultraviolet photons of KrF-laser (248 nm) were used for the synthesis by reactive pulsed laser deposition (RPLD) of nanometric iron oxide films with variable thickness, stoichiometry and electrical properties. Film deposition was carried out on <100>Si and SO2 substrate at 293-800 K. XRD analysis showed that films deposited on Si substrate were polycrystalline, while films deposited on SiO2 were amorphous. Films demonstrated semiconductor temperature behaviour with variable band gap Eg (Eg less than 1.0 eV) depending on oxygen pressure, the number of laser pulses, substrate nature and its temperature. Film thickness (13-60 nm) depended on oxygen pressure, substrate temperature and the number of laser pulses. The higher oxygen pressure, the lower crystallinity of the deposited film was observed resulted in decreasing of thermo electromotive force coefficient (S). The higher substrate temperature (Ts), the more crystallinity of the deposited films resulted in increasing the S coefficient. It was found the optimum oxygen pressure and substrate temperature when the S coefficient was high as 3-8 mV/K in the range 280-330 K . The fiigure of merit was ZT=1-6 in the range 280-330 K. So nanometric iron oxide films synthesized by UV photons using RPLD method are up-to-date materials for effective thermo sensors and thermo converters operating at moderate temperature.

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14:45 **PLD growth of KNN nanorods**

Authors : R. Ayouchi1, M. Leal1, A. Kholkin2, R. Schwarz1
Affiliations : 1 Department of Physics and ICEMS, Instituto Superior Técnico, P-1049-001 Lisbon, Portugal 2 DECV & CICECO, University of Aveiro, P-3810-193 Aveiro, Portugal

Resume : Recently, low dimensional piezo- and ferroelectric nanomaterials have attracted much attention because of their potential application in nanodevices such as nanosensors and actuators, nanogenerators and nanopiezotronics. Among them, Potassium Sodium Niobate (KNN) ceramics have received increasing attention because of their good piezoelectric and ferroelectric properties. KNN is made from volatile alkali metal compounds, which require carefully controlled manufacturing conditions and low reaction temperatures. In this study, KNN nanorods were prepared by PLD on sapphire and platinized silicon substrates at relatively low deposition temperature. Sintered targets with nominal composition of Na0.5K0.5NbO3 were ablated in 0.2 mbar oxygen atmosphere by the ultraviolet line of a Nd:YAG laser system (λ=266 nm, pulse duration of 5 ns, repetition rate of 10 Hz, and energy density of 0.1 J/cm2). The deposition temperature was varied between 400 and 600 ºC. The films were then analyzed by Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), optical transmittance and reflectance spectroscopy, capacitance-voltage characteristics and Piezo-electric Force Microscopy (PFM). SEM micrographs and XRD measurements showed that well crystallysed KNN rods could be obtained at 550ºC with good structural, dielectric, and ferroelectric properties. The measured dielectric constant was 300 and the remanent polarization and coercive field values were 7 kV/cm and 24 kV/cm, respectively. The nanoscale piezoelectric data obtained with piezoresponse force microscopy provide a direct evidence of strong piezoelectricity in as-prepared KNN rods.

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add to my program (close full abstract)

15:00 **Pulsed Laser Deposition of Ge-Sb-Se glasses: A plasma plume dynamics study**

Authors : R. Boidin, S. Gurlui, G. Dascalu, P. Nemec, V. Nazabal, C. Focsa
Affiliations : Department of Graphic Arts and Photophysics, Faculty of Chemical Technology, University of Pardubice, Studenská 573, 53210 Pardubice, Czech Republic; Alexandru Ioan Cuza" University, Faculty of Physics, 700506 Iasi, Romania; Alexandru Ioan Cuza" University, Faculty of Physics, 700506 Iasi, Romania; Department of Graphic

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Arts and Photophysics, Faculty of Chemical Technology, University of Pardubice, Studenská 573, 53210 Pardubice, Czech Republic; Institut des sciences chimiques de Rennes, UMR CNRS 6226, Equipe Verres et Céramiques, Université de Rennes1, 35042 Rennes, France; Laboratoire de Physique des Lasers, Atomes et Molécules (UMR CNRS 8523), Université Lille 1 Sciences & Technologies, 59655 Villeneuve d'Ascq, France

Resume : Pulsed laser deposition is a promising method for amorphous chalcogenide thin films deposition. This technique, relatively simple, offers the possibility to obtain stoichiometric transfer of target material to the substrate and to fabricate films of unusual compositions. To optimize the deposition parameters of Ge-Sb-Se amorphous thin films, knowledge of the plasma plume dynamics formed during laser ablation is necessary. In this work, plume dynamics is characterized by ICCD camera fast imaging and space- and time-resolved optical emission spectroscopy using the second harmonic (532 nm) of a Nd:YAG laser. From the space-time evolution of the optical emission spectra, axial velocities of various species (including neutrals and ions) have been derived. Using the relative intensity method, the space- and time-evolution of both, excitation temperature and electronic density, have been determined. Finally, behavior of the laser ablation plasma is discussed. Acknowledgement Czech Science Foundation (Project No. 13-05082S), Ministry of Education, Youth, and Sports of the Czech Republic (Project CZ.1.07/2.3.00/30.0058 "Development of Research Teams at the University of Pardubice" and 7AMB13FR039) and the CNRS PICS (Projet International de Cooperation Scientifique) program financially supported this work.

15:15 **Angular distribution of species in pulsed laser deposition of LaxCa1-xMnO3**

Authors : A. Ojeda, C. W. Schneider, M. Döbeli, T. Lippert, A. Wokaun
Affiliations : Paul Scherrer Institute: A. Ojeda, C. W. Schneider, T. Lippert, A. Wokaun; Laboratory of Ion Beam Physics, ETH Zürich: M. Döbeli;

Resume : Pulsed laser deposition (PLD) is a very flexible physical deposition technique for thin film deposition. Although most of the time it is assumed that a congruent material transfer from the target to the substrate takes place, numerous publications report otherwise. Non-uniform angular distributions of species in the ablation plume are identified as one of the main sources for non-stoichiometric transfer. In this paper an investigation of the angular distribution of species in the laser generated plasma of a LaxCa1-xMnO3 target is carried out by analyzing the composition of the deposited films using Rutherford Backscattering Spectrometry measurements (RBS). The film-thickness-angular distribution is also analyzed using profilometry. For the deposition, two different substrate configurations/holders are used: one carries long substrates normal to the main expansion direction of the induced plasma plume and the second consists of a semi-spherical holder with multiple substrates (10x10mm) positioned to cover the semi-sphere. In both cases Si substrates are used. Details of these measurements will be reported.

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15:30 Coffee Break

Poster Sesion J: Fundamentals of laser-mater interaction. Ultrafast phenomena. Biological applications : R. Cristescu, S. Guizard, I. Zergioti & F. Costache

16:00 **Structural phenomena in multicomponent silicate glasses after femtosecond laser pulse irradiation**

Authors : Thomas Seuthe1, Moritz Grehn2, Alexandre Mermillod-Blondin3, Jörn Bonse4 and Markus Eberstein1
Affiliations : 1 Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Winterbergstraße 28, 01277 Dresden, Germany; 2 Technische Universität Berlin, Department of Optics and Atomic Physics, Straße des 17. Juni 135, 10623 Berlin, Germany; 3 Max-Born-Institute for Nonlinear Optics and Short Pulse Spectroscopy, Max-Born-Straße 2a, 12489 Berlin, Germany; 4 BAM Federal Institute for Materials Research and Testing, Unter den Eichen 87, 12205 Berlin, Germany

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Resume : Structural changes of various silicate glasses due to femtosecond laser irradiation have been investigated. For that, simple model glasses composed of systematically varying alkaline- and earth-alkaline components (in detail: Li2O, Na2O, K2O, MgO and CaO) and multicomponent glasses containing Al2O3 and B2O3 were prepared. The glass samples were irradiated at the surface and in the volume with fs laser pulses having different energies (~100

fs, 800 nm). Subsequently, the glasses were investigated by means of micro-Raman spectroscopy and optical methods for alterations in the glass structure and quantitative optical refractive index changes. Within the laser-irradiated surface areas no variation in the average Q-structure distribution was found, but local changes of bond-angles and bond-length of the silica network. Glasses with a low amount of network modifiers show alterations in the Si-O network while glasses with a high amount of network modifiers react primarily via modifications of the non-bridging oxygen environment. Additionally, the reactions of those structural modifications to a subsequent temperature treatment have been observed in annealing experiments at various temperatures below and above the glass transition temperature. The residual refractive index changes were quantified in a phase contrast microscope setup. The results are discussed in terms of possible laser-induced modification mechanisms in silicate glasses and conclusions are drawn regarding the compositional suitability for technical applications.

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16:00 **Al-doped ZnO thin films grown by pulsed laser using a series of high quality ceramic targets**

Authors : Adel Taabouche1, 2,*, Abderrahmane Bouabellou1, Fouad Kermiche1, Faouzi Hanini1, Yacine Bouachiba1 and Azzeddine Grid2, Chawki Benazzouz3
Affiliations : 1 Thin Films and Interfaces Laboratory, University of Constantine1, Constantine, Algeria 2 Welding and NDT Research Centre (CSC). BP 64 CHERAGA – ALGERTA 3 Center CRNA, 2 Bd Franz Fanon, Algiers, Algeria

Resume : Undoped and Al-doped ZnO (AZO) polycrystalline piezoelectric thin films (Al: 3, 5at.%) using a series of high quality ceramic targets have been deposited at 450ºC onto glass substrates using pulsed laser deposition method. The used source was a KrF excimer laser (248 nm, 25 ns, 2 J/cm2). The study of the obtained undoped and Al-doped ZnO thin films has been accomplished using X-ray diffraction (XRD), M-lines spectroscopy and Rutherford back scattering (RBS) techniques. X-ray diffraction patterns showed that the Al-doped ZnO films crystallize in a hexagonal wurtzite type structure with a strong (002) orientation, highly c-axis preferred orientation, which is critical for piezoelectric applications (ultrasonic oscillators and transducers devices), and the grain sizes calculated from these patterns decrease from 37 to 25 nm by increasing Al doping. The optical waveguiding properties of the films were characterized by using prism-coupling method. The distinct M-lines of the guided transverse magnetic (TM) and transverse electric (TE) modes of the ZnO films waveguide have been observed. In the aim to study the optical properties of the ZnO films, an accurate refractive index and thickness measurement apparatus was set up, which is called M-lines device. An evaluation of experimental uncertainty and calculation of the precision of the refractive index and thickness were developed on ZnO films.

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16:00 **Fabrication of biodegradable polycaprolactone -polyethylene glycol composite coatings by Matrix Assisted Pulsed Laser Evaporation and Dip Coatings**

Authors : A. Visan1, M. Miroiu1, N. Stefan1, C. Nita1, G. Dorcioman1, I. Zgura2, O.L. Rasoaga2, C.S. Breazu2, A. Stanculescu2, R. Cristescu1, G. Socol1, I.N. Mihailescu1
Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics, Magurele, Ilfov, Romania 2 National Institute of Materials Physics, Magurele, Ilfov, Romania

Resume : We report on the deposition of polycaprolactone (PCL)-polyethylene glycol (PEG) composite coatings on titanium and <100> double side polished silicon substrates by both matrix assisted pulsed laser evaporation (MAPLE) and dip coating (DC) techniques using chloroform as a matrix solvent. PCL is known for its excellent tensile properties, flexibility and biodegradability, but a slow degradation rate. Therefore, PCL has been blended with the more soluble PEG in order to obtain biodegradable polymeric composite coatings. PEG and PCL were mixed in 1:3, 1:1 and 3:1 ratios. In order to find the optimal MAPLE deposition parameters, we conducted a study of laser fluence (0.2 - 0.5 J/cm2). On the other hand, in the case of DC method, we varied the withdrawal velocity to analyze the variation of the thickness and the uniformity of the thin films. FTIR spectra showed that the films are stoichiometric with no polymer decomposition. For composite coatings, PEG-PCL diffraction peaks have indicated that both polymers can crystallize when they are mixed. Surface morphology of composite coatings depends on the chemical composition, polymeric mixture ratio and deposition method while the wettability studies proved that the composite coatings exhibit highly hydrophilic surfaces. As such, the fabricated biodegradable PEG-PCL composite coatings can constitute a versatile biomaterial for tissue engineering applications.

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16:00 **Matrix Assisted Pulsed Laser Evaporation synthesis of biomimetic nanocrystalline apatite coatings for biomedical applications**

Authors : A. Visan1, D. Grossin2, N. Stefan1, L. Duta1, F.M. Miroiu1, G.E. Stan3, M. Sopronyi1, C. Luculescu1, M. Freche2, O. Marsan2, C. Charvilat2, S. Ciuca4, I.N. Mihailescu1

Affiliations : 1National Institute for Lasers, Plasma, and Radiation Physics, RO-77125, Magurele-Ilfov, Romania 2CIRIMAT - Carnot Institute, University of Toulouse, ENSIACET, 4 allée Emile Monso, 31030 Toulouse Cedex 4, France 3Politehnica University of Bucharest, Faculty of Materials Science and Engineering, Bucharest, Romania

Resume : We report on the deposition by Matrix Assisted Pulsed Laser Evaporation technique of biomimetic nanocrystalline apatite coatings on titanium substrates. The targets were prepared from metastable, poorly crystalline apatite powders, synthesized by a biomimetic approach. For the deposition of thin films, a KrF* excimer laser source was used . The analyses revealed the existence, in synthesized powders, of labile non-apatitic mineral ions, which form a hydrated layer at the surface of the nanocrystals. The thin film investigations showed that the structural and chemical nature of the nanocrystalline apatite was prevalently preserved. The perpetuation of the non-apatitic environments was confirmed. Our study demonstrated that MAPLE is a suitable technique for the congruent transfer of a delicate material, such as the biomimetic hydrated nanohydroxyapatite

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add to my program (close full abstract)

16:00 **Ultra-short pulsed laser ablation and deposition of magnesium diboride thin films**

Authors : A. De Bonis1, A. Santagata2, M. Sansone1, A. Galasso1, R. Teghil1

Affiliations : 1 Dipartimento di Scienze, Università della Basilicata, Viale dell'Ateneo Lucano 10, 85100 Potenza, Italy 2 CNR-ISM UOS Tito, C.da S. Loja, Zona Industriale, 85050 Tito Scalo (PZ), Italy

Resume : Metal borides films, which show peculiar characteristics at nanoscale level, are currently used in a large number of applications, in particular as corrosion resistant coatings and thermal and diffusion barriers [1]. Among metal diborides, magnesium diboride has risen great interest due to its superconductivity at about 40 K [2]. In fact, since MgB2 is the non-oxide material with the highest transition temperature, the deposits of this material in the form of thin films can be very important for many electronic applications. In this work a MgB2 target has been ablated by a Nd:glass laser with a pulse duration of 250 fs. The plasma produced by the laser-target interaction has been characterized by time and space resolved Optical Emission Spectroscopy and ICCD fast imaging. The films, deposited on silicon and SrTiO3 substrates, have been analyzed by Scanning Electron Microscopy, X-Ray Photoelectron Spectroscopy, micro-Raman Spectroscopy and X-Ray diffraction. The first steps of the films growth have been studied by Transmission Electron Microscopy. [1] S. Carenco, D. Portehault, C. Boissière, N. Mézailles, C. Sanchez, Chem. Rev., 113,7981–8065, 2013. [2] J. Nagamatsu, N. Nakagawa, T. Muranaka, Y. Zenitani, J. Akimitsu, Nature 410, 63-64, 2001.

JP.VIII 6

add to my program (close full abstract)

16:00 **Nanosecond and femtosecond laser irradiation for graphene related nanomaterials production**

Authors : Paola Russo1, Simon Federico Span?1, Anming Hu2, Giuseppe Compagnini1

Affiliations : 1Chemistry Department, University of Catania, Catania, Italy; 2Department of Mechanical, Aerospace and Biomedical Engineering, University of Tennessee, Knoxville, 509 Doughty Engineering Building, 1512 Middle Drive, Knoxville, TN 37996, USA

Resume : Graphene and graphene based nanomaterials are attracting the interest of many researchers for their outstanding properties, which make them suitable for several applications in photovoltaics, nanoelectronics and biology. Recently, researchers are focusing their attention on reduced graphene oxide (r-GO), porous graphene (PG) and graphene quantum dots (GQDs). These new materials may have applications in water treatment, gas separation and photovoltaics. According to the literature, the most employed production methods of these materials, are expensive, time consuming and far to be environmental friendly. Here, we present a novel and green approach for the synthesis of r-GO, PG and GQDs employing pulsed lasers. In particular, we found that nanosecond irradiation of GO solutions permits to obtain r-GO sheets with different degree of reduction, while the femtosecond laser ablation of graphite leads to the synthesis of PG and GQDs. The fluence regime plays a key role in the formation of PG and GQDs. Water breakdown, induced by the laser

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irradiation and coal gasification have been considered as possible mechanisms responsible for the formation of both these species. The successful synthesis of r-GO, PG and GQDs was confirmed by several characterization analyses. We also investigated the properties of r-GO for the photocatalytic degradation of the dye molecule, methylene blue, from water.

add to my program (close full abstract)

16:00 **Comparative study on the deposition of polymeric coatings based on PCL/PLGA blends**

Authors : G. Popescu-Pelin1, E. Axente1, F. Sima1, I. Iordache1, C. Nita1, A. Visan1, I. Zgura2, O.L. Rasoaga2, C.S. Breazu2, A. Stanculescu2, G. Socol1, I.N. Mihailescu1
Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics, Magurele, Ilfov, Romania 2 National Institute of Materials Physics, Magurele, Ilfov, Romania

Resume : The treatment of bone defects remains the major challenge of reconstructive surgery. In order to repair the defects caused by tumors or other disease, one can improve the properties of implants surface by adding organic or inorganic materials (polymers, bioglass). Simple and mixtures of poly(ε-caprolactone) (PCL) and poly(lactic acid-co-glycolic acid) (PLGA) in different ratios (1:3, 1:1, 3:1) have been deposited by matrix assisted pulsed laser evaporation (MAPLE) and dip-coating to produce thin films on titanium, glass and silicon substrates. We identify the optimum deposition conditions with respect to the structural, morphological, and wettability properties of films. In the case of MAPLE technique, PCL/PLGA composite films were deposited at different laser fluences, in the range (300-500)mJ/cm2, while the withdrawal speed was varied for dip-coating. Fourier transform infrared (FTIR) spectrometry evidenced that the chemical composition of coatings deposited by the two methods was preserved whereas the X-ray diffraction (XRD) studies revealed the presence of diffraction peaks of PCL only. SEM investigations exhibited a dependence of surface morphology on the chemical composition, polymeric mixture ratio and deposition method. Depending on the polymeric mixture ratio and deposition method, wettability tests performed on the polymeric coatings showed a either hydrophobic or hydrophilic behaviour.

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add to my program (close full abstract)

16:00 **Deposition and characterization of polyethylene glycol/poly(3-hydroxybutyrate -co-3-hydroxyvalerate) blends**

Authors : M. Sopronyi1, C. Nita1, V. Grumezescu1, O.L. Rasoga2, N. Stefan1, C.S. Breazu2, M. Socol4, I. Zgura2, A. Visan1, G. Popescu-Pelin1, A. Stanculescu2, I.N. Mihailescu1, G. Socol1
Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics, Magurele, Ilfov, Romania 2 National Institute of Materials Physics, Magurele, Ilfov, Romania

Resume : The latest research and advances in bio-nanotechnologies allows us to combine many of the available biocompatible polymers for tissue engineering applications. In this study, polyethylene glycol (PEG)/Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) composite coatings were deposited on grade 4 CP titanium and silicon substrates by Matrix Assisted Pulsed Laser Evaporation (MAPLE) and dip-coating (DC) techniques. These two polymers were chosen for their biocompatible properties, but also for their solubility or degradation properties. Three polymeric weight ratios were considered for thin films depositions (1:1, 1:3, 3:1). PEG/PHBV composite films were deposited by MAPLE at different laser fluences, in the range (300-500)mJ/cm2, while for dip-coating the withdrawal speed was varied between 60-100mm/min. Fourier transform infrared (FTIR) spectra evidenced the preservation of chemical composition for both deposition methods whereas the X-ray diffractograms recorded on the composite films revealed the presence of diffraction peaks typical for PEG and PHBV polymers. SEM images showed a dependence of surface morphology on the chemical composition, polymeric mixture ratio and deposition method. Also, the surface wettability investigations showed different hydrophilic behavior, depending on the polymeric mixture ratio and deposition conditions.

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add to my program (close full abstract)

16:00 **Modeling of laser annealing SiOx films**

Authors : Gavrylyuk O.O., Semchuk O.Yu
Affiliations : Phd student; Dr.Sci

Resume : To simulate the temperature profile in the corresponding film used the following laser parameters: pulse duration 10 ns, the intensity of the laser beam is varied in the range of 14-52 MW/cm2. The distribution of the temperature field in the film during its heated single laser beam described nonstationary heat equation, which is solved the numerical by finite element method. During the laser pulse of 10 ns with intensity of 52 MW/cm2 the

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temperature up to 1800 K can be reached on the sample surface. The temperature at the surface grows for some time after the laser pulse (t = 10 ns) finished. Further cooling of the film is due to the flow of heat from the film surface, and also due to heat transfer in the silicon substrate. After 30 ns from the beginning of irradiation the annealing temperature on the surface of the film is stabilized. The stabilized temperature depends on the laser intensity: the higher intensities, the higher temperature. The temperatures of the sample at higher intensities of laser irradiation are enough to stimulate the phase transition of SiOx film into nanocomposite SiO2(Si) film with Si nanocrystals.

add to my program (close full abstract)

16:00 **A study on the crystallization of thick a-Si layer as hard mask using pulsed laser annealing**

Authors : Seonkyeng Sim, Jinho Oh, and Hyunchul Sohn
Affiliations : Department of Materials Science & Engineering, Yonsei University, Seoul 120-749, Korea

Resume : As the semiconductor device density has been continuously increased by scaling down the device dimensions, it is difficult to fabricate the patterning with the nano-scale spacing and width using the conventional ArF immersion lithography process. The method which is capable of deceasing the pattern spacing and width below 40nm is double patterning lithography. When the double patterning technology is used, the a-Si film is utilized as the hard mask. As device is scaling down, the thickness of a-Si as the hard mask layer is continuously increasing. And the misalignment could be caused by low transmittance of the thick a-Si layer as hard mask. To eliminate misalignment problem, the laser-induced crystallization method for the formation of transparent poly-Si on align-key in the thick a-Si layer was proposed. In our study, laser crystallized poly-Si films were formed by the second harmonics (532nm wavelength) generated by pulsed Nd:YAG laser in the laser energy density range between 0.603 and 1.667 J cm-2. The effect of laser energy on the 1um-thick a-Si layer was investigated by using finite element heat transfer analysis and Raman spectroscopy. The thermal profile and the transient temperature field during heating of the thick a-Si layer by Nd:YAG laser irradiation were studied. Raman spectra showed the a-Si film crystallinity with variable laser energy.

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add to my program (close full abstract)

16:00 **Nonlinear refractive index in Ge-Sb-Se glasses: Comparison between experiment and simulations at telecom wavelength**

Authors : R. Boidin, J.C. Tchahame, P. Němec, M. Chauvet, G. Renversez, E. Baudet, V. Nazabal
Affiliations : Department of Graphic Arts and Photophysics, Faculty of Chemical Technology, University of Pardubice, Studenská 573, 53210 Pardubice, Czech Republic; FEMTO-ST, UMR 6174, Université de Franche Comté, 16, route de Gray, 25000 Besançon, France; Department of Graphic Arts and Photophysics, Faculty of Chemical Technology, University of Pardubice, Studenská 573, 53210 Pardubice, Czech Republic; FEMTO-ST, UMR 6174, Université de Franche Comté, 16, route de Gray, 25000 Besançon, France; Institut Fresnel, CNRS UMR 7249, Université d'Aix Marseille, Campus de Saint Jérôme, 13013 Marseille, France; Institut des sciences chimiques de Rennes, UMR CNRS 6226, Equipe Verres et Céramiques, Université de Rennes1, 35042 Rennes, France; Institut des sciences chimiques de Rennes, UMR CNRS 6226, Equipe Verres et Céramiques, Université de Rennes1, 35042 Rennes, France

Resume : Development of ultrafast all-optical switching requires materials presenting high optical nonlinearities which allow low switching energy and small device size. Chalcogenide glasses present large nonlinear refractive index (10 to 800 times higher than that of silica glass) making them promising materials for mentioned applications. Theoretical nonlinear refractive indices of selected glasses were determined by a model developed by Lenz [1] using the dispersion of the Kerr coefficient function determined by Sheik-Bahae [2]. Nonlinear parameters for a series of (GeSe2)100-x(Sb2Se3)x glasses (where x varied from 5 to 60) were estimated at 1.55 μm in femtosecond regime using an original method based on direct analysis of beam profile change while propagating in the chalcogenide glasses. The study of their photosensitivity at 1.55 □m revealed highly glass composition dependent behavior and quasi-photostable compositions have been identified in femtosecond regime. Predictions, realized for the Ge-Sb-Se glasses using Lenz model, are in good agreement with experimental results and will be discussed. Czech Science Foundation (Project 13-05082S), Ministry of Education, Youth, and Sports of the Czech Republic (Project CZ.1.07/2.3.00/30.0058) and CNRS PICS (Projet International de Cooperation Scientifique) program financially supported this

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work. References 1. G. Lenz et al., Opt. Lett. 25, 254-256 (2000). 2. M. Sheik-Bahae et al., IEEE J. Quantum Electron. 27, 1296-1309 (1991).

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16:00 **Ultrafast direct laser writing of buried waveguides in the 0.8CaSiO3-0.2Ca3 (PO4)2 eutectic glass doped with Nd3+ ions**

Authors : D. Sola1, J. Martínez de Mendibil2, J.R. Vázquez de Aldana3, G. Lifante2, A.H. de Aza4, P. Pena4, J.I. Peña1

Affiliations : 1Instituto de Ciencia de Materiales de Aragón, Universidad de Zaragoza-CSIC Departamento de Ciencia y Tecnología de Materiales y Fluidos C/ María de Luna, 3 50.018 Zaragoza, Spain 2 Departamento de Física de Materiales, C-04, Facultad de Ciencias Universidad Autónoma de Madrid 28.049 Madrid, Spain 3 Grupo de Optica. Facultad de Ciencias Universidad de Salamanca 37.008 Salamanca, Spain 4 Instituto de Cerámica y Vidrio-CSIC C/ Kelsen 5 28.049 Madrid, Spain

Resume : In this work the formation of buried optical waveguides by femtosecond laser inscription in the 0.8CaSiO3-0.2Ca3(PO4)2 eutectic glass doped with Nd3+ ions is reported. The glass samples were prepared by melting the eutectic powder mixture in a Pt-Rh crucible at 1600 ºC and pouring it in a preheated brass mould. Afterwards, the glass was annealed to relieve the inner stresses. Buried waveguides were fabricated by focusing beneath the sample surface a pulsed Ti:sapphire laser with a pulsewidth of 120 fs working at 1 kHz. The waveguides were produced by the double filament and cladding techniques. The effects produced by the laser pulse energy as well as the distance between tracks, scanning speed and focusing distance were studied and compared between the different techniques. After the laser processing the near-field intensity distribution of the waveguide´s modes at 633 nm was studied. In order to diminish the losses by colour centres absorption a heat treatment was carried out in the samples. The waveguide´s modes were compared with those of the samples without heat treatment. The spectroscopic properties of the neodymium ions have been characterized to evaluate if their optical properties have been modified by the waveguide fabrication. Laser experiments are in progress to evaluate the ability of the waveguides for 1064 nm laser light generation under 800 nm optical pumping.

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add to my program (close full abstract)

16:00 **Femtosecond laser pulse influence on binary mixed Be, W and C layers**

Authors : C. P. Lungu1, C. Porosnicu1, I. Jepu1, C. Ticos1, P. Chiru1, O. Pompilian1, M. Lungu1, P. P. Dinca1, A. Marcu1, C. Luculescu1, R. Banici1, G. Cojocaru1, G. R. Ungureanu1, D. Ursescu1, C. E. A. Grigorescu2, A. Marin3, P. Osiceanu3

Affiliations : 1National Institute for Laser, Plasma and Radiation Physics, 077125 Bucharest, Romania; 2National Institute R&D for Optoelectronics INOE 2000, 077125 Bucharest, Romania; 3Institute of Physical Chemistry Ilie Murgulescu, 060021, Bucharest, Romania

Resume : Binary beryllium, tungsten and carbon mixed layers prepared by thermionic vacuum arc (TVA) method were irradiated by short duration, high power laser pulses in vacuum as well in gaseous environment. The laser beam produced by the TEWALAS laser system at the National Institute for Laser, Plasma and Radiation Physics operated with the following parameters: pulse duration: 70 fs, the pulse energy: 6 mJ and the repetition rate: 10 Hz. The 10*14 W/cm*2 density power. The laser beam was oriented at 45 and around 3 degrees respectively in respect to the layers surfaces in vacuum, air and deuterium atmosphere in order to simulate the phenomena produced during operation of the tokamak type plasma fusion devices. The mixed layers were characterized before and after exposures using scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and Raman spectroscopy. The changes of the layers morphologies, structures and chemical bonding were highlighted. Acknowledgements: This work was supported by a grant of the Romanian National Authority for Scientific Research, CNCS, UEFISCDI, project number PN-II-IDPCE- 2011-3-0522

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add to my program (close full abstract)

16:00 **Emitter formation using laser doping technique on n- and p-type c-Si substrates**

Authors : Gema López*, Pablo R. Ortega, Cristóbal Voz, Isidro Martín, Mónica Colina, Anna B. Morales, Albert Orpella, Ramón Alcubilla

Affiliations : MIcro and Nano Technologies Group, Universitat Politecnica de Catalunya

Resume : The high temperature steps involved in the emitter creation by conventional diffusion processes during the fabrication of c-Si solar cells have a negative impact on the final device cost. The formation of locally doped emitters regions by laser doping (LD) is a cost-effective technique avoiding these expensive processes. In this work LD technique is used to create highly-

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doped regions defined in a point-like structure to form n+/p and p+/n junctions applying a pulsed Nd-YAG 1064 nm laser in the nanoseconds regime. Particularly, a phosphorous-doped silicon carbide stack (a-SiCx/a-Si:H (n-type)) deposited by Plasma Enhanced Chemical Vapor Deposition (PECVD) and aluminum oxide (Al2O3) layer deposited by atomic layer deposition (ALD) are used on 2±0,5 Ω.cm p- and n-type FZ c-Si substrates respectively. These dielectric layers are used as dopant sources at the LD stage. Laser pulse energy, pulse duration and number of pulses are explored to obtain the optimal electrical behavior of the formed junctions. In order to contact and passivate the rear surface of the device base regions we use Al2O3 film and a-SiCx/a-Si:H (n-type) stack on p- and n-type c-Si respectively, which are locally fired (Laser Fired Contacts, LFC) creating a highly doped back surface field (BSF). Finally, both surfaces are metallized with evaporated aluminum. To assess the quality of the p+ and n+ regions, the fabricated n+/p and p+/n junctions are electrically characterized by means of dark J-V measurements

add to my program (close full abstract)

16:00 **Optical limiting effect in laser irradiated graphene oxide nanomaterials**

Authors : Giuseppe Isgr?1, Simon Federico Span?1, Luisa D?Urso1, Giuseppe Compagnini1, Enza Fazio2, Fortunato Neri2
Affiliations : 1 Dipartimento di Scienze Chimiche, Universit? di Catania, Viale Andrea Doria 6, 95125 Catania, Italy 2 Dipartimento di Fisica e di Scienze della Terra, Universit? di Messina, Viale F. Stagno d?Alcontres, 31, 98166 Messina

Resume : The nonlinear optical properties of graphene oxide (GO), synthesized by a Hummers method and post-irradiated by a 532 nm pulsed laser source to obtain partially reduced GO (r-Go) [1,2], were studied by using a nanosecond pulsed excitation. GO and r-GO were characterized by Raman, UV-vis absorption spectroscopies and atomic force microscopy. It was found that the r-GO can be considered as modified graphene sheets with graphitic-like domains decorated with oxygen functional groups on the basal planes and carbonyl group on the edges of the graphene nanosheets. A strong optical limiting response was detected at laser fluences above 1 J/cm2. The nature of the nonlinear effect was investigated by the Z-scan technique, determining both the nonlinear absorption coefficient β and the refraction one n2. Then, the proposed synthesis method allows the preparation of r-GO material with tunable nonlinear optical response. Moreover, the good optical transparency covering the entire visible spectrum and the relatively good photo-stability make these carbon based materials interesting for potential applications as broadband optical materials. [1] L.J.Cote, F.Kim, J. Huang, J. Am. Chem. Soc., 131, 1043-1049 (2009) [2] Lei Huang *, Yang Liu, Le-Chun Ji, Yi-Qun Xie, Tao Wang, Wang-Zhou Shi, Carbon,49, 2431-2436(2011)

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add to my program (close full abstract)

16:00 **Laser-induced forward transfer of a bis-pyrene compound for o-TFTs**

Authors : C. Constantinescu, A.K. Diallo*, A. D'Aleo*, F. Fages*, C. Videlot-Ackermann*, P. Delaporte, P. Alloncle
Affiliations : Aix-Marseille University, CNRS, LP3 UMR 7341, F-13288, Marseille, France; *Aix-Marseille University, CNRS, CINaM UMR 7325, F-13288, Marseille, France

Resume : Pyrene is a polycyclic aromatic hydrocarbon made of four fused benzene rings. Usually used in dyes and dye precursors, its derivatives are also valuable molecular probes via fluorescence spectroscopy: having high quantum yield and lifetime, its derivatives have been used to determine specific environments, e.g. photodegradation effects related to laser processing. We present here results on a newly synthesized bis-pyrene compound that, besides the typical fluorescence, also exhibit semiconducting properties. Thin films have been grown by vacuum thermal evaporation on oxidized silicon, and on transparent suprasil substrates. The influence of the temperature on the thin film's morphology, optical, and electrical properties, are discussed. Micrometric-sized pixels have subsequently been printed by laser-induced forward transfer (LIFT) using a Nd:YAG laser source (355 nm, 50 ps pulse duration), to produce functional organic thin film transistors (o-TFTs). Top-contact vs. bottom-contact configurations are presented, and the influence of the ambient pressure during LIFT procedure is discussed.

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add to my program (close full abstract)

16:00 **Synthesis and characterization of carbon-coated molybdenum disulfide from solid precursor by laser pyrolysis**

Authors : L. Gavrila-Florescu, E. Popovici, A. Ilie, I. Morjan
Affiliations : National Institute for Lasers, Plasma and Radiation Physics, P.O. Box MG-36, Bucharest, Romania

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Resume : Carbon coatings have been reviewed in terms of its advantages on the newly developed electrode materials for rechargeable lithium-ion battery, in addition to various metals and metal oxides. In this frame, this paper reports the use of laser pyrolysis method for preparing carbon-coated MoS2 (C-MoS2) nanoparticles from solid precursor. To obtain C-MoS2 nanoparticles, molybdenum hexacarbonyl Mo(CO)6 (Mo donor) hydrogen sulphide H2S (S donor) and ethylene C2H4 (C donor) were used as reactant gases. Also, sulphur hexafluorine SF6 has been used as energy transfer agent. To obtain a reasonable vapor pressure, the Mo(CO)6 solid precursor was heated between the melting and boiling temperatures (150 0C-156 0C). The synthesized C-MoS2 nanopowders were investigated by scanning electron microscopy equipped with an energy dispersive X-ray analyzer, Raman spectroscopy and X-ray diffraction techniques. The results demonstrated that the C-MoS2 have a well-developed crystalline structure.

add to my program (close full abstract)

16:00 **Investigation of the rapid fabrication of multiple nanofoam materials via femtosecond laser irradiation**

Authors : J A Grant-Jacob*, B Mills and R W Eason
Affiliations : Optoelectronics Research Centre, University of Southampton, Southampton, UK

Resume : Nanofoams are permeable, nanostructured materials, which have applications in many areas, including electronics, biological sciences and aerospace engineering [1-4]. Nanofoam fabrication using an ultrafast laser enables control over the precise location as well as the fabrication rate, leading to the possibility of applications such as evanescent sensors and energy harvesting devices. Here, we extend our initial work on glass nanofoam fabrication [5] by demonstrating the production of metal, ceramic, polymer and novel chalcogenide glass nanofoam at atmospheric pressure, with dimensions of ~hundred microns in height and millimetre-square in area. Our investigation showed that both the volume and density of the nanofoam was a function of both the material as well as the exposure protocol (number of pulses and their energy density). [1] Brock S L (2007), Science (New York, N.Y.) 317 460–1. [2] Fischer A E et al. (2007), Nano Letters 7 281–6. [3] Viswanathan P et al. (2012), J. Amer. Chem. Soc. 134 20103–9. [4] Burchell M J et al. (2006), Ann. Rev. Earth and Plan. Sciences 34 385–418. [5] Grant-Jacob J A et al. (2014), J. Phys. D: Appl. Phys. 47 055105.

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add to my program (close full abstract)

16:00 **Morphological, structural and biological characteristics of ultra-high molecular weight polyethylene acetabular cups functionalized with bioactive glass coatings by pulsed laser deposition**

Authors : L. Duta1, G.E. Stan2, A.C Popescu1, A.C. Popa2,3,4, F. Miculescu5, I.N. Mihailescu1
Affiliations : 1National Institute for Lasers, Plasma and Radiation Physics, Magurele-Ilfov, Romania 2National Institute of Materials Physics, Magurele-Ilfov, Romania 3Army Centre for Medical Research, Bucharest, Romania 4Department of Cellular and Molecular Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania 5Politehnica University of Bucharest, Faculty of Materials Science and Engineering, Bucharest, Romania

Resume : We report on the synthesis by PLD of bioactive glass (BG) thin films of SiO2–Na2O–K2O–CaO–MgO–P2O5 compositional system onto ultra-high molecular weight polyethylene (UHMWPE) acetabular cups, and their characterization by immersion in simulated body fluid (SBF). After 42 days of immersion in SBF under homeostatic conditions, a partial dissolution of the BG film was observed, followed by the chemical growth of a carbonated hydroxyapatite layer. This behavior of the PLD glass coatings is the result of ion exchanges between BG and SBF solution, and is in accordance with the bioactivity mechanism proposed by Hench. Fourier Transform Infrared Spectroscopy evidenced the strong depolymerization of the deposited BG coatings, favorable to a high bioreactivity and rapid osteointegration. The top-view Environmental Scanning Electron Microscopy showed significant morphological changes, the typical PLD film surface being converted after 42 days of soaking in SBF to a rough one consisting of acicular crystals. Energy Dispersive Spectroscopy analysis demonstrated the conservation of the targets stoichiometry after transfer. Moreover, the parent BG films showed an excellent purity, without any traces of contamination. We consider that the functionalization of UHMWPE acetabular cups with BG films by PLD opens good prospective for the fabrication of implants with improved osteoinductive characteristics.

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add to my program (close full abstract)

16:00 **Synthesis of biological hydroxyapatite thin films by pulsed laser deposition**

Authors : L. Duta1, G.E. Stan2, N. Serban1, F.N. Oktar3,4,5, I.N. Mihailescu1
Affiliations : 1National Institute for Lasers, Plasma and Radiation Physics, Magurele-Ilfov, Romania 2National Institute of Materials Physics, Magurele-Ilfov, Romania 3Department of Bioengineering, Faculty of Engineering, Marmara University, Istanbul, Turkey 4Department of Medical Imaging Techniques, School of Health Related Professions, Marmara University, Istanbul, Turkey 5Nanotechnology and Biomaterials Application & Research Centre, Marmara University, Istanbul, Turkey

Resume : We report on biological hydroxyapatite (HA) thin films (1.29 – 3.3 μm thick) of human (dentine, DHA) and animal (bovine, BHA and ovine, OHA) origin synthesized by PLD. X-Ray Diffraction studies evidenced a monophasic HA structure of the films, with a crystallinity degree influenced by the biological origin. Scanning Electron Microscopy investigations showed film surfaces with moderate roughness consisting of particulates with a mean size of ~2μm. Energy Dispersive Spectroscopy analysis revealed the presence of traces of Mg, Na, Cl, F and C besides the prevalent Ca and P. This composition is similar to that of the genuine human healthy bone. The OHA thin films exhibited the highest adherence (~69 MPa) to titanium substrate as compared to the DHA (50 MPa) and BHA (42 MPa) structures. Based upon their improved performances and low cost manufacturing, these renewable biomaterials could develop into valuable competitors to commercial HA for implantology applications.

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16:00 **Laser printed thin films of organometallic and azo-derivative compounds for non-linear optical applications**

Authors : Andreea Matei (1), Valentin Ion (1), Catalin Constantinescu (1), Bogdana Mitu (1), Iulian Ionita (2), Maria Dinescu (1), Ana Emandi (3)
Affiliations : (1) INFLPR – National Institute for Laser, Plasma and Radiation Physics, 409 Atomistilor St, RO-077125, Magurele, Romania; (2) UB – University of Bucharest, Faculty of Physics, 405 Atomistilor St, RO-077125, Magurele, Romania; (3) UB – University of Bucharest, Faculty of Chemistry, 90-92 Panduri St., RO-050663, Bucharest, Romania;

Resume : Azo-dyes and organometallic compounds have been studied lately, in bulk or as thin films, due to their particular optical properties for potential applications in optoelectronics and sensors. Such particular properties include non-linear interactions, e.g. two-photon absorption, second harmonic generation, optical limiting and all-optical poling. We present here a study on the LIFT printing of micrometric-sized pixels, using MAPLE deposited thin film donors. Details about the influence of the pixel's morphology, structure, interface, and thickness, on their optical behaviour, are presented and discussed.

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add to my program (close full abstract)

16:00 **Bi2O3 thin films surface responses under KrF excimer laser treatment**

Authors : O. Van Overschelde (a), S. Konstantinidis (a), M. Buffière (c;d) , R. Snyders (a;b)
Affiliations : a) Chimie des interactions Plasma-Surface, Université de Mons, 20 place du parc, 7000 Mons, Belgium b) Materia Nova research center, 1 Avenue Nicolas Copernic, 7000 Mons, Belgium c) Department of Electrical Engineering, KU Leuven, Kasteelpark Arenberg 10, B-3001 Heverlee, Belgium d) Imec, Kapeldreef 75, B-3001 Heverlee, Belgium

Resume : Thin Bi2O3 films are deposited on silicon substrate by magnetron sputter deposition. They are irradiated in air by means of a 248 nm wavelength KrF excimer laser. The ablation rate is measured as a function of the laser fluence per pulse, F, and of the number of pulses, N. The influence of the treatment is studied by mechanical profilometry, SEM, EDX and XPS. We defined the couple of parameter (F, N) required to control the ablation of the film. Furthermore, we highlighted the presence of different regimes, namely: clean ablation, transition, droplets formation, substrate cleaning and substrate damaging. We describe the experimental conditions needed to get these regimes and discuss the mechanisms involved in the processes. We show that the ablation of the film could be done in a controllable way, with respect of the chemical composition.

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add to my program (close full abstract)

16:00 **Improved surface coverage and conductivity of Cu complex ink-coated films by laser sintering**

Authors : (a) Jeonghyeon Lee, (b) HeungYeol Lee

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Affiliations : (a) Department of Materials Science and Engineering, Yonsei University, Seoul 120-749, Korea; (b) Surface Engineering R&D Group, Korea Institute of Industrial Technology, Incheon 406-840, Korea

Resume : We here show that highly conductive copper films can be obtained from Cu complex ink by laser sintering. The synthesized Cu formate ink was spin-coated onto polyimide substrate and the coated films were scanned by an ultraviolet laser beam at 355 nm. During laser sintering, N2 gas was blown into the irradiated area and this successfully prevented oxidation. While the film connectivity and surface coverage became very poor by typical thermal sintering, laser-sintered films exhibited tightly packed, compact microstructure maintaining a uniform thickness. This made it possible to achieve much lower sheet resistances by laser sintering, especially when the film thickness was less than 1 um. A minimum resistivity of 1.92 x 10-5 ohm cm was obtained.

16:00 **Micro- and nanoparticles of CdMnTe generated by pulsed laser ablation in liquids**

Authors : A.I. Savchuk, F. Gontad, A. Perrone, I.D. Stolyarchuk, O.A. Savchuk, O.A. Shporta, V.I. Garasym
Affiliations : Department of Physics of Semiconductors and Nanostructures, Chernivtsi National University, 2 Kotsubynsky Str., 58012 Chernivtsi, Ukraine ; University of Salento, Department of Mathematics and Physics "E. De Giorgi" and National Institute of Nuclear Physics, 73100 Lecce, Italy

Resume : Pulsed laser ablation in liquids (PLAL) has attracted recently much attention because of its advantage for fabrication of semiconductor and metal nanoparticles compared to the other growth routes. Our previous application of this technique for preparation of Zn(1-x)Mn(x)O diluted magnetic semiconductor (DMS) nanoparticles has revealed peculiarities of the obtained nanostructures [1]. In the present work, experimental investigations on structural and optical properties of the other member of DMS family Cd(1-x)Mn (x)Te micro- and nanoparticles generated by PLAL are reported. The target material was Cd(1-x)Mn(x)Te crystal grown by the vertical Bridgman method. Two different contents of Mn in the grown crystals were used x = 0.25; 0.36. The target was irradiated using a frequency-quadrupled Q-switched Nd:YAG pulsed laser, operating at 10 Hz with pulse width of 7 ns. Laser fluence was changed in range of (1-3) J/cm2. The target was immersed in bidistilled water inside a glass vessel. The colloidal aqueous solution with micro- and nanoparticles and appropriate layers onto Si and Al substrates were characterized using scanning electron microscopy (SEM) and atomic force microscopy (AFM). In addition, the optical absorption and photoluminescence spectra were measured. 1. A.I. Savchuk, A. Perrone, I.D. Stolyarchuk, O.A. Savchuk, V.V. Makoviy, M.M. Smolinsky, O.A. Shporta, AIP Conf. Proc., 1566 (2013) 439.

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16:00 **Photo-fragmentation of selenium powder by excimer laser ablation in water**

Authors : O. Van Overschelde (1), G. Guisbiers (1,2)
Affiliations : (1) Chimie des Interactions Plasma-Surface, CIRMAP, Research Institute for Science and Material Engineering, University of Mons, Place du Parc n°23, 7000 Mons (Belgium) (2) Materia Nova, R & D center, Avenue Nicolas Copernic n°1, 7000 Mons (Belgium)

Resume : Pure selenium powder was irradiated in de-ionized water by means of an excimer laser (248 nm) operating at low fluence (F ~ 1 J/cm²). The treatment induced the fragmentation of the original micro-sized powder into smaller particles. The obtained solutions were characterized by UV-visible spectroscopy, Raman spectroscopy and Transmission Electronic Microscopy. It appears from these investigations that the treatment was successfully applied in order to control the shape and reducing the size of the particles down to 60 nm in diameter. We also discuss the crystal phase changes induced by the irradiation. Finally, the physico-chemical mechanisms implied in the process are described in relation with the laser parameter used.

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16:00 **Laser nanopatterning of glass and glass covered by aluminum thin film**

Authors : O. Krylov, S. Nedilko, S. Rozouvan
Affiliations : Taras Shevchenko National University of Kyiv, Physics Dept. . Acad.Glushkova 4b, Kyiv, Ukraine

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Resume : Laser light pulses of different lasing pulse duration were applied to etch a raster nanostructure on a polished glass and glass with deposited aluminum thin film. The substrates for etching were taken to be different by values of its electric conductivities. Atomic force microscopy (AFM) revealed

strong dependence of the both dielectric and metal nanoparticles sizes and numbers from laser pulse duration and etched linear raster structure geometry. The AFM measurements were performed with spatial resolution near 40nm. The components of electrostriction degenerate tensor which are responsible for size and concentrations distributions of deposited nanoparticles were theoretically derived and numerically evaluated. Possible mutual spatial orientations of electrostriction forces components and focused laser beam spot have been also discussed.

add to my program (close full abstract)

16:00 **New kind of micro-system based on pure or doped amorphous-carbon films designed by pulsed laser for detection of toxic metals, emerging pollutants and pathogens**

Authors : C.Maddi a, T. Tite a, N. Zehani c, P. Fortang c, A.-S. Loir a, V. Barnier b, K. Wolski b, T.C. Rojas d, J.C. Sanchez-Lopez d, C. Donnet a, F. Garrelie a, C. Chaix c, P. Namour c, N. Jaffrezic-Renault c

Affiliations : a Université de Lyon, F-69003, Lyon, France, Université de Saint-Étienne, Laboratoire Hubert Curien (UMR 5516 CNRS), 42000 Saint Étienne, France ; b Laboratoire Georges Friedel, Ecole Nationale Supérieure des Mines de Saint Etienne, France ; c Université de Lyon, F-69003, Lyon, France, Université Claude Bernard Lyon 1, Institut des Sciences Analytiques (UMR 5280 CNRS), 69622 Villeurbanne, France ; d Instituto de Ciencia de Materiales de Sevilla (CSIC-US), Avenida Americo Vespucio 49, 41092 Sevilla, Spain

Resume : The overall aim of this work is to build a new kind of micro-system for the detection of toxic metals, emerging pollutants and pathogens in both sewer overflow and river water which responds to a strong societal demand in public health and environmental safety. New multi-sensor networks are based on carbon materials such as graphene, Diamond-Like Carbon (DLC), boron-doped DLC and nitrogenated DLC. Thin films have been synthesized on standard silicon or silicon nitride substrates by either nanosecond or femtosecond pulsed laser deposition. The doped coatings have been deposited at room temperature by ablating graphite targets with an ultrashort laser (800 nm, 35 fs, 1 kHz). Doping with boron has been performed by ablating alternatively graphite and boron targets whereas doping with nitrogen has been obtained by ablating graphite in a nitrogen atmosphere with and without plasma assistance. A KrF excimer laser (248 nm, 20 ns, 10Hz) has been also used for the synthesis of few-layer graphene. The carbon materials were used as working electrodes by using cyclic voltammetry to detect electroactive pollutants (heavy metals, phenols, …). The structural and morphological film characteristics have been correlated with the electrochemical performances. The femtosecond laser technology was also used to design flexible analytical microsystems.

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add to my program (close full abstract)

16:00 **MAPLE deposition of biodegradable silk fibroin/poly(sebacic acid) diacetoxy terminated composite coatings**

Authors : N. Stefan1, F.M. Miroiu1, A. Visan1, O.L. Rasoga2, I. Zgura2, C.Nita1, A. Stanculescu2, G. Socol1

Affiliations : 1National Institute for Lasers, Plasma, and Radiation Physics, 409 Atomistilor 077125, Magurele - Bucharest, Romania; 2 National Institute for Materials Physics, 105 Atomistilor 077125, Magurele - Bucharest, Romania

Resume : The aim of our study was to deposit biodegradabile poly(sebacic acid) diacetoxy terminated (PSADT) coatings reinforced with silk-fibroin (SF) by matrix assisted pulsed laser evaporation (MAPLE) method for biomedical applications (local drug delivery). The composite coatings were deposited on titanium and silicon substrates from solutions based on chloroform as solvent and mixtures of SF with PSADT in different weight ratios (1:4, 1:1 and 4:1). The structural, morphological, and wettability properties of the SF/PSADT composite coatings were optimized with respect to the laser fluence, in the (300-500) mJ/cm2 range. FTIR spectra of composite coatings evidenced the stoichiometric transfer of the main constituents, while the XRD diffractograms revealed the partial crystallinity of coatings and the presence of diffraction peaks typical for SF and PSADT polymers. SEM micrographs of the biocomposite coatings exposed mainly flower-like aspect uniform films, characteristic to PSA polymer, with a large specific area, appropriate for low wettability contact angle. Their morphology slightly depends on the chemical composition, mixture ratio and deposition conditions. The wettability studies on SF/PSADT coatings showed a superhydrophilic behaviour, with contact angle < 10°. The physico-chemical investigation's results encourage release

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applications, where degradation may be adjusted by control of the mixture ratio, surface morphology, crystalline status and/or coating thickness.

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16:00 **Structure and valence properties of ceria films synthesised by laser ablation under reducing atmosphere**

Authors : A Pereira1, M Blouin2, A Pillonnet1, D Guay2
Affiliations : 1 Institut Lumière Matière, UMR5306 Université Lyon 1-CNRS, Université de Lyon 69622 Villeurbanne cedex, France ; 2 INRS-EMT, 1650 Boulevard Lionel-Boulet, C.P. 1020, Varennes, Québec J3X1S2, Canada

Resume : The ability to form oxygen vacancies associated with the easy change of valence between Ce(IV) and Ce(III) confers to cerium oxide properties that have attracted great interest. Such properties are very attractive for the realisation of devices based on ceria (CeO2) nanoparticles in many fields. It has also an important role in promoting noble metal activity, such as Au, Pt and Ag. Recently, CeO2 was also investigated as a catalyst support for electrochemical biosensors, because it is chemically inert, biocompatible and a good electrical conductor. In this work, CeOx thin films are prepared by ablating a metallic cerium target under reducing atmosphere to minimize the cerium oxidation during the deposition. A systematic study has been made regarding the influence of various parameters both on the surface composition and on the structure of the deposited films. The effects of the background pressure, the composition of the gas, the target-substrate and the radial distance have been studied. A correlation between the deposition parameters and the valence states of cerium in the deposited films is established. We demonstrate that PLD is a powerful method that allows control of the crystallinity, morphology (grain size) and the composition (Ce3+ and Ce4+ ions contents, oxygen vacancies) of the deposited films. We also demonstrate that it is possible to produce films containing high surface concentrations of Ce3+, up to 70% of the total cerium content. The possible core-shell structure of the nanoparticles is discussed.

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add to my program (close full abstract)

16:00 **Improved retention in Ar+ ion irradiated BiFeO3 thin films**

Authors : L. Jin,1 Y. Shuai,1 T. You,2 N. Du,2 D. Bürger,2 I. Skorupa,2 W. Luo,1 C. Wu,1 W. Zhang,1 X. Ou,3 S. Zhou,3 Oliver G. Schmidt,2,4 and H. Schmidt2
Affiliations : 1. State Key Laboratory of Electronic Thin Films and Integrated Devices, UESTC, 610054 Chengdu, China; 2. Technische Universität Chemnitz, Department of Materials for Nanoelectronics, Faculty of Electrical Engineering and Information Technology, Chemnitz 09126, Germany; 3. Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden, Germany; 4. Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstraße 20, Dresden 01069, Germany

Resume : Low energy Ar+ ion irradiation has been applied to an Au/BiFeO3/Pt capacitor structure before deposition of the Au top electrode. The irradiated thin film exhibits multilevel resistive switching without detrimental resistance degradation, which makes the intermediate resistance states more distinguishable as compared to the non-irradiated thin film. The stabilization of resistance states after irradiation was discussed based on the analysis of conduction mechanism [1] during the resistive switching, which was investigated by means of temperature-dependent current-voltage measurement from room temperature to 423 K. The retention of the LRSs was improved in a controllable manner by Ar+ ion irradiation. Stabilization of the LRSs is attributed to the reduced randomicity of the defect states induced by manipulation of the oxygen vacancy concentration via irradiation. The present work shows that low-energy ion irradiation is an efficient tool for tuning of the resistive switching properties Au/BiFeO3/Pt capacitor structures [2]. [1] Y. Shuai, X. Ou, W. Luo, N. Du, C. Wu, W. Zhang, D. Bürger, C. Mayr, R. Schüffny, S. Zhou, M. Helm, and H. Schmidt, Nonvolatile Multilevel Resistive Switching in Ar+ Irradiated BiFeO3 Thin Films, IEEE Electr. Dev. Lett. 34, 54-56 (2013) [2] X. Ou, Y. Shuai, W. Luo, P.F. Siles, R. Kögler, J. Fiedler, H. Reuther, S. Zhou, R. Hübner, S. Facsko, M. Helm, T. Mikolajick, O.G. Schmidt, and H. Schmidt, Forming-Free Resistive Switching in Multiferroic BiFeO3 thin Films with Enhanced Nanoscale Shunts, ACS Appl. Mater. Interfaces 5, 12764-12771 (2013)

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add to my program (close full abstract)

16:00 **Metallic tin-based nanoparticles synthesis by laser pyrolysis: parametric studies focused on the decreasing of the crystallite size**

Authors : E. Dutu1, F. Dumitrache1, C. T. Fleaca1, I. Morjan1, L. Gavrila-Florescu1, I. Sandu, M. Scarisoreanu1, I. P. Morjan1, C. Luculescu1 , A. M. Niculescu1 , E. Vasile2
Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics, Lasers Dept,

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Bucharest - Magurele, 409, Atomistilor Street, 077125, Romania; 2 METAV SA, Res & Dev., 31, C. A. Rosetti Street, 020011, Bucharest, Romania
Resume : Tin based nanoparticles have been synthesized by laser pyrolysis using thetrametyl tin as reactive precursors and ethylene as energy transfer agent. Regarding their application, as electrode for rechargeable battery, the dimensions of the tin based nanoparticles are required to be minimum. Considering this requirement, the experimental parameters have been varied and the mean diameter of the tin nanoparticles has been decreases from 120 nm to 45 nm, as deduced from XRD and TEM analysis. The synthesis of small nanoparticle dimension has performed obtained by decreasing the residence time and the reactive zone, and varying the temperature of pyrolysis flame between 520 to 560 0C. The inlet nozzle diameter, dedicated for reactive gas mixtures, and the thetrametyl tin vapor flow strongly influences the reactive mechanism and consequently the nanoparticle dimensions. Furthermore, when the flame reactive temperature exceed 600 0C a minor ethylene decomposition is generated. The EDX elemental evaluation and Raman Spectroscopy revealed that Sn- nanoparticles with high C content (around 20 at.%) have been synthesized.

add to my program (close full abstract)

16:00 **Hydroxyapatite thin films obtained by PLD and MAPLE: comparative study of physical, chemical and biological properties**

Authors : G. Popescu-Pelin1, F. Sima1, G. Socol1, L. Sima2, C. Ristoscu1, I. N. Mihailescu1
Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics, Magurele, Ilfov, Romania 2 Institute of Biochemistry of the Romanian Academy, Bucharest, Romania
Resume : The aim of the study is to critically compare hydroxyapatite thin films deposited on Ti substrates by two different laser techniques: pulsed laser deposition (PLD) and matrix assisted pulsed laser evaporation (MAPLE). An enhanced chemical and biological activity is expected for the films deposited by MAPLE from nanopowders due to the extended surface area in contact with the reactive media. The experiments were carried out in a reaction chamber using the same KrF* excimer laser source (λ=248nm, τ(FWHM)≈25ns). All films were post-deposition treated in a flux of water vapors in order to improve morphology and crystallinity. Specific coating surface features were evidenced by optical, scanning electron and atomic force microscopy investigations. They were shown to depend on deposition technique. The crystalline structure of the coatings was monitored by X-ray diffraction before and after thermal treatment. To evaluate the biocompatibility of coatings, cellular adhesion, proliferation and differentiation tests were conducted.

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16:00 **Processing of the precursors in SiC synthesis by laser pyrolysis**

Authors : L. Gavrila-Florescu, E. Popovici, I. Morjan
Affiliations : National Institute for Lasers, Plasma and Radiation Physics, P.O. Box MG-36, Bucharest, Romania
Resume : Some of our previous works which have made an analysis of the combustion process in the laser synthesis of nanopowders delineated two combustion processes; a volume and an ignition combustion one. Both of them appear in the pyrophoric synthesis, in which some gases are decomposed in a strongly exothermic process produced by a focused laser beam with high power density, up to 50 kW/cm2. These types of combustion processes enable a good control of the flame temperature in the synthesis zone. By studying the SiH4/C2H2 combustion process we intend present two precursor's preparing pathways: the dilution of reactant gases into a mixing chamber by keeping the stoichiometric ratio of the active precursors and, preheating the precursors with and without their partial and / or complete decomposition. As results we present an imaging study of the flame. The dependences between different synthesis parameters and characteristics of nanoparticles are presented basing on the measurements performed through various methods such as TEM, SEM, EDAX, XRD, etc

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16:00 **Real-time laser diagnostic of CNTs growth : In-situ Raman spectroscopy**

Authors : Thibault Labbaye(1), Mireille Gaillard(1), Eva Kovacevic(1), Thomas Lecas(1), Nadjib Semmar(1), Chantal Boulmer-Leborgne(1), Mohamed-Ramzi Ammar(2), Nicole Raimboux(2), Patrick Simon(2) and Aurélien Canizarès(2)
Affiliations : (1) GREMI, Université-CNRS, BP6744, 45067 Orléans cedex 2, France (2) CEMHTI, CNRS, 45071 Orléans cedex 2, France

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Resume : In this work we present in situ time-resolved observations of the formation and growth of the carbon nanotubes (CNT) by a newly developed in situ Raman diagnostic. The in situ observations are compared with ex situ measurments on the CNTs bonding situation and morphology by means of NEXAF(*), XPS(*), SEM(*) and TEM(*). A thick layer of several µm of vertically aligned CNTs is obtained by PECVD(*) technique in C2H4:H2 or C2H4:NH3 mixture, after a metallic thin catalyst film is deposited by PLD(*) technique onto different substrates. This catalyst film is heated up to obtain catalyst nanoparticles. The quality of CNT carpets for applications, for example interconnections in microelectronics, depend a lot on the first moments of the growth, thus our interest of in-situ monitoring of the process. The last stage-plasma aided growth, is done in continuous plasma regime. In case of the in situ Raman diagnostic, the process is regularly interrupted because the plasma emission is much intense that the Raman signal and the growth of CNT is followed in real-time. In situ Raman results show that already after several seconds of plasma, the CNT fingerprint is evidenced when Fe is used as catalyst. In case of Ni catalyst, several minutes of plasma are necessary. The growth dynamic is different and related to the catalyst nanoparticles morphology and structure, and such a difference can be rapidly and easily evidenced by the in situ device. These results are consistent with NEXAFS resultsNEXAFS: Near Edge X-ray Spectroscopy, XPS: X-ray Photoelectron Spectroscopy, TEM: Transmission Electronic Microscopy, SEM: Scanning Electron Microscopy, PECVD : Plasma Enhanced Chemical Vapor Deposition, PLD : Pulsed Laser Deposition

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16:00 **LASER annealing process for solution processed ITO films**

Authors : Han-Ki Kim, Jin-A Jeong, Chang-Hyun Cho, and Kwon-Bum Chung
Affiliations : Kyung Hee University; Kyung Hee University; Kyung Hee University; and Dankook University

Resume : In this study, we have demonstrated that laser annealed indium tin oxide (ITO) films can be used as a transparent conducting electrode for organic solar cells (OSCs). The ITO films were prepared using ITO nanoparticle solution by brush-painting process. Using laser annealing system (IPG Photonics, ELR-20, 20 W average power erbium fiber laser), we investigated the characteristics of brush-painted ITO films as a function of laser power, background gas, and laser scanning speed, respectively at a constant laser annealing power of 16 W. With increasing laser scanning speed, the brush-painted ITO films showed linearly decreasing sheet resistance and resistivity up to 12 mm/s laser scanning speed under N2 ambient conditions. The ITO film showed a sheet resistance of 159.9 Ohm/square and a resistivity of 15.9 × 10-3 Ohm-cm with laser scanning speed of 4 mm/s. However, the brush-painted ITO film laser annealed with scanning speed 12 mm/s showed the lowest sheet resistance and resistivity of 56.79 Ohm/square and 5.67 × 10-3 Ohm-cm, respectively, which are acceptable values for the fabrication of OSCs. The all laser annealed ITO films showed a fairly high optical transmittance. At optimized conditions, the laser annealed ITO film exhibited a high optical transmittance of 85.77 %. This indicates that laser annealed ITO film is a promising transparent conducting electrode for printing-based OSCs with its electrical and optical properties.

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16:00 **Comparative study on the deposition of biodegradable PCL/PLA blend coatings**

Authors : C.Nita1,2, E. Axente1, F. Sima1, I. Iordache1, R. Cristescu1, A. Visan1, I. Zgura3, O.L. Rasoaga3, C.S. Breazu3, A. Stanculescu3, G. Socol1
Affiliations : 1Lasers Department, National Institute for Lasers, Plasma and Radiation Physics, 409 Atomistilor Street, Magurele, Ilfov RO-77125, Romania 2Faculty of Physics, University of Bucharest, 405 Atomistilor Street, Magurele, Ilfov RO-77125, Romania 3 National Institute of Materials Physics, 105 Atomistilor Street, Magurele, Ilfov RO-77125, Romania

Resume : During the last decades, polycaprolactone (PCL) and Poly(L-lactide) (PLA) have been extensively studied for controlled delivery of small molecule drugs, proteins and other macromolecules mainly due to theirs biocompatibility. Moreover, it was revealed that these materials ranked in terms of their rate of degradation, due to theirs different crystalline structure and hydrophobic to hydrophilic characteristics. We report the successful deposition by matrix assisted pulsed laser evaporation (MAPLE) and dip-coating (DC) methods of PCL, PLA, and mixtures of these two compounds in different weight ratios (25:75, 50:50, and 75:25) on titanium, glass and silicon substrates. We optimized the deposition conditions with respect to structural, morphological, and wettability properties of the polymeric blend films. Therefore, in case of

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MAPLE, we conducted experiments at different laser fluence (0.3-0.5J/cm2) and varios withdrawal velocities (30-100 mm/min) for DC. Fourier transform infrared (FTIR) spectroscopic results confirmed for both deposition methods the preservation of the chemical composition while the X-ray diffractograms revealed the diffraction peaks typical for PCL and PLA polymers. SEM images showed a surface morphology of coatings which strongly depends on the polymeric mixture ratio and deposition parameters. Wettability tests performed on PCL/PLA coatings exhibited a hydrophilic behaviour.

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16:00 **High magnetic Fe2O3 nanoparticles synthesized by laser pyrolysis used for biological and heat transfer applications**

Authors : F. Dumitrache, I. Morjan, C. Fleaca, C. Luculescu, A. Niculescu, A. Badoi, L. Vegas, O. Marinica, G. Manda, S. Pop, G. Huminic, A. Huminic

Affiliations : 1. NILPRP 409 Atomistilor st., Magurele, Romania 2. Romanian Academy Timisoara branch, Timisoara, Romania 3. "Victor Babes" National Institute of Research-Development in the Pathology Domain and Biomedical Sciences Splaiul Independenţei nr. 99 - 101, sector 5, 050096 Bucureşti 4. Trasilvania University , Brasov, Romania

Resume : Gamma Fe2O3 or Fe2O3/Fe3C nanoparticles were synthesized by laser pyrolysis using various optimized Fe(CO)5, O2 and C2H4 flow ratios in the reactive mixture and different laser power. Based on particular conditions two different iron oxide based nanoparticles were synthesized with a hydrophilic or hydrophobic behavior, both having a good magnetization saturation value (around 90 emu/g). TEM EDX, XRD and magnetic analysis were performed for a comprehensive characterization. The raw powders were successfully dispersed in an aqueous solution, using L- Dopa or TMAOH as stabilizing agents. Dispersed samples having concentrations of grams or tens of grams per liter, with or without stabilization agents, have been tested and DLS measurements proved their good stability, with hydrodynamic diameter varying between 70 to 150 nm when stabilizing agents were used. Thermal conductivity and viscosity tests on L-Dopa and TMAOH based on magnetic nanofluids (tens grams/l powder concentration)reveal an increasing up to 40% in thermal conductivity and no more than 5% increasing in viscosity validating them as thermal transfer fluids. Water-based nanoparticle dispersions and also those stabilized with L-Dopa proved good biocompatibility, as demonstrate by an in vitro study in which cellular uptake, cytotoxicity, and intracellular H2O2 production were assessed in primary leukocytes and a breast carcinoma cell line (MCF7).

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16:00 **The effects induced in transition metal nitrides thin films by heavy ions irradiation**

Authors : G. Dorcioman1, G. Socol1, D. Craciun1, N. Stefan1, Dominique Gosset2, David Simeone2, V. Craciun1

Affiliations : 1Laser Department, National Institute for Laser, Plasma, and Radiation Physics, Bucharest-Magurele, Romania; 2 DMN/SRMA-LA2M, LRC CARMEN CEA Saclay, France

Resume : We report here the pulsed laser deposition (PLD) of transition metal nitrides (TMN) thin films with excellent physical, chemical and mechanical properties (density, hardness, Young modulus) for application in nuclear industry and space exploration as hard and protective coatings under extreme irradiation and temperature conditions. The TMN thin films (TiN and ZrN) were deposited on silicon substrates at elevated temperatures (up to 800°C) and nitrogen atmosphere. X-ray reflectivity (XRR) measurements revealed mass densities of deposited thin films close to the bulk values while X-ray diffractograms showed that the films were <111> textured. Mechanical properties evaluated by nanoindentation exhibited hardness values in the 30-40 GPa range. TMN thin films were irradiated with two kinds of ion beams: i) with low energy (a few hundreds of keV) heavy ions, simulating the damage induced by the fast neutron flux in the reactor. In this case, the damage is induced by ballistic effects but is located in the sub-surface (damaged thickness about a few hundreds of nanometers). ii) with high energy-heavy ions, simulating the effect of the fission products; the damage is known to arise from electronic interactions of the swift particles with the electronic structure of the material. In this case, an important issue to be solved was to establish the radiation resistance tolerance of these materials with the stoichiometry and the grain size.

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16:00 **Deposition and characterization of calcium phosphates/poly(3-hydroxybutyrate-co-3-hydroxyvalerate) biocomposite coatings**

Authors : G. Socoll*, V. Grumezescu1, C. Nita1, G. Dorcioman1, N. Stefan1, M.

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Miroiu1, I. Zgura2, M. Socol2, A. Visan1, G. Popescu-Pelin1, R. Cristescu1, O. Rasoga2, C.S. Breazu2, A. Stanculescu2
Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics, Magurele, Ilfov, Romania 2 National Institute of Materials Physics, Magurele, Ilfov, Romania
Resume : Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) is a biocompatible polymer completely biodegradable, whose degradation products are natural metabolites in human blood. In order to increase its bioactivity, hydroxyapatite (HA) or β-tricalcium phosphate was embedded into the PHBV polymeric coatings by Dip Coating (DC) and Matrix Assisted Pulsed Laser Evaporation (MAPLE) methods. Thus, calcium phosphates (CaPs) and PHBV were mixed in 1:3 and 1:1 weight ratios. In the case of MAPLE, the structural, morphological, and wettability properties of the composite coatings were optimized with respect to the laser fluence (200 - 400 mJ/cm2) whereas the withdrawal speed was varied for DC. X-ray diffractograms revealed the diffraction peaks of CaPs and PHBV while the Fourier transform infrared (FTIR) spectra proved the preserving of the polymer chemical composition for both deposition methods. Surface morphology of coatings observed from SEM micrograph strongly depends on the mixture ratio and deposition parameters typical for each method. We demonstrated that the addition of CaPs into PHBV matrix induces an increase of bioactivity. Moreover, we found out an improvement of mechanical properties and hydrophilicity when the CaP content was larger.

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16:00 **MAPLE deposition of organic structures on IZO flexible substrates**

Authors : M. Socol1, N. Preda1, O. Rasoga1, A. Stanculescu1,C. Breazu1, F. Stanculescu2, G. Socol3
Affiliations : 1 National Institute of Material Physics,105 bis Atomistilor Street, PO Box MG-7, 077125, Bucharest-Magurele, Romania 2 University of Bucharest, Faculty of Physics, 405 Atomistilor Street, PO Box MG-11, 077125, Bucharest-Magurele, Romania 3National Institute for Lasers, Plasma and Radiation Physics, 409 Atomistilor Street, PO Box MG-36, 077125, Bucharest-Magurele, Romania
Resume : We report the deposition of organic structures based on maleic anhydride–aniline derivatives (maleic anhydride-cyano aniline-A3 or maleic anhydride-2,4 dinitroaniline-A6) by matrix assisted pulsed laser evaporation (MAPLE) method on In doped ZnO (IZO) electrode. IZO films were obtained by pulsed laser deposition (PLD) on polymeric flexible substrates like polyethylene terephtalate (PET) and biaxially-oriented polyethylene terephthalate (Mylar). After the deposition, the IZO films were annealed up to 150oC for 1h or oxygen plasma treated at 0.6 mbar for 60 s. The MAPLE films were characterized by UV -VIS, Photoluminescence and FTIR spectroscopy. Atomic Force Microscopy was used to investigate the morphological features of the obtained layers. I-V characteristics of (metal/organic/IZO/flexible substrate) structures were recorded in dark and under the illumination with solar simulator (AM1.5). We found a good transparency of the organic film/IZO structures and the preservation of the PL properties after the laser transfer of the monomers. An improvement of electrical and optical performances was observed after the post -deposition treatments of IZO films. The correlation between the morphology and the electrical properties of the thin films was also investigated. I-V measurements revealed a diode behavior for metal/A6/IZO(annealed)/Mylar structure.

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16:00 **Synthesis of Nickel silicides by excimer laser irradiation for photovoltaic application**

Authors : T. Schutz-Kuchly1, N. Zimmermann1, J. Bartringer1, D. Muller1, A. Slaoui1, D. Aureau2, R. Cabal 3
Affiliations : 1 Laboratoire ICUBE, Universit? de Strasbourg and CNRS, 23 rue du Loess, 67037 Strasbourg, France 2 Institut Lavoisier de Versailles, Universit? de Versailles-St-Quentin en Yvelines, 45 avenue des Etats Unis, 78000 Versailles, France 3 CEA-INES 50 avenue du Lac L?man, 73375 Le Bourget du Lac, FRANCE
Resume : In this work, we investigate the formation of NiSi silicide by combining a deposition of Ni on silicon followed by a localized excimer laser irradiation. The Ni is electro-less deposited on silicon in an alkaline bath containing dissolved Ni chloride. The main advantage of the electro-less technique is the selectivity as the Ni can be deposited only on silicon surface and not on the dielectric films such as SiNx that can serve as surface passivation and antireflection coating. The Ni film was then irradiated by laser. The laser source is a UV Krypton Fluorine (KrF) excimer laser. The pulse duration is 50 ns and the repetition frequency is low, about 10 Hz. We have

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varied the Ni layer from 65 to 260nm and the laser energy densities from 0.5 to 2.5 J/cm?. SIMS, RBS and XPS techniques were applied to analyse the composition and quality of the laser irradiated area. For an electro-less Ni thickness of ~ 130 nm , Sheet resistances below 10 □/sq were measured on the irradiated Si/Ni regions for laser energy densities > 1 J/cm?. Rutherford Backscattering spectroscopy analysis revealed the formation of a NiSi phase for laser energy density of 0.5 J/cm?, and a NiSi2 phase for laser energy density of 2.5 J/cm?. These results are in good agreement with literature data concerning laser silicidation of PVD deposited Ni. The suitability of the formed Ni silicides for Si solar cells application will be discussed. corresponding author : abdelilah.slaoui@unistra.fr

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16:00 **Fabrication of cardiovascular drug delivery systems by matrix-assisted pulsed laser evaporation**

Authors : Alexandra Palla Papavlu, Valentina Dinca, Maria Dinescu
Affiliations : National Institute for Lasers, Plasma, and Radiation Physics, Bucharest-Magurele, MG 16, ZIP 077125, Romania

Resume : Over the last few years comprehensive research has been carried out for finding new approaches for transdermal drug delivery systems (TDS). In this study TDSs of Captopril employing thin polymer multilayers (i.e. polyisobutylene, ethylcellulose and hydroxypropyl (methyl)cellulose in different ratios) were fabricated by matrix-assisted pulsed laser evaporation (MAPLE). The TDSs were characterized in terms of their appearance, thickness, Captopril content, in vitro release rate and diffusion profiles. Atomic force microscopy and scanning electron microscopy have been applied to investigate the surface morphology of the TDSs. More insight on surface morphology, Captopril distribution and content in the deposited thin films has been achieved by contact angle measurements, Fourier transformed infrared spectroscopy and spectrophotometry measurements. In vitro release studies demonstrated controlled release for each TDS developed. The dissolution data suggested that the TDSs followed Higuchi kinetics i.e. cumulative amount of drug was proportional to the square root of time. These results indicate that MAPLE could be an alternative technique for the fabrication of Captopril transdermal patches.

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16:00 **Silver nanoparticle-oligothiophene nanocomposites and related time-resolved spectroscopy studies and structural properties**

Authors : A. Guarnaccio (1,2), P. A. Loukakos (3), D. Anglos (3), A. Santagata (1), M. D'Auria (2), R. Racioppi (2), R. Teghil (1,2), A. De Bonis (1,2)
Affiliations : (1) CNR-ISM U.O.S. Potenza, Zona Ind. – 85050 Tito Scalo (PZ) – Italy; (2) Department of Science, University of Basilicata, Via dell'Ateneo Lucano 10 – 85100 Potenza – Italy; (3) Institute of Electronic Structure and Laser -IESL, Foundation for Research and Technology Hellas – FORTH, 71110 Heraklion, Greece

Resume : In this work nanocomposites obtained by combining Ag nanoparticles with oligothiophenes have been investigated via optical and structural characterizations. The versatile Laser Ablation in Liquid method, for producing colloidal stable and defined Ag nanoparticle solutions has been adopted. UV-vis absorption spectra of the colloidal solutions of Ag nanoparticles obtained by ablating an Ag target in water using 100 fs laser pulses have provided the Ag nanoparticles evaluation mean size in the range of 50±20 nm. The Ag nanoparticle-oligothiophene nanocomposites solutions have been characterized by fluorescence and absorption techniques. For this purpose steady-state photoluminescence and absorption (350-800nm) together with time-resolved photoinduced absorption and emission spectroscopies have provided insights on the electronic structure, as well as the excitation and de-excitation mechanisms involved. The hybrid nanocomposites used have shown a blue shift with the increase of the concentration of metal nanoparticles. A study on their optical, electronic and structural characterizations has been drawn.

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16:00 **Synthesis, coordination chemistry, and photophysical properties of the 2-chloroethoxy-iron(III)(ethylthio) porphyrazine**

Authors : D. Pietrangeli (a), A. Santagata (a), P. A. Loukakos (b)
Affiliations : (a) CNR-ISM U.S.O. Potenza, Zona Ind. 85050 Tito Scalo (Pz) Italy; (b) Institute of Electronic Structure and Laser - IESL, Foundation for Research and Technology Hellas - FORTH, 711 10 Heraklion, Greece

Resume : Most of the promising properties of iron porphyrazines rely on the quite peculiar electronic structure of the porphyrazine ring and its impact on the metal-ligand interaction. The basic porphyrazine (Pz) macrocycle is composed

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of four pyrrole rings bridged by nitrogen atoms, the most relevant electronic effect of which is to induce a significant stabilization of the lowest oxidation states of the coordinated iron ion. This makes FePzs of potential interest in electrocatalysis [1-2]. Owing to the presence of aza bridges, Pzs are much stronger σ-donors than porphyrins. This has a significant impact on the pattern of the frontier Fe-3d based molecular orbitals and the related properties of Fe (III)Pzs. In this contribution the fundamental properties of FePzs and their modifications induced by peripheral heteroatom-containing chemical functions will be addressed using the iron(III)-2-chloroethoxy-2,3,7,8,12,13,17,18-octakis(ethylthio)porphyrazine (LFeOESPz) as a case study. An overview of the adopted synthetic route, the electronic and coordination chemistry properties of this complex in media of different polarity will be provided. The role of the metal- and ligand-centered excited states in the photo-physical behavior of the complex will be highlighted through steady-state and time-resolved UV-visible absorption spectroscopy studies. References 1. Pietrangeli, D.; Rosa, A.; Ristori, S.; Salvati, A.; Altieri, S.; Ricciardi, G. Coord. Chem. Rev., 2013, 257, 2213-2231 2. Pietrangeli, D.; Garramone, G.; Guascito, M. R.; Pepe, A.; Rosa, A.; Ricciardi, G. J. Porphyrin Phthalocyanines, 2013, 17,870-880

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16:00 **Precise surface modification of polymethyl-methacrylate with near-infrared femtosecond laser**

Authors : F. Caballero-Lucas, C. Florian, J.M. Fernández-Pradas, J.L. Morenza, P. Serra
Affiliations : Departament de Física Aplicada i Òptica, Universitat de Barcelona, Martí i Franquès 1, E-08028 Barcelona, Spain

Resume : Polymers like polymethyl-methacrylate (PMMA) are gaining interest for the design of microfluidic and lab-on-a-chip devices due to its transparency and chemical stability. Since laser beams can be focused to deliver energy with high spatial resolution, laser ablation can be used for the micromachining of a variety of materials. However, thermal effects, which for polymers are particularly critical, limit the resolution. Use of femtosecond laser pulses reduces these effects and allows the activation of non-linear absorption mechanisms on the beam waist for producing ablation even if polymers are transparent to the laser radiation. Ablation of PMMA was performed with a laser of 450 fs and 1027 nm. Series of laser pulses were fired on PMMA samples at different energies and focusing conditions (z-scans). In-situ measurement of the transmittance is evaluated as a high-precision method for controlling the z position of the sample surface. Ablated surfaces were inspected through optical and scanning electron microscopies. The morphology of the surface is related with the different energies and focusing conditions. The results show how under proper focusing conditions and pulse energies near the ablation threshold, PMMA surface can be machined with sub-micrometric resolution. At 200 nJ of incident energy, there is a range of 2 μm in the z position where the ablation produced on the surface is similar.

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16:00 **Laser assisted nitriding and surface characterization of titanium alloy Ti6Al4V for dental applications**

Authors : A. May (1), N. Agarwal (1), M. Lambert (1), C. Kaan Akkan (2), F. Nothdurft (3), C. Aktas (1)
Affiliations : (1) Leibniz Institute for New Materials, CVD/Biosurfaces, Saarbrücken, Germany (2) Institute of Biomedical Engineering, Boğaziçi University, Istanbul, Turkey (3) Department of Prosthetic Dentistry and Dental Materials Science, Saarland University, Homburg/Saar, Germany

Resume : Micro and nano structuring of surfaces have greatly proven to be essential for biomedical purposes. Lasers have been primarily used to achieve these surfaces rather than the ancient techniques. Titanium and its alloys are quite suitable for implant applications due to their biocompatibility, high wear and tear resistance and durability. Laser assisted nitriding of these alloys with different parameters, e.g., frequency, pulse duration and power lead to structures of different crystallinity on the surface. A self-developed nozzle to maintain the constant flow of nitrogen over the surface for nitriding was employed. Role of surface topography and chemistry is of key importance for dental implants. Contact angle measurements prove the hydrophobicity of the surface which can reduce biofilm formation. Roughness profiles of these surfaces are quite high to that of the bulk material. Analysis of the crystal structures and nitrogen concentration and depth would determine the actuality of the parameters for the cell growth. Usage of atmosphere led to different phase compositions of TiN and Al2O3 both suited for implants. This approach would help in the understanding of the cell and tissue interaction with the

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implant surfaces. Further research will aim to optimization of more complex surfaces suitable for implant application with improved characteristics. Laser-assisted structuring should accelerate the osseointegration process with long-term durability.

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16:00 **Bi0.5Sb1.5Te3 thin films for thermoelectric cooling applications**

Authors : E. Symeou, M. Pervolaraki, C. N. Mihailescu, G. I. Athanasopoulos, Ch. Papageorgiou, Th. Kyratsi, and J. Giapintzakis
Affiliations : Nanotechnology Research Center and Department of Mechanical and Manufacturing Engineering, University of Cyprus, 75 Kallipoleos Av., PO Box 20537, 1678 Nicosia, Cyprus

Resume : The development of thermoelectric thin films has brought a new perspective to the integration of thermoelectric cooling devices into microelectronic systems for thermal management purposes. Bulk Bi0.5Sb1.5Te3 exhibits the highest room-temperature power factor among p-type materials and is considered a state-of-the-art thermoelectric material. Bi0.5Sb1.5Te3 thin films with thermoelectric properties similar to or even better than bulk are desired. We used pulsed laser deposition at 248 nm to deposit thin films of the title compound from dense targets of Bi0.5Sb1.5Te3 with an excess of 1 wt% Te. Targets with excess of Te were used in order to avoid Te deficiency during synthesis. Fused silica substrates were employed for the deposition of the thin films at various temperatures in the range of RT and 350°C. We investigated the effect of deposition temperature, film thickness, fluence and annealing temperature on the thermoelectric properties of the films. We will present our recent results on the Seebeck coefficient, electrical resistivity and Hall carrier concentration as a function of temperature (2-400K) for Bi0.5Sb1.5Te3 thin films grown at different temperatures and of different thickness. Also we will present the annealing effects to the topology and electrical properties of the films. We will compare the thermoelectric properties of the Bi0.5Sb1.5Te3 films to those of the bulk material. Acknowledgement: The work was supported in part by the Cyprus Research Promotion Foundation (Project ANAVATHMISI/ 0609/06).

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16:00 **Fabrication and characterization of functionalized surfaces with silicon polymer films for anti-infective therapy applications**

Authors : Alexandru Mihai Grumezescu1, Alina Maria Holban3, Gabriel Socol2, Bogdan Stefan Vasile1, Rodica Cristescu2, Valentina Grumezescu1,2, Denisa Ficai4, Anton Ficai1, Roxana Twrusca5, Elena Grosu6, Florin Iordache7
Affiliations : 1Department of Science and Engineering of Oxidic Materials and Nanomaterials, Faculty of Applied Chemistry and Materials Science, University Politehnica of Bucharest, 1–7 Polizu Street, 011061 Bucharest, Romania 2Lasers Department, National Institute for Lasers, Plasma & Radiation Physics, P.O. Box MG-36, Magurele, Bucharest, Romania 3Microbiology Immunology Department, Faculty of Biology, University of Bucharest, 1–3 Portocalilor Lane, Sector 5, 77206 Bucharest, Romania 4Department of Inorganic Chemistry, Faculty of Applied Chemistry and Materials Science, University Politehnica of Bucharest, 1–7 Polizu Street, 011061 Bucharest, Romania 5S.C. Metav-CD S.A., 31Rosetti Str., 020015 Bucharest, Romania 6CPE-Bistrita SA, Parcului street no7, 420035 Bistrita, Romania 7Institute of Cellular Biology and Pathology of Romanian Academy, "Nicolae Simionescu", Department of Fetal and Adult Stem Cell Therapy, 8, B.P. Hasdeu, Bucharest 050568, Romania

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Resume : In the recent years, it has been noticed great percentages of severe and resistant infections associated with medical devices, surfaces and prosthesis. The aim of this study was to optimize the surface of wide use medical devices with silicon polymer films deposited by matrix assisted pulsed laser evaporation (MAPLE) method in order to improve their resistance to infections. The functionalized surfaces were characterized by infrared microscopy (IRM), scanning electron microscopy (SEM), high-resolution transmission electron microscopy (HR-TEM) and in vitro tests. Their anti-infectious potential was established by evaluating the microbial adherence and biofilm formation on the modified surfaces. The microbiological assays proved that MAPLE deposed silicon polymer films inhibited the adherence capacity and biofilm development of Gram-positive and Gram-negative bacterial strains. Furthermore, this films proved to be highly biocompatible (estimated up to five days by qualitative and quantitative analyses), allowing normal growth and development of human endothelial cells. All these properties recommend silicon polymer films in anti-infective therapy for improving different surfaces of medical use, including prosthesis and implantable devices.

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16:00 **Transfer by pulsed laser deposition of biological hydroxyapatite thin films doped with MgF2, MgO and Ti**

Authors : N. Mihailescu1, G. E. Stan2, L. Duta1, F. N. Oktar3-5, M. Sopronyi1, C. Luculescu1, M. C. Chifiriuc6, C. Ristoscu1, I. N. Mihailescu1
Affiliations : 1National Institute for Lasers, Plasma and Radiation Physics, Lasers Department, 409 Atomistilor Street, Magurele, Romania 2National Institute of Materials Physics, 105 bis Atomistilor Street, Magurele, Romania 3Department of Bioengineering, Faculty of Engineering, Marmara University, Goztepe, Istanbul 34722, Turkey 4Department of Medical Imaging Technics, Vocational School of Health Services, Marmara University, Uskudar, Istanbul 34668, Turkey 5Nanotechnology and Biomaterials Application & Research Centre, Marmara University, Istanbul, Turkey 6Department of Microbiology, Faculty of Biology, University of Bucharest, 1-3 Portocalelor Street, Bucharest, Romania

Resume : Hydroxyapatite (HA) is a well consecrated biomaterial for bone substitution. In form of thin films deposited by advanced pulsed laser technologies, it can be used for coating of metallic implants with good mechanical strength. We used for deposition HA of animal (bovine, BHA) doped with (2%) MgF2 or (5%) MgO and human (dentine, DHA) doped with (5%) Ti origin to improve the hardness, fracture toughness, thermal stability, densification and to enhance the biocompatibility and bioactivity. In PLD experiments, a KrF* (λ = 248 nm, τFWHM ≤ 25 ns) excimer laser source was used. The deposited thin films were characterized by XRD, FTIR, SEM, EDS and Pull-out adherence tests. The cytotoxic activity was tested using human fibroblasts and the vital staining assay. The specimens proved to be not cytotoxic in contact with human fibroblasts. The film microbiological assay was performed on three strains isolated from patients with dental implants failure, i.e. Candida albicans, Enterobacter sp. and Micrococcus sp. The tested materials behaved differently in the three cases. The best antimicrobial activity was proved in case of Enterobacter sp. when the tested specimens strongly inhibited the bacterial adherence, the most significant effect being obtained in the presence of BHA:MgO thin film, followed by DHA:Ti and BHA:MgF2. The improved antibacterial performance recommend these biomaterials as an alternative to commercial HA for implants coating.

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16:00 **Comparison between femtosecond and nanosecond laser processing of PDMS polymer: Raman spectroscopy investigation**

Authors : N.E. Stankova, P.A. Atanasov, T.R. Stoyanchov, K.N. Kolev, E. Valova, J. Georgieva, St. Armyanov
Affiliations : Institute of Electronics, Bulgarian Academy of Sciences; Institute of Physical Chemistry, Bulgarian Academy of Sciences

Resume : Medical grade polydimethyl siloxane (PDMS) elastomer is a widely used biomaterial as encapsulation and/or as substrate insulator carrier for long term neural implants because of its remarkable properties. Femptosecond and nanosecond laser irradiation of PDMS-elastomer surface under ambient conditions is investigated. Different processing parameters including pulse duration, wavelength (266, 355 and 532 nm), fluence and scanning speed have been investigated to optimize the surface activation without altering the polymer bulk properties and to fabricate high definition tracks and electrodes. Remarkable alterations of the morphological and the structural characteristics as well as of the chemical composition of the ablated traces in comparison with the native material are observed. Comparison of the Raman spectroscopic results illustrates well defined dependence of the chemical composition on the pulse duration. A local chemical transformation is occurred in the nanosecond laser fabricated tracks. An extra peak at about 516 cm-1 is observed in the spectrum which is ascribed to crystalline silicon. Obvious ablative decomposition in the Raman spectra of the femptosecond laser treated surface is not observed. Femptosecond and nanosecond laser activated tracks are metallized selectively with Ni or Pt. It is observed the time interval between the laser irradiation and the electroless deposition is not critical parameter for successful metallization to occur.

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16:00 **AN INEXPENSIVE ALTERNATIVE TECHNIQUE FOR LASER-INDUCED SURFACE MODIFICATION IN BISMUTH THIN FILMS**

Authors : Adela Reyes Contreras, Alejandro Esparza García, Oscar Olea Mejía, Mathieu Hautefeuille, Marco Antonio Camacho-López
Affiliations : Facultad de Ciencias - Universidad Autónoma del Estado de México, Departamento de Tecnociencias - Centro de Ciencias Aplicadas y DEsarrollo Tecnológico - Universidad Nacional Autónoma de México, Centro Conjunto de Investigación en

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Química Sustentable - UNAM-UAEM, Facultad de Ciencias - Universidad Autónoma del Estado de México, Facultad de Química - Universidad Autónoma del Estado de México

Resume : In this work, we present a low-cost laser processing technique using laser pulses from a CD-DVD pickup head (PUH) to generate localized surface changes on a bismuth thin film. The optical setup is based on two laser diodes located on a three-axis platform with micro-displacement, controlled by computer. The 785nm laser beam is then precisely focused and pulsed onto the sample, a 500nm thick bismuth film deposited by sputtering onto a glass slide. It was observed that final results are strongly dependent on irradiation parameters as well as material properties and deposition conditions. Usually, the illumination of solid surfaces by polarized laser beam with a fluence below the material damage threshold results in Laser Induced Periodic Surface Structures (LIPSS) formation, useful in gratings formation. These structures have been extensively investigated on different materials as they present a variety of potential applications in microelectronics, sensors and biomedical technology. We demonstrated that the PUH is a simple and inexpensive alternative to high power lasers for bismuth direct micropatterning. The influence on the surface modification of parameters such as pulse duration, fluence, and power density as well as beam polarization was studied by examining and characterizing laser etched patterns. In particular, the circular polarization of the laser beam normally coming out of the PUH was modified by means of an external polarizer.

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16:00 **In-process measurement of the impact of laser irradiation on the electrical properties of thin-film samples**

Authors : Klaus Zimmer1, Xi Wang1, Pierre Lorenz1, Martin Ehrhardt1, Christian Scheit2, Alexander Braun2
Affiliations : 1 Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany; 2 Solarion AG, Ostende 5, 04288 Leipzig, Germany

Resume : Laser processing for thin-film applications requires the fabrication of high resolution and well-defined patterns written by laser but also addresses the electrical functionality of the laser written patterns. Due to the high energy impact on laser irradiation and subsequent laser-induced processes laser modifications of the film materials or the substrate can change the electrical properties in consequence of the laser processing. Hence, an application-oriented optimization of laser processing requires both the evaluation of geometrical as well as electrical characteristics of the laser process. In this presentation a recently developed approach of in process evaluation of the laser impact on the electrical characteristics of thin-film samples is presented. The experimental set-up, the methodology of the measurements, and the evaluation of the measurements will be presented and discussed. The presented technique will be applied to the P3 scribing process of thin film solar cells to allow the minimization of the electrical losses due to laser scribing.

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16:00 **Femtosecond laser-induced refractive index change in dielectrics: Newton ring formation**

Authors : J. Hernandez-Rueda,M. Garcia-Lechuga, J. Siegel, J. Solis
Affiliations : Laser Processing Group, Instituto de Óptica, CSIC, Serrano 121, 28006 Madrid, Spain

Resume : Optical changes induced at the surface of dielectric materials upon femtosecond laser irradiation have been investigated and quantified by using an interferometric method which makes analyses o the surface reflectivity modulation. The observed modulation changes are attributed to the formation of a sub-micrometric layer of modified material underneath the laser-ablated region. The layer with modified optical constants acts as a micro Fabry-Perot etalon, which has been confirmed by optical microscopy measurements performed with different monochromatic illumination sources, revealing interference patterns in form of wavelength-dependent Newton rings. This behaviour has been recently reported for phosphate glass and fused silica below and over the ablation threshold respectively. We find that it is a general phenomenon in inorganic dielectrics (amorphous and crystalline), transparent polymers and semiconductors. In this study, the optical response of three different dielectric materials has been investigated in more detail, namely fused silica, quartz and phosphate glass, at fluences above and below the ablation threshold. The analysis of the Newton rings allows to quantify the changes in the complex refractive index (Δκ, Δno) as well as the thickness of the laser modified layer can be determined. In addition the results linked to the thickness

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of the modified layer have been compared consistently to calculations based on a one dimensional heat conduction equation.

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16:00 **Spatiotemporal dynamics of ultrashort pulse laser excitation of transparent dielectrics: Modeling based on Maxwell?s equations**

Authors : Vladimir V. Zhukov, Nadezhda M. Bulgakova
Affiliations : V.P. Zhukov: (1) Institute of Computational Technologies SB RAS, 6 Lavrentyev Ave., 630090 Novosibirsk, Russia; (2) Novosibirsk State Technical University, 20 Karl Marx ave., 630073, Novosibirsk, Russia; N.M. Bulgakova: (1) HiLASE Project, Institute of Physics ASCR, Na Slovance 2, 18221 Prague, Czech Republic; (2) Institute of Thermophysics SB RAS, 1 Lavrentyev Ave., 630090 Novosibirsk, Russia

Resume : We report on the results obtained in the frames of a 2D (axially-symmetric) model describing laser beam propagation through transparent solids, based on non-linear Maxwell?s (NLM) equations. The model accounts for the Kerr effect, photo-ionization, frequency dispersion of dielectric permittivity, and plasma hydrodynamics with laser-induced electron acceleration and avalanche. Material excitation induced by single femtosecond laser pulses at 800 nm wavelength focused inside the samples has been studied numerically for the fused silica case. Additionally, a widely utilized model based on the non-linear Schr?dinger (NLS) equation has been applied to simulate laser-induced excitation of fused silica under the same irradiation conditions to compare with the NLM results. For typical modification conditions, the NLS results have been found to differ considerably from those obtained with the NLM model. This discrepancy is explained by the fact that the NLS approach does not take into account considerable laser light scattering to large angles by free electrons in spite of the fact that the electron density remains subcritical during the pulse action. We will discuss spatiotemporal dynamics of free-electron density, laser intensity, and energy absorption in glass vs. pulse energy, duration, and focusing angle and analyze the development of an ionization scattering instability which can be responsible for the formation of volumetric nanogratings in a number of transparent materials.

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16:00 **Femtosecond Laser Ablation of Molybdenum**

Authors : PINAKI DAS GUPTA, GERARD O'CONNOR
Affiliations : National University of Ireland, Galway, Ireland

Resume : Molybdenum is widely used in solar cell industry, OLED devices and as an element in 2D dichalcogenide materials. Selective laser patterning of such structures offers a potential route to high volume production. Laser molybdenum interactions are very interesting due to its partly-filled d band electronic configuration. The objective of this study is to explore to laser ablation of Molybdenum with different parameters of a femtosecond laser. A repetitively pulsed femtosecond laser source with wavelengths 1030 nm, 515 nm and 343 nm, each of pulse duration 500 fs, was used to ablate Molybdenum with thickness of 0.125 mm. A beam scanning system was used to direct beam over surfaces. The threshold fluence was determined for different wavelengths, spot sizes and repetition rates. The spectral emission from the ablated Molybdenum plume was also investigated. Experiments were performed on rough and polished Molybdenum samples. Results show the damage threshold of Molybdenum at 1030 nm is characterised by single absorbed threshold fluence (0.09 ± 0.01 Jcm-2) for the range of experimental parameters used. Laser ablation at 515nm is described by two threshold values. Gentle and strong ablation was measured to be 0.05 ± 0.002 Jcm-2 and 0.2 ± 0.03 Jcm-2 respectively. Initial results confirm the threshold fluence for UV to be 0.12 ± 0.004 Jcm-2. A full parametric study on femtosecond laser ablation of molybdenum will be presented.

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16:00 **Physical-chemical transformations of organic compounds under intense laser influences**

Authors : K. V. Khishchenko
Affiliations : Joint Institute for High Temperatures RAS, Moscow, Russia

Resume : Models of thermodynamic properties and transformations of materials are required for simulations of processes in condensed media under intense laser pulsed influences. In the present work, an equation-of-state model for organic compounds is proposed with taking into account the physical-chemical transformations at high pressures and temperatures. These transformations are connected with decomposition of initial molecules and formation of diamond-like carbon and other components under intense loading conditions. Multiphase equations of state for polystyrene,

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polymethylmethacrylate and epoxy composition are developed. As distinct from the previously obtained equations of state [1], new expressions for the thermodynamic potentials are formulated. Those provide for a more correct accounting for physical-chemical transformations of the substances under ultrafast heating and rarefaction [2]. A critical analysis of calculated results is made in comparison with available experimental data for the organic compounds over a wide range of densities and temperatures. [1] K. V. Khishchenko, I. V. Lomonosov and V. E. Fortov, Int. J. Thermophys. 23, 211–219 (2002). [2] M. E. Povarnitsyn, N. E. Andreev, P. R. Levashov, K. V. Khishchenko, D. A. Kim, V. G. Novikov and O. N. Rosmej, Laser Part. Beams 31, 663–671 (2013).

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16:00 **Matrix Assisted Pulsed Laser Evaporation of Biological Thin Films: Lipase**

Authors : A.Aronne (a), F. Bloisi (b), R. Calabria (c), V. Califano (c), L. E. Depero (d), E. Fanelli (a), S. Federici (d), P. Massoli (c), L. Vicari (b)
Affiliations : (a) Department of Material and production engineering, University of Naples Federico II (b) CNR-SPIN and Department of Physics, University of Naples Federico II (c) Istituto Motori-CNR (d) DIMI, University of Brescia

Resume : Lipase is an enzyme catalyzing reactions borne by triglycerides such as transesterification for biodiesel production and has been used in biosensors for detection of β-hydroxyacid esters [1] and triglycerides in blood serum [2]. Immobilization of the enzymes is essential for their industrial application, since it allows the development of continuous processes, easier separation of products, the reuse of the catalyst and, in some cases, it enhances enzyme properties such as pH and temperature stability and their catalytic activity in non-aqueous media [3]. MAPLE is a thin film deposition technique derived from Pulsed Laser Deposition (PLD) for deposition of delicate materials (biomolecules, polymers, etc.) in undamaged form. The main difference in comparison to classical PLD is the use of a frozen (usually by means of a liquid nitrogen flux) target obtained from a solution or a suspension of the guest material (to be deposited) in a matrix (a volatile solvent). In this way, the laser beam energy is mainly absorbed by the matrix while only the guest material reaches the substrate, since the solvent is pumped away by the vacuum system. By MAPLE technique it can be possible to "freeze" the conformation of the lipase as it is in solution, in such a way to tailor lipase properties in solution. In this way the lipase conformation, essential for its catalytic activity, would be independent on the support properties. Here we show that Matrix Assisted Pulsed Laser Evaporation (MAPLE) technique can be used to deposit lipase. 1. T. Kullick, R. Ulber, H.H. Meyer, T. Scheper, K. Schlügerl. Anal. Chim. Acta. 239 (1994) 271 2. Mohanasundaram Sulur Veeramani, Karuppiah Prakash Shyam, Noel Prashant Ratchagar, Anju Chadhabc and Enakshi Bhattacharya, Miniaturised silicon biosensors for the detection of triglyceride in blood serum, Anal. Methods, 2014, Advance Article; DOI: 10.1039/C3AY42274G. 3. P.M. Nielsen, J. Brask, L. Fjerbaek. Eur. J. Lipid Sci. Technol. 110 (2008) 692-700.

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16:05 **Fs-Laser Processing of Polydimethyl Siloxane**

Authors : P.A. Atanasov, N.N. Nedyalkov, E.I. Valova, J.S. Georgieva, St.A. Armyanov, K.N. Kolev, S. Amoruso, X. Wang, R. Bruseze, M. Sawczak, G. Śliwiński
Affiliations : P.A. Atanasov, N.N. Nedyalkov; Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko shose, Sofia 1784, Bulgaria E.I. Valova, J.S. Georgieva, St.A. Armyanov, K.N. Kolev; Rostislaw Kaischew Institute of Physical Chemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., block 11, Sofia 1113 S. Amoruso, X. Wang, R. Bruseze; CNR-SPIN, Dipartimento di Scienze Fisiche, Universita degli Studi di Napoli Federico II, Complesso Universitario di Monte S. Angelo, Via Cintia, I-80126 Napoli, Italia M. Sawczak, G. Śliwiński; Photophysics Department, The Szewalski Institute, Polish Academy of Sciences, 14 Fiszera St, 80-231 Gdańsk, Poland

Resume : Surface structuring of polydimethyl siloxane films, deposited on different substrates, by femtosecond UV laser pulses in air is presented. The influence of the laser fluence on the surface morphology is studied. The as processed areas are analyzed by AFM, SEM and optical microscopy. The study is emphasizing on the Raman spectroscopy. The change of the Raman spectra prior and after laser treatment is observed. Finally, successful metallization of laser processed traces is produced. Some practical aspects of fs-laser treatment and chemical metallization of the processed area are discussed with respect to use such technology for micro-fabrication of a PDMS device in MEMS and NEMS.

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16:05 **Laser transfer and reduction of graphene oxide and chemical sensing applications**

Authors : S. Papazoglou1, V. Tsouti2, Y. S. Raptis1, S. Chatzandroulis2, I. Zergioti1
Affiliations : 1National Technical University of Athens, Physics Department, Iroon Polytehneiou 9, 15780 Zografou, Athens, Greece 2Institute of Microelectronics, NCSR Demokritos, Athens, Greece

Resume : The aim of this work is the pulsed laser printing of graphene oxide (GO) using the Laser Induced Forward Transfer technique (LIFT) and the subsequent laser-assisted reduction of the deposited graphene oxide patterns on silicon and flexible substrates for gas sensing applications. In parallel, a comparative study between the efficiency of the thermal and laser-assisted reduction mechanisms was performed. The transfer and reduction experiments were carried out using a pulsed Nd:YAG laser (266 nm wavelength, 4 ns pulse duration) combined with a high power imaging micromachining system. Graphene oxide, an otherwise insulating material due to its surface characteristics, which include the presence of functional carboxyl and hydroxyl groups on its basal plane, can be effectively reduced in order to restore its electrical properties. In this context, the LIFT printed GO patterns was irradiated after the deposition, using the 4th harmonic (266 nm) at 2 Hz, so as to obtain its reduced form. The laser-assisted reduction study was performed by irradiating the GO surface with 50-200 pulses at a range of different fluences, in order to determine the optimum reduction conditions. In addition, the printing mechanism of graphene oxide on different substrates is being investigated and the transferred structures are characterized, structurally and morphologically. The reduction efficiency of the laser printed and reduced GO was determined by Raman spectroscopy and electrical measurements, aiming towards the exploitation of reduced graphene oxide electrical conductivity, for the fabrication of resistive gas sensors.

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16:05 **Dimension analysis of the refractive index change in borosilicate glass induced by femtosecond laser irradiation**

Authors : A. Dias 1 2, M. Gómez-Aranzadi 1 2, A. Pan 1 2, A. Rodriguez 2, S. M. Olaizola 1 2
Affiliations : 1 CEIT-IK4 and Tecnun (University of Navarra), Manuel Lardizabal 15, 20018 San Sebastián 2 CIC microGUNE, Goiru Kalea 9 Polo Innovación Garaia, 20500 Arrasate-Mondragón, Spain.

Resume : Glass processing with ultrafast laser is becoming a competitive technology to fabricate integrated devices and systems. When a femtosecond laser pulse penetrates a transparent material, the refractive index is changed in the focal volume due to nonlinear absorption processes . We have studied the dimensions and the effective index change in AF45 borosilicate glass as a function of the laser power and number of pulses. We have focused the laser light with a 20x high energy objective (NA=0,4). We have found that the threshold power for visible lines with phase contrast microscopy is 0.158mW. The length of the volume of the index change along the propagation axis of the laser is an increasing function of the power and beam radius and ranges from 9 um (0,158 W) to 43 um (1,680 W). The diameter of the circumference section perpendicular to the laser propagation has a minor dependence with fluence. An analysis of the position and dimensions of the process volume results on a process that depends on the transient femtosecond-induced Kerr Effect, the spherical aberration of the glass and the filamentation of light in the glass media. As a practical result of this analysis we have found that the process length depends on the distance of the focal point to the glass surface.

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Laser interaction with advanced materials: fundamentals and applications

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start at	Subject	Num.
	Laser Processing: Laser writing and applications : N. Semmar	
08:30	**Direct Laser Writing: Principles and Applications in Photonics, Metamaterials and Biomedicine (Invited)** **Authors :** Maria Farsari **Affiliations :** N. Plastira 100, Vassilika Vouton, 71300, Heraklion, Crete, Greece. **Resume :** Direct Laser Writing (DLW) based on the multi-photon polymerization of photosensitive materials is a technique that allows the fabrication of three-dimensional structures with sub-micron resolution. The polymerization is based on multi-photon absorption; when the beam of an ultra-fast laser is tightly focused into the volume of a transparent, photosensitive material, the polymerization process can be initiated by non-linear absorption within the focal volume. By moving the laser focus three-dimensionally through the material, 3D structures can be fabricated. The technique has been implemented with a variety of materials and several components and devices have been fabricated such as photonic crystal templates, mechanical devices and microscopic models. The unique capability of DLW lies in that it allows the fabrication of computer-designed, fully In this seminar we summarize the principles of microfabrication by DLW. We discuss the fundamental principles of multi-photon absorption and describe a typical DLW experimental set-up. Then we concentrate on the materials used for DLW microfabrication, and on our recent work in the functionalization of the surface and the bulk of the 3D fabricated structures. Finally, we discuss the future applications and prospects for the technology. add to my program (close full abstract)	J.VIII 1
09:00	**Photo-inscription of surface relief gratings in sol-gel materials** **Authors :** N. Desboeufs, AD. Vu K. Lahlil, L. Martinelli, J. Peretti, Y. Lassailly, JP. Boilot, T. Gacoin **Affiliations :** Laboratoire de Physique de la Matière Condensée, UMR 7643-CNRS, Ecole Polytechnique, 91128 Palaiseau Cedex, France **Resume :** Several spectacular photomechanical processes driven by the photo-isomerization of azobenzene molecules have been investigated in recent years . The cis-trans transition of the azobenzene is indeed accompanied by various changes of the material properties. An impressive example is the significant light induced mass transport. This phenomenon allows one-step inscription of high quality surface relief gratings (SRG). The originality of the process is that it is an uncontacted and non-destructive lithographic technique. However, applications are limited by the strong light absorption of the films in the visible range due to the azobenzene chromophores. Starting from our previous work on azobenzene doped sol-gel films , we report here a new method to remove all the organic chromophores while preserving the structuration. This method provides a way to obtain uncolored and transparent silica based SRG that could have interesting applications for example in the field of light extraction . We also improved our understanding of the photo-deformation process. This allowed us to optimize the amplitude of the grating that seems to be mainly limited by mechanical stresses at the interface between the substrate and the layer. Varying the rheological properties of the sol-gel film, we show that these stresses can be released by heating softly the film during the optical patterning, thus largely improving the amplitude of the structures. add to my program (close full abstract)	J.VIII 2

09:15 **Two-photon lithographic fabricated plasmonic nanowires for anti-counterfeiting application**

Authors : Xing Yi LIng
Affiliations : Nanyang Technological University, Singapore

Resume : We present the next generation covert plasmonic security labels based on Ag nanowire structures fabricated by two-photon lithography and thermal evaporation. Selective read-out of molecular information is based on their polarization-dependent surface-enhanced Raman scattering (SERS) imaging. Simulation and experimental results show that the SERS signals from the embedded molecules depend significantly on the polarization of the incident field. The covert molecular information cannot be revealed directly from the physical features, but can only be read-out selectively by polarization-dependent SERS imaging. Our plasmonic security labels exhibit very narrow spectral fingerprint vibration, which is more specific than broadband colorimetry-based systems. The polarization-dependent SERS intensity, molecular fingerprint of SERS spectra, and versatile geometrical design by two-photon lithography have made our plasmonic Ag nanowire structures an ideal candidate as advanced security solutions for anti-counterfeiting application.

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09:30 **Laser scribing of thin film solar cells**

Authors : Michele Sozzi, Daniele Menossi, Alessio Bosio, Annamaria Cucinotta, Nicola Romeo, Stefano Selleri
Affiliations : Dept. of Information Engineering, University of Parma, Parma, Italy; Dept. of Physics and Earth Sciences, University of Parma, Parma, Italy; Dept. of Information Engineering, University of Parma, Parma, Italy; Dept. of Physics and Earth Sciences, University of Parma, Parma, Italy; Dept. of Information Engineering, University of Parma, Parma, Italy

Resume : The low cost production of photovoltaic solar modules is a key factor to achieve the objective of reducing the cost of electricity in order to obtain the so called grid parity, and photovoltaics (PV) would be more convenient than the traditional fossil fuels. Thin films can be a promising technology to achieve this goal, and a good alternative to the traditional silicon (Si) based solar modules. The module fabrication with this technology, compared to crystal Si based one, is monolithic and completely automatic, with the result of dropping production costs. In this way thin films based modules can be competitive with the Si based ones, despite their lower efficiency. Nowadays poly-Si based modules are sold at 0.88 €/W, mono-Si based modules at 0.99 €/W, while thin films modules at 0.89 €/W. It's then easy to understand that thin films PV modules are really competitive with Si ones and this is possible because of the lower production cost for thin films. In the thin films module fabrication, the material is deposited all over the module surface, and a scribing process is needed in order to divide the module in smaller areas that form the single cells of the module. All the cells must be connected in series, such as the power produced by the module is suitable for industrial and domestic application. The employment of high power, high quality lasers is fundamental in order to improve the working speed and the easiness of operation, that are basic requirements for a large scale production. The two most innovative materials for the production of thin films based modules are CdTe (Cadmium Telluride) and CIGS (CuInGaSe2), with an efficiency of 19% and 20.3%, respectively obtained on small area samples (1cm2). That is comparable with the 25% efficiency of Si based modules. The thin film stack is composed by three layers, an absorber layer and a window layer are inserted between two electrical contact layers, and the whole thickness is about 2-3□m for CIGS, and 8-10□m for CdTe. One of the two contact layer, called front contact, must be transparent, in order to let the light pass through and be absorbed by the absorber layer. A Transparent Conductive Oxide (TCO) is used. TCO is the first layer of the stack for CdTe based cells and it is deposited on the substrate, while for CIGS based ones it is the third layer and it is deposited on the top of the stack. Then the back contact is the third layer for CdTe cells, composed by As2Te3, Copper (Cu), and Molybdenum (Mo) films. For CIGS solar cells, the back contact is instead the first layer to be deposited and it is constituted by a Mo double layer, directly deposited on the substrate. Since in CdTe based cells the front contact is deposited on the substrate, this must be of course transparent and Soda Lime Glass (SLG) is usually used. On the other hand CIGS based cells can be more versatile because the front contact is on the top of the layers stack and different kind of substrates can be used, as polymers or steel foils to fabricate flexible modules, and ceramic. The scribing process is composed by three different steps called P1, P2, and P3. Every step is performed after the deposition of one of the layers of the film stack. P1 is performed after the deposition of the front contact for CdTe cells, and the back

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contact for CIGS cells, on the substrate. The aim is to isolate the front/back contact of the adjacent cells, and defining the single cell area. P2 is performed after the deposition of the absorber layer to make sure that the front/back contact will not be isolated from the back/front contact. P3 is performed after the deposition of the back contact for CdTe cells, and the front contact for CIGS cells, in order to isolate the back/front contact layer of the adjacent cells, and make possible their connection in series. In this work an extensive number of tests have been carried out on both CdTe and CIGS based solar cells. P1, P2, and P3 scribes have been performed and characterized. Three different lasers have been used for the scribing process. A standard double clad optical fiber laser, developed inside the Department of Information Engineering of the University of Parma (UniPr), emitting in the nanosecond (ns) regime at the wavelength of 1064nm with an average power of 1W, and a M2 of 1.1. A rod-type photonics crystal fiber laser provided by Eolite Systems (Eolite) , emitting in the ns regime at the wavelength of 1030nm, and 515nm. In this case the output beam has a maximum average power of 40W in the IR regime, and 15W in the green regime with a M2 below 1.3. A diode pumped solid state (DPSS) laser provided by Innolight GmbH (now produced by Coherent Inc.), emitting in the picoseconds (ps) regime at the wavelength of 1064nm with an average output power of 5W, and a M2 below 1.2. All the lasers were mounted on a machine equipped with translating stages, along X and Y directions, on which the samples were positioned for the exposure. The obtained scribes have been characterized by means of an optical microscope, and a Scanning Electron Microscope (SEM). For testing 10x10cm2 mini-modules have been fabricated. Three different sets of mini-modules laser scribing tests have been made. In the first set P1 was performed with the UniPr fiber laser while P2 and P3 with a traditional solid state laser. For the second set P2 was performed with the Eolite fiber laser while P1 and P3 with a traditional solid state laser, and for the third set P3 was performed with the same laser while P1 and P2 with a traditional solid state laser. This was done in order to verify if performing one of the three steps with a fiber laser could bring to an efficiency improvement compared to a mini-module whose P1, P2, and P3 have been performed all with a traditional solid state laser. Results showed that high quality incisions have been obtained. P1, P2, and P3 performed on CdTe samples proved to have a clean groove, with no cracks inside, and a minimum re-deposition of TCO on the edges for P1, and if compared to those performed with a traditional solid state laser they have a minimal Heat Affected Zone (HAZ) with very steep edges, moreover the ones performed with the solid state laser suffer from heavy cracks inside the groove. Most probably the higher quality of the scribes obtained with the fiber lasers is due to their better beam quality, compared to the one of the solid state laser, that has an M2 above 1.5. The mini-module efficiency measurements proved that the mini-modules fabricated with the scribes performed with the fiber lasers were more efficient than the ones scribed with the solid state one, taken as a reference. The measured efficiency was 10.31% for the P1, 10.41% for the P2, and 10.24% for the P3, while for a reference mini-module a measured efficiency of 9.46% has been measured, proving an efficiency increase if the scribes are performed with a fiber laser. CIGS P1 and P2 have been performed with the Eolite laser. P1 has been performed glass-side; the groove looked clean in the middle, some Mo re-deposition and micro-cracks were visible on the edges, but not so significant to consider the scribe of bad quality. P2 was performed at first film-side, considering that Mo is not transparent. In this case a clean groove has been obtained, but with clear re-deposited material on the edges. This problem has been resolved by performing P2 glass-side, exploiting the fact that Mo has a higher boiling point than CIGS. It was then possible to heat the Mo layer and remove the overlying layer, without damaging the Mo. This resulted in a clean groove with steep edges, and no re-deposition. The tests done to perform the P3 suggest that the same principle used for the P2 can be applied here, but due to lack of samples it was not possible to find the exact experimental conditions to obtain a scribe of very good quality. An improvement for the P1 has been obtained by performing it with the picoseconds laser. In this case it was possible to avoid at all cracks and re-deposition of Mo, and the edges resulted to be very steep. The use of high quality, high power fiber lasers can lead to an effective fabrication of thin films PV modules. This has been demonstrated by the high quality incisions that have been obtained. The use of such lasers in an industrial process can help to reduce the €/W ratio, and make the thin films PV modules more competitive. Moreover by reducing the pulse duration it would be possible to further improve the scribes quality.

09:45 **Femtosecond ablation using an intensity spatial light modulator: What is the minimum machinable feature size?**

Authors : B. Mills*, D. J. Heath, J. A. Grant-Jacob, M. Feinaugle and R. W. Eason
Affiliations : Optoelectronics Research Centre, University of Southampton, Southampton, UK.

Resume : Advances in digital multimirror devices (DMDs), which consist of arrays of micron-sized mirrors that are individually switchable, have recently led to their use in a variety of applications in optics and laser science. Here, a DMD is used as an intensity spatial light modulator for 800nm, 1mJ, 150fs pulses, at a 1kHz repetition rate, for high-resolution subtractive machining of thin films. The use of a high-energy laser pulse enables an entire complex pattern, with approximately 1000 by 1000 pixel resolution, to be ablated in a thin film by a single ultrashort pulse. We continue the progress of [1] by reducing the minimum feature size from ~400nm down to <200nm, through careful management of the multiphoton processes, to controllably create connecting structures. Initial results show designed features that are thinner than one-tenth of the laser wavelength. We show that the ability to pattern unique structures for each individual laser pulse enables the patterning of large areas of contiguous complex structures (1mm-squared per hour), with sub-wavelength feature sizes. We will also present recent experimental results on the application of this technique to the rapid parallel processing of bulk materials, including diamond. [1] B.Mills et. al. Journ. Micromech. and Microeng. 23 (2013) 035005

J.VIII 5

add to my program (close full abstract)

10:00 **Cofee Break**

Laser processing: Modification of material properties : L. Zhigilei

10:30 **New Material Phases through Fs-Laser Induced Confined Microexplosion (Invited)**

Authors : L. Rapp (1), B. Haberl (2), C. J. Pickard (3), J. E. Bradby (2), J. S. Williams (2), E. G. Gamaly (1), A. V. Rode (1)
Affiliations : (1) Laser Physics Centre and (2) Electronic Materials Engineering, Research School of Physics and Engineering, The Australian National University, Canberra ACT 0200 Australia (3) Department of Physics and Astronomy, University College London, London WC1E 6BT, UK

Resume : Intense ultrafast laser pulses tightly focused in the bulk of transparent material produce plasma in the extreme conditions similar to those in the cores of planets. The plasma generates strong shock waves in such confined geometry, thus inducing a laser-ignited microexplosion. This new method of compression of matter by ultra-short laser induced micro-explosion generates pressures in excess of Terapascals, leaving all the pressure/temperature-affected material confined inside the bulk of pristine crystal for the further investigations. In contrast to dynamic (shock wave) and static (diamond-anvil cell) methods, the initial materials in a microexplosion are transformed into the high entropy state of extreme dense plasma where the memory of the initial state is completely lost. This state is similar to "a primeval soup" at the early stages of the Universe evolution. The randomised material swiftly cools down isochorically to ambient in a short, nanosecond-scale time. For example, it was demonstrated that a sapphire crystal converted by a fs-laser pulse to plasma returns to the ambient state as a mixture of nano-crystallites of the previously unobserved form of bcc-aluminium (Nat. Commun. 2, 455 (2011)). In this presentation the new experimental results evidencing the formation of novel structures in laser-induced confined micro-explosion in silicon and diamond will be highlighted.

J.IX 1

add to my program (close full abstract)

11:00 **Shifting the VO2 phase transition: A chromium doping solution**

Authors : R. Zaabi, JC Orlianges, F.Dumas Bouchiat ,C.Champeaux
Affiliations : SPCTS UMR 7315 CNRS / Université de Limoges Centre Européen de la Céramique - 12 rue Atlantis, 87068 Limoges, France

Resume : Vanadium dioxide (VO2) presents a first order metal-to-insulator transition (MIT) exhibiting an abrupt change in its resistivity and near-infrared transmission accompanied by a structural phase transition from a room temperature monoclinic to a high temperature tetragonal phase. This characteristic MIT occurs above 68°C under external stimuli such as heating, applying electrical voltage or current, strain… The transition properties

J.IX 2

(temperature, dynamic) depend on the elaboration process and parameters (deposition temperature, ambient gas, film thickness…) and can also be managed by doping allowing enlarged electronics applications. One of the new challenges for studies on this smart material is to tune its transition temperature without degrading its transition properties. In this study, we report on the elaboration of Cr doped VO2 thin films on C-sapphire substrates by multitarget pulsed laser deposition from vanadium and chromium targets. The structural, electrical and optical properties are investigated for Cr-doped thin films from few to about 20 percent and compared to pure VO2 films. The doping leads to a shift of the transition temperature to higher values up to about 2.5% doping and to lower values below coupled with modification of the transition amplitude and width. This behavior will be discussed as a function of the intra or intergranular position of Cr in the film.

add to my program (close full abstract)

11:15 **Femtosecond Laser Magnetic Patterning of Fe-V Thin-Film Alloys Based on Ultrafast Diffusive Transformations**

Authors : N. I. Polushkin^1,2, V. Oliveira^1,3, O. Conde^2, R. Vilar^1,
Affiliations : ^1University of Lisbon, Instituto Superior Tecnico and ICEMS, 1049-001 Lisbon, Portugal; ^2University of Lisbon, Faculty of Sciences and ICEMS , 1749-016 Lisbon, Portugal; ^3Instituto Superior de Engenharia de Lisboa and ICEMS, 1959-007 Lisbon, Portugal

Resume : Emergent challenges in condensed matter physics and nanoscience demand developing novel approaches for producing lateral structures at the nanoscale. It is of particular interest to produce patterned nanostructures in continuous magnetic films in order to allow different transport processes, e.g., electric current, heat transfer, or spin-wave propagation across the structures. Here, we demonstrate direct patterning of thin-film magnetic alloys due to ultrafast diffusive transformations induced locally with femtosecond laser. Importantly, such patterning was created without any significant changes in the topographical relief. Using magneto-optic Kerr effect and magnetic force microscopy, we show that even a single ultrashort (500 fs) shot with a fluence of 0.5 J/cm^2 is sufficient to induce a strong enhancement of the saturation magnetization in Fe-V alloyed films and formation of the magnetic gratings with submicron periodicities. The obtained results demonstrate an opportunity for producing magnetic nanostructures with engineered properties upon this basis.
Acknowledgement: Work was supported by the Portuguese Foundation for Science and Technology (FCT) through the project PTDC/FIS/121588/2010 and program "Ciencia 2008" (N.I.P.).

J.IX 3

add to my program (close full abstract)

11:30 **Nanosecond-laser-induced graphitization and amorphization of thin nano-crystalline graphite films**

Authors : Loïc Loisel,Bérengère Lebental,Majid Kabiri Samani,Chong Wei Tan,Costel Sorin Cojocaru,Dominique Baillargeat,Beng Kang Tay
Affiliations : CINTRA CNRS/NTU/THALES, UMI 3288, Research Techno Plaza, 50 Nanyang Drive, Border X Block, Level 6, Singapore 637553, School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, SINGAPORE 639798, Laboratoire de Physique des Interfaces et Couches Minces (LPICM), UMR 7647, Ecole Polytechnique-CNRS, Palaiseau, France; Laboratoire de Physique des Interfaces et Couches Minces (LPICM), UMR 7647, Ecole Polytechnique-CNRS, Palaiseau, France, Université Paris-Est, IFSTTAR, Cosys, 14 - 20 Bd Newton, Champs-Sur-Marne, F-77447, Marne-la-Vallée, France; School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, SINGAPORE 639798; School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, SINGAPORE 639798; Laboratoire de Physique des Interfaces et Couches Minces (LPICM), UMR 7647, Ecole Polytechnique-CNRS, Palaiseau, France; XLIM Laboratory, Unité Mixte de Recherche, CNRS 6172, University of Limoges, 87060 Limoges, France; CINTRA CNRS/NTU/THALES, UMI 3288, Research Techno Plaza, 50 Nanyang Drive, Border X Block, Level 6, Singapore 637553, School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, SINGAPORE 639798

Resume : To develop optically-controlled resistive memories, we study the laser -induced graphitization and amorphization of vertically oriented nano-crystalline graphite (vnC-G) thin films deposited with the filtered cathodic vacuum arc method. vnc-G films consist in graphitic planes perpendicular to the substrate within a matrix of amorphous carbon [1]. Controlled graphitization and amorphization of carbon materials is a long-standing issue with unclear mechanisms [2-5]. Here, we report on graphitization and amorphization of vnc-G controlled by single 532 nm-5 ns laser pulses of various intensities. We demonstrate partial reversibility between graphitization and amorphization,

J.IX 4

opening the way toward device applications. Depending on pulse energy, samples also display an intricate typology of degradations, from periodic ripples, cracks, upheavals and spheroids to traces of explosions. Supported by a finite-element thermo-mechanical model, we discuss the impact of the orientation of the graphitic planes. [1] D. W. M. Lau, D. G. McCulloch, M. B. Taylor, J. G. Partridge, D. R. McKenzie, N. A. Marks, E. H. T. Teo, and B. K. Tay, "Abrupt stress induced transformation in amorphous carbon films with a highly conductive transition phase," Physical Review Letters, vol. 100, May 2008. [2] M. Shakerzadeh, N. Xu, M. Bosman, B. K. Tay, X. Wang, E. H. T. Teo, H. Zheng, and H. Yu, "Field emission enhancement and microstructural changes of carbon films by single pulse laser irradiation," Carbon, vol. 49, pp. 1018-1024, 2011. [3] A. Barreiro, F. Börrnert, S. M. Avdoshenko, B. Rellinghaus, G. Cuniberti, M. H. Rümmeli, and L. M. K. Vandersypen, "Understanding the catalyst-free transformation of amorphous carbon into graphene by current-induced annealing," Sci. Rep., vol. 3, 2013. [4] J. Brooks and G. Taylor, "The formation of graphitizing carbons from the liquid phase," Carbon, vol. 3, pp. 185-193, 1965. [5] J. Steinbeck, G. Braunstein, M. S. Dresselhaus, T. Venkatesan, and D. C. Jacobson, "A model for pulsed laser melting of graphite," Journal of Applied Physics, vol. 58, pp. 4374-4382, 1985.

add to my program (close full abstract)

11:45 **Ultrafast laser-induced Faraday rotation in ferromagnetic EuO films**

Authors : Takayuki Makino
Affiliations : University of Fukui, Japan; CEMS, RIKEN, Japan

Resume : The laser-induced ultrafast spin dynamics have been investigated by time-resolved pump-probe and Faraday rotation spectroscopies in ferromagnetic EuO thin films. We demonstrate that the laser beam can enhance the magnetization on an ultrafast time scale. The decays time for the magnetization enhancement is about 1 nanosecond. In its temperature dependence, there is a maximum slightly below the Curie temperature associated with this dynamical enhancement of magnetization. It also dominates the demagnetization counterpart at 55 K. It is attributed that this transient collective ordering to the enhancement of the f-d exchange interaction as a result of photoexcitation. We also observed that the circularly polarized light can control the magnetization precession at 10 K. This takes place within the 100-fs duration of a single laser pulse, through combined contribution from two nonthermal photomagnetic effects, i.e., enhancement of the magnetization and an inverse Faraday effect. From the magnetic field dependencies of the frequency and the damping parameter, the intrinsic Gilbert damping coefficient was also evaluated.

J.IX 5

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12:00 **Lunch until 13:30**

Poster Sesion J: Laser-assisted deposition & processing methods for the development of advanced materials : M. Castillejo, M. Farsari, F. Garrelie & N. Bulgakova __NOTE Early Start: 13h30

13:30 **Random lasing correlated with structural properties of ZnO thin films grown by pulsed-laser deposition**

Authors : C. Cachoncinlle (1), C. Hebert (2,3), J. Perriere (2,3), W. Seiler (4), E. Millon (1)
Affiliations : 1) GREMI, UMR 7344 CNRS-Université Orléans, 45067 Orléans Cedex 2, France; 2) Sorbonne Universités, UPMC Univ Paris VI, UMR 7588, INSP, 75005, Paris, France 3) CNRS, UMR 7588, INSP, 75005, Paris, France 4) PIMM, UMR 8006 CNRS-ENSAM, 75013 Paris, France

Resume : ZnO is a promising material for UV photonic devices such light-emitting diodes (LED) or laser diodes. UV LEDs and laser diodes require high quality films for which the composition and morphostructure have to be perfectly controlled. Random lasing due to light amplification can occurs in cavities self formed by these film microstructure. This effect has already been observed in ZnO material in various states : powders, polycrystalline and highly textured materials(nanowires)or epitaxial thin films. In this work, PLD was used to grow ZnO thin films onto c-cut sapphire substrates under different oxygen pressures (from vacuum to 0.1 mbar) and substrate temperatures (from room temperature to 700°C). The stimulated emission photoluminescence spectra were recorded under excitation by a frequency tripled pulsed NdYAG laser (355 nm ; 10 ns pulse duration) at different pump powers. The PL emission in the UV

JP.XI 1

-visible range was collected using a UV-visible (300-800 nm) USB spectrometer. The lasing effect is evidenced in these PLD ZnO films and the wavelength and the peak intensities are demonstrated to be depending upon the composition and structural properties of films.

add to my program (close full abstract)

13:30 **Growth and properties of Zn-Fe oxide thin films**

Authors : C. Hebert1,2, N. Jedrecy1,2, J. Perrière1,2, E. Millon3, M. Nistor4, W. Seiler5,
Affiliations : 1-Sorbonne Universités, UPMC Univ Paris 06, UMR 7588, INSP, F-75005, Paris, France 2-CNRS, UMR 7588, INSP, F-75005, Paris, France 3-GREMI, UMR 7344 CNRS-Université d'Orléans, 45067 Orléans Cedex 2, France 4-National Institute for Lasers, Plasma and Radiation Physics (NILPRP), L22 P.O. Box. MG-36, 77125 Bucharest-Magurele, Romania 5-PIMM, UMR CNRS 8006 Arts et Métiers ParisTech, 151 Boulevard de l'Hopital, 75013 Paris, France

Resume : The expected electrical and magnetic properties of Fe-doped ZnO and Zn-doped Fe3O4 films make such systems as promising functional materials for spintronic applications. In this work the growth and properties of the mixed Zn-Fe oxide films were studied as a function of the element concentration. The mixed Zn-Fe oxide thin films were grown by pulsed-laser deposition (PLD) on Si, c-cut sapphire and MgO single crystal substrates at various oxygen pressures and substrate temperatures. The composition and structure of Zn-Fe oxide thin films were investigated by means of Rutherford Backscattering Spectrometry and X-ray diffraction analyses. For up to 25% Fe dopant concentration in ZnO films the wurtzite (ZnO) structure is preserved and epitaxial semi transparent and conductive films are grown on c-cut or MgO substrates. However, these films do not present any significant magnetism whatever the substrate temperature and oxygen pressure. On the other hand, low Zn concentrations (about 10%) lead to the epitaxial growth of films presenting the spinel structure (Fe3O4). Such films are ferromagnetic at room temperature while they present very lower conductivities than pure Fe3O4 films, indicating that Zn2+ ions are substituted to Fe2+ in the spinel structure. The correlation between the structural characteristics and the physical properties will be presented and discussed for the various film compositions.

JP.XI 2

add to my program (close full abstract)

13:30 **NANOPARTICLE-DECORATED CERAMIC AS SUBSTRATE IN SURFACE ENHANCED RAMAN SPECTROSCOPY**

Authors : N.Nedyalkov, Ru. Nikov, M. Koleva, P.A. Atanasov
Affiliations : Institute of Electronics, Bulgarian Academy of Sciences, Tzarigradsko shousse 72, Sofia 1784, Bulgaria

Resume : Laser assisted method for fabrication of nanoparticles on the surface of ceramic substrate is presented. The method is based on laser nanostructuring of thin metal film deposited on the substrate. Using this technique, gold nanoparticles on alumina ceramic surface are fabricated. The influence of the laser fluence and pulse number on the characteristics of the produced nanoparticles is studied and discussed. The obtained structures are tested as substrates in Surface Enhanced Raman Spectroscopy of standard dyes. The efficiency of the substrates is estimated by the ability of detection of the smallest dye concentration compared to that of bare ceramic substrate, thin gold film on ceramic substrate, and nanoparticles on polished crystalline alumina. The strongest enhancement is observed for the ceramic substrate covered by nanoparticles. This could be attributed to the highest density of the areas with strong near field intensity enhancement in the vicinity of gold nanoparticles in the porous material, and the specific spatial distribution of the near field intensity. These effects are studied and discussed on the basis of Finite Difference Time Domain simulations. The proposed method could be a base of a simple fabrication technique for cheap and reliable substrates for Raman spectroscopy analysis with ultra-high sensitivity.

JP.XI 3

add to my program (close full abstract)

13:30 **Pulsed Laser Ablation of Cu2ZnSn multi-metallic target: Composition and Morphology Studies**

Authors : Stela Canulescu(1), Andrea Cazzaniga(1), Rebecca B. Ettlinger(1), Jørgen Schou(1) and Nini Pryds(2)
Affiliations : (1)DTU Fotonik, Technical University of Denmark, DK-4000 Roskilde, Denmark (2)DTU Energy Conversion, Technical University of Denmark, DK-4000 Roskilde, Denmark

JP.XI 4

Resume : Cu2ZnSnS4 (CZTS) has recently emerged as a promising thin film absorbing material for the low-cost thin-film solar cells. Cu2ZnSnS4 (CZTS) thin films can be grown by reactive pulsed laser deposition in a sulfur containing atmosphere using a multi-metallic target of Cu2ZnSn. However, the ablation of

a target alloy containing highly volatile elements, such as Sn is still poorly explored. Here we present an experimental study of laser ablation of a multi-metallic target of Cu2ZnSn in vacuum using a KrF excimer laser operating at a wavelength of 248 nm. The thin films were characterized by scanning electron microscopy (SEM) and energy dispersive spectrometry (EDS). The morphology and composition of the thin metallic alloys grown at room temperature was studied as a function of laser fluence. Ablation of the metallic target at high fluence results in deposition of large irregular features on the substrate, and thus growth of highly non-uniform thin metallic films. The distribution of the metallic droplets for an on- or off-axis geometry will be discussed.

add to my program (close full abstract)

13:30 **Current-carrying abilities of high-temperature superconductor (YBa2Cu3O7-x) PLD thin films with a different nanostructure** JP.XI 5

Authors : V.I.Matsuy, V.S.Flis, V.O.Moskalyuk, A.L.Kasatkin, N.A.Skoryk, V.L.Svechnikov
Affiliations : Institute of Metal Physics, NASU, 03142 Kiev, 36 Vernadsky st., Ukraine

Resume : High temperature superconductor (HTS) YBa2Cu3O7-x (YBCO) thin films and coatings deposited on textured metal tapes now are of great interest for applications in electrical engineering as HTS conductors with high current-carrying abilities for dissipation-free current flow. The latter is usually characterized by the critical current density Jc(T,B), and one of the most important problems now is to increase Jc and make it less dependent on magnetic field and thickness of HTS coating . High Jc values in HTS films and coatings arise due to strong pinning of magnetic flux (Abrikosov vortices) by defect nano-structure of HTS material, which prevents flux motion and emergence of the related resistive state of HTS. In the present work we study a series of pulse laser deposited (PLD) YBCO films with a different defect nano-structure and thickness, namely: (a) pristine YBCO films; (b) YBCO films with implanted BaZrO3 (BZO) nano-particles; multilayer YBCO/Y2O3 films with a sequence (5 layers) of HTS (YBCO) and dielectric phase (Y2O3). All these films were deposited on single crystalline La2AlO3 substrates by use of two-beam PLD technique. The Jc(T,B) dependencies for the films under study were obtained from ac susceptibility measurements with a subsequent treatment of experimental results on the base of the Clem-Sanches critical state model. The highest Jc values (Jc(78K) □ 3 MA/cm2) in this films series were obtained for the multilayer YBCO/Y2O3 film. We have also performed structural (XRD and HREM) studies of these films and subsequent theoretical treatment of obtained results for Jc(T,B) dependencies.

add to my program (close full abstract)

13:30 **Sum-frequency mixing in laser ablation plasmas of boron carbide** JP.XI 6

Authors : Mohamed Oujja, Antonio Benítez-Cañete, Mikel Sanz, Ignacio Lopez-Quintas, Rebeca de Nalda, Marta Castillejo*
Affiliations : Instituto de Química Física Rocasolano, CSIC, Serrano 119, 28006 Madrid, Spain

Resume : Laser ablation plasmas are capable to sustain efficient generation of short wavelength coherent radiation by frequency up-conversion to low- and high-order harmonics. Complex plasmas possess compositional and dynamical properties that allow for some degree of tuning in the selection of nonlinear optical (NLO) species and phase matching conditions, and reversely in some cases harmonic generation (HG) can be employed as a diagnosis tool for such plasmas. In this work we investigate low-order, two-colour pump HG in nanosecond laser ablation plasmas of boron carbide (B4C), a material that generates ceramic microstructures of various geometries by pulsed laser deposition. Frequency tripling of a fundamental driving beam at 1064 nm (Nd:YAG laser pulses of 15 ns) resulted in 3rd HG at 355 nm, while sum-frequency mixing of two driving beams at 532 and 1064 nm resulted in 4th HG at 266 nm. In both cases, the ablation plume of B4C was created with a different Nd:YAG laser with controllable delay with respect to the driving source, and monitored by optical emission spectroscopy to help elucidate the species responsible for the NLO processes studied. We characterized the even and odd harmonic intensities as a function of the polarizations and pulse energies of ablation and driving lasers. This, together with the spatiotemporal mapping of the plasma by the driving beams, has provided clues about the nature and distribution of the NLO generated by ablation of the B4C target.

add to my program (close full abstract)

13:30 **Combine free cluster generator with pulsed laser deposition: a flexible route to produce nanocomposite materials** JP.XI 7

Authors : M. GAUDIN, F. DUMAS-BOUCHIAT, J.C. ORLIANGES, C. CHAMPEAUX

Affiliations : SPCTS, UMR 7315, Université de Limoges/CNRS, 12 rue Atlantis, 87068 Limoges Cedex, France

Resume : We report on the development of a free nano-sized cluster generator coupled to a Pulsed Laser Deposition (PLD) conventional set-up. The particularity of this process is the use of two independent lasers, respectively, an excimer laser (248 nm, 25 ns) and a third-harmonic-Nd-YAG laser (355 nm, 7 ns) for the matrix and free clusters synthesis. This flexible complex laser-based process offers possibilities to synthesis clusters by gas phase aggregation embedded in a co-deposited host matrix by PLD. In this communication, we will focus on silver and copper metallic clusters embedded in two different oxide matrix, Al2O3 and VO2, respectively. A very narrow clusters size distribution centered on 3 nm is confirmed by both high-resolution transmission electron microscopy (HRTEM) and spectroscopic absorption due to clusters Surface Plasmon Resonance (SPR). In addition, a shift of the thermo chromic cluster-doped VO2 temperature transition will be presented.

add to my program (close full abstract)

13:30 **Contact-free measurement technique for thermoelectric power of Au nanoclusters deposited on graphite by pulsed laser deposition**

Authors : Troyan V.I., Borisyuk P.V., Vasilyev O.S., Lebedinskii Yu.Yu.
Affiliations : National Research Nuclear University (NRNU MEPHI)

Resume : New contact-free measurement technique for thermoelectric power is developed. The technique allows of determination of the thermoelectric power value by analyzing the differential tunnel volt-ampere characteristics obtained by scanning tunneling microscopy. By the use of this technique the thermoelectric power of Au nanoclusters pulsed laser deposited on highly oriented pyrolytic graphite HOPG(0001) was studied. It was found out that thermoelectric power of nanocluster decreases with its size. The results obtained might be used for the development of nanoelectronics, for example, the development of nanocoolers and temperature sensors of integrated circuits.

JP.XI 8

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13:30 **Control of pentacene thin film growth deposited by conventional PLD**

Authors : A. Pereira1, Y. Larmande1, J. Penuelas2, S. Guy1
Affiliations : 1 ILM- Université de Lyon, Université Lyon 1, CNRS UMR5306, Villeurbanne F-69622, France ; 2 Institut des Nanotechnologies de Lyon - Université de Lyon, CNRS UMR5270, Ecole Centrale de Lyon, Ecully F-69134, France

Resume : Laser Induced Forward Transfer (LIFT) proved its ability to print Organics Thin Films Transistors. This process allows the transfer from a donor substrate of pixels with micrometer sizes of organic and inorganic materials with a submicronic resolution. However, the properties of each layers and the quality of the interfaces are key factors for the performances of the devices. It is then necessary to optimize the preparation of donor substrates. The focus is put here on the growth of pentacene layers by PLD, a well-known organic semiconductor chosen for its high charge carrier mobility. The main objectives are to control its molecular degradation that can occur during the deposition and its structural and morphological properties which influence the device performance. We show that by tuning the laser fluence, the background atmosphere and the substrate temperature, it is possible to obtain high-quality (high crystallinity and low surface roughness) pentacene thin films without chemical degradation. For each experimental condition, both the thickness and the refractive index were in-situ monitored by means of ellipsometry, whereas conventional analysis technique (absorption, microRaman and FTIR spectroscopy, AFM, XRR and GIXD) were used to control the film quality and their properties. Moreover, varying the substrate (Suprasil, PMMA or Triazene which is used as a sacrificial layer on the LIFT process) the influence of surface properties on pentacene thin films structure and morphology is also investigated. Finally, optimized pentacene layers have been characterized by current-voltage measurements

JP.XI 9

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13:30 **Characterization of nanocomposite cobalt ferrite/ magnetite films grown by pulsed laser deposition on SrTiO3 substrates**

Authors : Mikel Sanz 1, Mohamed Oujja 1, Esther Rebollar 1, José F. Marco 1, Juan de la Figuera 1, Matteo Monti 1, Adrián Quesada 2, Alberto Bollero 3, Julio Camarero 3,4, Francisco J. Pedrosa 3, Marta Castillejo 1*
Affiliations : 1 Instituto de Química Física Rocasolano, CSIC, 28006 Madrid, Spain; 2 Instituto de Cerámica y Vidrio, CSIC, Campus Universidad Autónoma de Madrid, 28049 Madrid, Spain; 3 IMDEA Nanoscience, Instituto Madrileño de Estudios Avanzados en Nanociencia, Madrid, Spain; 4 Departamento de Física de la Materia Condensada, Instituto Nicolás Cabrera, Campus Universidad Autónoma de Madrid, 28049 Madrid, Spain

JP.XI 10

Resume : Magnetic nanomaterials with controlled magnetic structure are good candidates for spintronic applications. In this work, nanocomposites of cobalt ferrite (CoFe2O4) and magnetite (Fe3O4) were grown as thin films on SrTiO3 (100) substrates by nanosecond pulsed laser deposition. Self-prepared sintered targets of cobalt ferrite were irradiated under vacuum (10-6 mbar) with Nd:YAG laser pulses of 1064 nm and 15 ns. The composition, crystallinity, surface structure and magnetic properties of the films were determined by atomic force microscopy (AFM), scanning electron microscopy/energy dispersive X-ray spectroscopy (SEM/EDX), X-ray diffraction (XRD), micro-Raman and Mössbauer spectroscopies and magneto-optic Kerr effect (MOKE) measurements. Deposits consist of a mixture of nanostructures of rectangular and cubic prisms having alignment directions offset by 45º. The former, of sizes around 20x30 nm, appear with high superficial density, while the latter of larger sizes, side of 50-100 nm, appear scattered at lower density. XRD patterns supply evidence of monocrystalline deposits, whereas Mössbauer and micro-Raman spectra show that their composition differs from that of the target and consist of a mixture of cobalt ferrite and magnetite. SEM/EDX measurements suggest that rectangular prisms would be made of cobalt ferrite and cubic prisms by magnetite. These results, together with MOKE analysis, give clues on the control of magnetic properties at the nanoscale of the grown films.

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13:30 **Surface modification of middle ear implants using Double Laser Beam Interference technique**

Authors : P. Kwasniak(1), J. Pura(1), M. Zwolinska(1), H. Skarzynski(2,3), L. Olszewski (2,3), J. Marczak(4), H. Garbacz(1), K.J. Kurzydlowski(1)
Affiliations : (1) Faculty of Materials Science and Engineering, Warsaw University of Technology, Poland; (2) Institute of Physiology and Pathology of Hearing, Warsaw, Poland; (3) World Hearing Center, Kajetany, Poland; (4) Military University of Technology, Institute of Optoelectronics, Poland;

Resume : Middle ear implants are an excellent alternative to external hearing aids and are widely developed for over 50 years. It is well known that surface parameters like surface energy, chemical composition and roughness strongly influences cell adhesion, proliferation and differentiation. Optimal topography of the implants surface is still discussed, however most promising results are obtained for multiscale topography (from nano- to micrometers)[1]. In this work we present surface topography modifications of titanium using double laser beam interference technique. This method allows to obtain periodic striated topography with variable geometry (shape, dimensions and the distance between ridges) and the roughness range from nano- to micrometers. Numerous of research methods have been used: scanning electron microscopy, atomic force microscopy, optical profilometery, microhardness measurements and energy dispersive X-ray spectroscopy, to investigate shape, roughness, mechanical properties and chemical composition of the obtained structures. Presented surface modification method can be an effective tool for manufacturing periodic structures on both flat and curved surfaces. The future studies of in vitro cells growth will be also highly valuable for description of the relation between implant surface topography and osteointegration phenomenon.
[1] D. Khong, J. Choi, Y-M Im, Y-J Kim, J-H Jang, S.S. Kang, T-H Nam, J. Song, J-W. Park, Biomaterials, 33 (2012) 5997

JP.XI 11

add to my program (close full abstract)

13:30 **γ-cyclodextrine/usnic acid thin film fabricated by MAPLE for improving the resistance of medical surfaces to Staphyloccocus aureus colonization**

Authors : Valentina Grumezescu1, Alina Maria Holban2, Alexandru Mihai Grumezescu3, Gabriel Socol1, Bogdan Stefan Vasile3, Anton Ficai3, Roxana Trusca4, Florin Iordache5
Affiliations : 1Lasers Department, National Institute for Lasers, Plasma & Radiation Physics, P.O. Box MG-36, Magurele, Bucharest, Romania 2Microbiology Immunology Department, Faculty of Biology, University of Bucharest, 1–3 Portocalilor Lane, Sector 5, 77206 Bucharest, Romania 3Department of Science and Engineering of Oxidic Materials and Nanomaterials, Faculty of Applied Chemistry and Materials Science, University Politehnica of Bucharest, 1–7 Polizu Street, 011061 Bucharest, Romania 4S.C. Metav-CD S.A., 31Rosetti Str., 020015 Bucharest, Romania 5Institute of Cellular Biology and Pathology of Romanian Academy, "Nicolae Simionescu", Department of Fetal and Adult Stem Cell Therapy, 8, B.P. Hasdeu, Bucharest 050568, Romania

Resume : Staphylococcus aureus represents one of the major infectious threats for hospital environment, because of its wide spread and increasing antibiotic resistance. This study reports on the deposition of γ-cyclodextrine/usnic acid thin film by Matrix Assisted Pulsed Laser Evaporation (MAPLE) as anti-adherent coating on medical surfaces, in order to improve their resistance to microbial

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colonization. The prepared surfaces were characterized by Transmision Electron Microscopy (TEM), Scanning Electron Microscopy (SEM) and Infrared Microscopy (IRM). Microbial biofilm formation was established from SEM images and culture -based assays for up to 3 days of incubation at 37oC, while biocompatibility was evaluated by analyzing the qualitative and quantitative phenotypic changes of the treated eukaryotic cells up to 5 days. SEM micrographs revealed uniform morphologies of the prepared films, while IRM proved the functional groups integrity and the homogeneity of the γ-cyclodextrine/usnic acid thin film. Microbiologic results showed that the obtained thin films efficiently inhibited S. aureus adherence and biofilm formation potentials for all tested time points. These results demonstrated that the functionalized surfaces with γ-cyclodextrine and usnic acid deposited by MAPLE can successfully prevent the microbial cells adhesion and biofilm development on the medical surfaces.

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13:30 **Tetracycline local delivery from γ-aminobutiric acid-silica networks thin films for preventing microbial infections**

Authors : Valentina Grumezescu1,2,, Ecaterina Andronescu2, Gabriel Socol1, Alina Maria Holban3, Alexandru Mihai Grumezescu2, Anton Ficai2, Roxana Trusca4, Florin Iordache5
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Resume : The purpose of this study was the fabrication, characterization and bioevaluation of □-aminobutiric acid-silica network thin film prepared by Matrix Assisted Pulsed Laser Evaporation (MAPLE) as a matrix for controlled local delivery of tetracycline, with practical applications in developing of improved medical surfaces for the prevention or reduction of surface-associated infections. Thin films were characterized by Infrared Microscopy (IRM), X-Ray Diffraction (XRD), Brunauer?Emmett?Teller Analysis (BET), and High Resolution Transmision Electron Microscopy (HR-TEM). Microbial colonization was investigated by quantitative and qualitative biofilm formation assays, while the biocompatibility of the prepared materials was evaluated by microscopy and biochemical assays. TEM analysis reveals a good homogeneity and an average size of particles lower than 10 nm. The prepared thin films significantly improved the resistance to microbial colonization, inhibiting the biofilm formation on both Gram positive and Gram negative tested strains, when peliculised on the tested medical surfaces. These results, correlated with the high biocompatibility of these thin films, highlight the possibility of using the γ-aminobutiric acid-silica network films for the controlled local delivery of the therapeutic agents in lower active doses, thus reducing the occurrence of rejection for implanted prosthetic devices.

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13:30 **LASER INDUCED PHASE-STRUCTURE CHANGES IN IRON OXIDE NANOPARTICLES**

Authors : 1,2 N.N.Tarasenka, 1 D.A.Kotsikau, 2 N.V.Tarasenko, 1 V.V.Pankov
Affiliations : 1 Belarusian State University, 4 Nezalezhnasti Ave., 220002 Minsk, Belarus, 2 Institute of Physics, National Academy of Sciences of Belarus, 68 Nezalezhnasti Ave., 220072 Minsk, Belarus

Resume : Laser irradiation of nanoparticles (NPs) can result in the particles size and shape changes through the fragmentation and aggregation processes, can lead to the defects removal and crystallinity improvement, as well as to the phase transitions, that change the composition and inner structure of the particles. In this paper the effect of laser irradiation on the changes in the morphology and structure of the iron oxide NPs has been studied. The colloidal and powder iron oxide NPs were subjected to laser irradiation by the second harmonic of the Nd:YAG laser (wavelength 532 nm, pulse duration 10 ns) with fluence 400 mJ/cm2 for 15 min. It has been shown that the result of laser modification of NPs is mostly determined by the temperature that is reached during the irradiation. Laser irradiation resulted in the ordering of crystal structure and partial removal of adsorbed and structural hydroxyl groups from the particle surface. The morphology of NPs changed from the irregularly shaped particles to spherical ones with diameters close to the initial particle sizes (50-90 nm). Besides, a fraction of small NPs with sizes in the range of 5-8 nm has been observed after laser modification. It has been found that laser heating of α-

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Fe2O3 phase in non-equilibrium conditions result in the formation of spinel phases of iron oxide (γ-Fe2O3, Fe3O4) while single-phase γ-Fe2O3 sample undergoes a partial thermo stimulated phase transition to the thermodynamically stable α-Fe2O3 phase.

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13:30 **Induced processes in binary metal-semiconductor eutectic nano-structured systems.**

Authors : Tamara P. Doroshenko
Affiliations : V. E. Lashkaryov Institute of Semiconductor Physics of the National Academy of Sciences of Ukraine, Kyiv

Resume : Research and development of new nanostructuring materials for engineering of nanoplasmonic and nanophotjnic structures is perspective direction of material science. Low-temperature solid-phase interaction in a simple eutectic pairs of metal- semiconductor thin films is one of the ways to create such materials. Such materials are used for recording media and could be used for criation of photonic crystals. Two-component systems of semiconductors and metals forming simple eutectic pairs was investigated. The solid-state interactions on the interface of systems metal-metal or metal-semiconductor are discussed. The results of the laser and thermal annealing are represented. Transmission spectra of binary mixtures Ge-metals measured in situ during the annealing demonstrate changes as a function of the annealing temperature. Change in reflection index spectra and dimensional photonic crystals is demonstrated. The advantage of these materials (low-energy interactions, long lifetime and environmental) make them promising for neoteric tecnology.

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13:30 **Er/Yb doped LiYF4 thin films obtained by pulsed laser deposition of a silica xerogel**

Authors : F. Stokker-Cheregi1, A. Matei1, M. Dinescu1, C. E. Secu2, M. Secu2
Affiliations : 1 National Institute for Laser, Plasma and Radiation Physics, Bucharest-Magurele 077125, Romania 2 National Institute for Materials Physics, Bucharest-Magurele, 077125, Romania

Resume : We discuss the properties of thin films obtained following the pulsed laser ablation (PLD) of a silica xerogel that is normally used to synthesize Er/Yb doped LiYF4 by the sol-gel technique. Although PLD is a particularly suited growth technique for such multi-component glass ceramics that are unstable at high temperatures, classical PLD growth of thin films starting from doped LiYF4 sintered ceramic targets has been shown to yield thin films with large roughness values, of the order of hundreds of nanometers [1]. Similar roughness values have also been reported by other groups following laser ablation of a doped LiYF4 single crystal target [2, 3]. This is an issue when considering possible practical applications of doped LiYF4 thin films. These materials are generally obtained using the sol-gel technique, which however does not enable a precise control over the thickness of the resulting films. In our study we explore the viability of using laser ablation of a silica xerogel, followed by substrate annealing, in view of achieving composite thin films of Er/Yb doped LiYF4 crystals embedded in a SiO2 matrix. Such thin films may be considered for the realization of coatings meant to improve the quantum efficiency of solar cells by up-conversion. [1] F. Stokker-Cheregi et al., J. Phys. D: Appl. Phys. 47 (2014) 045304. [2] C. Garaponet al., Appl. Phys. A 91(2008) 493. [3] S. Barsanti et al., Thin Solid Films 516 (2008) 2009; S. Barsanti et al., Thin Solid Films 517 (2009) 2029.

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13:30 **Gold thin films synthesized by pulsed laser deposition using a picosecond laser source: future sensing platforms**

Authors : C. Popescu1, M. Pervolaraki2, A.C. Popescu1*, G.E. Stan3, I. Pasuk3, I. Iordache (Urzica)1, G.I. Athanasopoulos2, J. Giapintzakis2
Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics, Bucharest-Magurele, Romania 2 Nanotechnology Research Center and Department of Mechanical and Manufacturing Engineering, University of Cyprus, Nicosia, Cyprus 3 National Institute of Materials Physics, Bucharest-Magurele, Romania

Resume : There is currently a lack of experimental evidence concerning thin films grown by ultra fast pulsed laser deposition (UFPLD) using picosecond laser sources. To this end, Au thin films have been grown on glass substrates by UFPLD using a 10-ps high-repetition-rate laser source. A systematic parametric study has been carried out with variation of laser fluence, substrate temperature, deposition time and target-substrate separation distance. The investigations has focused on surface characterization (SEM), depth profiling,

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structural (XRD) and optical properties (spectrophotometry) of the obtained thin films. Maps with morphological (thickness, roughness, porosity, uniformity) and structural (planes orientation, crystallites sizes, compactness) parameters for each film were made and used in conjunction with optical spectra to determine the decisive parameters in changing the optical properties. Due to the large number of particles present on the films surface, there has been a need to understand the dependence of the surface plasmon resonance shift on the particles shape and/or particles interactions with other particles and the substrate. For this, the model proposed by Yamauchi et al. and Fedotov et al. [1, 2] has been employed. In addition, we will describe the possible sensing strategy which employs Au nanoparticles as individual sensing elements. [1] T. Yamaguchi, S. Yoshida, A. Kinbara 1974 Thin Solid Films, 21 173 [2] V.A. Fedotov, V.I. Emelyanov, K.F. Macdonald, N.Zheludev, J. Opt. A: Pure Appl. Opt. 6 (2004) 155–160

add to my program (close full abstract)

13:30 **Synthesis and photocatalytic properties of novel multifunctional TiO2-based magnetic nanocomposite**

Authors : M. Scarisoreanu1, I. Morjan1, C-T Fleaca1, I.P.Morjan1, A.Niculescu1, E.Dutu1, A.Badoi1, R. Birjega1, C. Luculescu1, E. Vasile2, V. Danciu3, G. Filoti4,
Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics, POB MG-36, Bucharest 077125, Romania; 2 Metav, Research and Development, 31 C.A. Rosetti Str, 020011, Bucharest, Romania; 3National Institute for Materials Physics (NIMP), Atomistilor 105bis, P.O. Box MG7, R-077125 Magurele, Bucharest, Romania; 4 ,,Babes-Boyai? University, Faculty of Chemistry and Chemical Engineering, Electrochemical Research Laboratory, 11 Arany Janos Str, Cluj- Napoca, 400028, Romania;
Resume : TiO2/Fe/HMDSO nanoparticles presenting core?shell structures were simultaneously manufactured by the single-step laser pyrolysis. The present study is a continuation of our previous investigations on the TiO2/Fe and TiO2/HMDSO systems. The aim of this work is to study the synthesis by IR laser pyrolysis of magnetic TiO2 based nanocomposites which implies many concurrent processes induced in the gas phase by the laser radiation. The dependence between characteristic properties and the synthesis parameters was determinated by many analytical and complementary methods: crystallographic analysis (X-ray diffraction), UV-Vis and IR spectroscopy, EDAX, SEM, TEM and HRTEM analysis, magnetic measurements and photocatalytic degradation of specific water pollutants. Magnetic TiO2 - based nanopowders with carbosilane polymer shells contains particle with mean dimensions (about 13-23 nm diameter) and narrow diameter distributions. Photocatalytic properties of novel multifunctional TiO2-based magnetic nanocomposite were tested as compare with the reference P25 Degussa sample.

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13:30 **Combined micro- and nanoscale topography on Zirconia surfaces modulates human mesenchymal stem cells growth and cell nuclei alignment**

Authors : L.E. Sima1, V. Dinca2*, L. Rusen2,3, M. Cazan4, M. Chiritoiu1, A. Palla-Papavlu2 and M. Dinescu2
Affiliations : 1Department of Molecular Cell Biology, Institute of Biochemistry, Romanian Academy, 296 Splaiul Independentei, 060031 Bucharest 17, Romania 2Lasers Department, National Institute for Lasers, Plasma and Radiation Physics, 409 At-omistilor Street, PO Box MG-16, Zip RO-077125, Magurele, Bucharest, Romania 3Faculty of Physics, Univesity of Bucharest, RO-077125, Magurele, Bucharest, Romania 4 University of Medicine and Pharmacy "Carol Davila" Bucharest, Romania
Resume : Within various applications such as tissue engineering, prosthetics, microfluidic devices, providing biomaterials with the ability to tailor cell response remains still a challenge. In this work, we designed combined micro- and nanoscale topographical cues by using femtosecond laser direct ablation of Zirconia substrates. The response of human mesenchymal stem cells (hMSCs) to Zirconia peaks and troughs wavy/steep substrates was analysed and quantified. Cells spread less and have an elongated morphology, with reduced formation of focal adhe-sion complexes on laser structured surfaces, depending on the topographical cues. Although cell growth and adhesion were depending on the topography of the substrates, cell viability was apparently not affected by topography. The efficacy of cell nuclei alignment along the troughs was significantly higher on wavy than on steep topographies. The increase in available surface area by design of interrupted troughs induced increased spreading of cell on all di-rections, which triggered dramatic modification of cell morphology towards polygonal shape and consequently increased circularity of stem cell nuclei. The results presented here indicate that substrate features play a key role in hMSCs spreading response and more importantly that even

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smoother patterns than grooves and ridges are able to provide contact guidance. Our results demonstrate potential use of laser micropatterned Zirconia to modulate cell fate during bone implantation.

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13:30 **Proliferation of cell cultures on polymers coated laser patterned Ti substrates**

Authors : F. Stokker-Cheregi1, A. Matei1, M. Dumitru1, M. Zamfirescu1, C. Mustaciosu2, A. Acasandrei2, M. Dinescu1

Affiliations : 1 National Institute for Lasers, Plasma, and Radiation Physics, Bucharest 77125, Romania 2 National Institute of Physics and Nuclear Engineering "Horia Hulubei", RO-77125 Magurele, Bucharest, Romania

Resume : We present results obtained following a multi-stage study, in which: i) Ti supports are irradiated and patterned using a femtosecond laser source; ii) the obtained structures are covered with various types of polymers using the matrix assisted pulsed laser evaporation (MAPLE) technique, which has proven to be particularly suitable for such coatings [1]; iii) lastly, different cell types are cultured in order to check the functionality of the obtained coating/substrate systems. Our study is motivated by the possibility of achieving a type of medium in which electrical stimulation can be used to generate preferential growth and/or cells differentiation. In order to achieve this, the patterned Ti supports will be covered, by MAPLE, with three types of polymers meant to provide electrical stimulation [polypyrrole (PPy)] and increased biocompatibility [poly (lactic-co-glycolic) acid (PLGA) and polyurethane (PU)]. The functionality of the obtained polymer coatings/patterned Ti substrate systems will be tested by osteoblasts and fibroblasts cell cultures. Our study reports on cells proliferation, viability and morphology analyses. [1] A. Matei, J. Schou, S. Canulescu, M. Zamfirescu, C. Albu, B. Mitu, E.C. Buruiana, T. Buruiana, C. Mustaciosu, I. Petcu, M. Dinescu, Appl. Surf. Sci. 278, 357 (2013).

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13:30 **Fatty acids/ layered double hydroxides (LDH) composite thin films deposited by MAPLE and PLD**

Authors : R. Birjega1, A. Matei1, B. Mitu1, A. Vlad1, M. Dinescu1, R. Zavoianu2, M. C. Corobea3

Affiliations : 1. National Institute for Lasers, Plasma and Radiation Physics, Romania 2. Faculty of Chemistry, University of Bucharest, Romania 3. National R.&S. Institute for Chemistry and Petrochemistry, ICECHIM, 202 Splaiul Independentei Str., CP-35-274, 060021, Bucharest, Romania

Resume : We have previously reported on the ability of the laser techniques to produce thin films of layered double hydroxides (LDHs) and composite films organic/LDH. The aim of this work is to produce and characterize composite films of fatty acids/ LDH as hydrophobic surfaces. LDH based on Mg-Al and Zn-Al with different ratio were investigated and acetic acid, stearic and lauric acid have been considered as short, medium and long -chain fatty acid. Standard matrix assisted pulsed laser evaporation (MAPLE) and combined matrix assisted pulsed laser evaporation/ pulsed laser deposition have been employed for the growth of the composite layers. The morphological, structural and chemical characterization of the films is presented; the intercalation of the selected fatty acids in the LDH structure has been correlated with the Mg2+/Al3+, Zn2+ /Al3+ ratio and it was found to strongly influence the film wettability.

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13:30 **The grain size dependence of piezoelectric properties on ZnO films grown by pulsed laser ablation**

Authors : Qin Wei Wei, Wang Rui, Li Tao, Gao Zhi Qiang, Hu Xue Feng, Xu Meigui, Huang Shengming, Liang Qi, and Wei Zhang,*

Affiliations : a State Key Laboratory of Material-oriented Chemical Engineering and School of Chemical Engineering, Nanjing Tech University, Nanjing, Jiangsu 210009, PR China b School of Physical Science, Hefei University of Technology, Hefei, Anhui 230009, PR China

Resume : Recent discovery in ZnO nanogenarator has spurred tremendous interest in micro sensor power application. The fundamental principle of ZnO nanogenarator is to utilize the environmental mechanical energy, which is available everywhere from irregular vibrations, light airflow, noise and human activity with a wide spectrum of frequencies and time-dependent amplitudes. The first prototyping of a nanogenarator by means of ZnO piezoelectric nanowire (NW) arrays, piezoelectric nanostructured materials have demonstrated to able to drive micro-sensor and sensor network nods in micro-power range. However so far the power output from NW nanogenarator is still in the power range micro watt, which is still far way from milli-power output source requested by most applications of individual sensor and sensor network system. The lacking of high

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power output in current ZnO NW generator is partially attribute to non-well c-axis oriented crystalline of ZnO NW material and low yield in NW device, both are synthesized by chemical method. In this paper, the piezoelectric properties of ZnO film grown by pulsed-laser deposited (PLD) in the temperatures range of 400 to 600 degree are investigated. Structurally, special emphasis is placed on XRD grain size characterizations of the grown films. Additional characterizations using Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) will be detailed at a later date. The piezoelectric properties of these films are characterized by Piezoelectric Force Microscopy (PFM). It is found that the piezoelectric properties of the films are strongly dependent on grain size of the films. The observed corresponds of piezoelectric (PE) property to grain size is also theoretically explained. *Corresponding author, zhangw@njut.edu.cn

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13:30 **Nanostructured tungsten oxide gas sensors prepared by pulsed laser deposition** JP.XI 23

Authors : M. Filipescu1, A. Palla Papavlu1,2, C.W. Schneider2, T. Lippert2, M. Dinescu1

Affiliations : 1 National Institute for Lasers, Plasma, and Radiation Physics, Bucharest-Magurele, MG 16, ZIP 077125, Romania 2 General Energy Research Department, Paul Scherrer Institute, 5232 Villigen PSI, Switzerland

Resume : Metal-oxide semiconductor gas sensors have been widely used in applications including environmental monitoring and industrial control. In particular, tungsten trioxide is a very promising sensor material with large gas sensitivity and fast response time. Thin films of tungsten trioxide are deposited onto gas sensor substrates by pulsed laser deposition. The gas sensing mechanism is a surface process, therefore the microstructure, morphology, and composition of the WO3 thin films is investigated. Scanning electron microscopy, X-ray diffraction and Raman microscopy characterization showed that the deposited thin films are nanocrystalline. The WO3 based gas sensor properties including response and recovery time upon exposure to ammonia were examined over a temperature range from 100 to 350 °C. It has been found that the optimal operating temperature for the highest sensitivity to ammonia is 300 °C. At 300 °C the response of the WO3 sensors is reversible and repeatable. In addition, the sensors recovery time decreases from several ten minutes when operated at 100 and 200 °C to a few seconds at 300 °C. The results shown in this presentation evidence that WO3 gas sensors fabricated by pulsed laser deposition represent a promising platform to detect trace level of ammonia gas.

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13:30 **Time-resolved imaging of multi-jet interaction during laser-induced forward transfer** JP.XI 24

Authors : (1) A. Patrascioiu, (1) J.M. Fernández-Pradas, (1) J.L. Morenza, (2) G. Hennig, (3) P. Delaporte, (1) P. Serra

Affiliations : (1) Departament de Física Aplicada i Òptica, Universitat de Barcelona, Martí i Franquès 1, E-08028 Barcelona, Spain; (2) DI Projeckt AG, Flugplatz, CH – 3368 Bleienbach, Switzerland; (3) Aix Marseille University, CNRS, LP3 UMR 7341, 163 Avenue de Luminy , 13288 Marseille, France

Resume : The growing needs of the printing industry require increasingly faster and cost-effective technologies capable of delivering with precision and reliability material deposition on a diverse range of substrates. A promising solution is laser-induced forward transfer (LIFT), a versatile, high-resolution printing technique that enables the deposition of a wide range of materials. LIFT allows the precise printing of micron-sized droplets from a donor to an acceptor substrate through the use of a pulsed laser beam that is focused into a thin-film of donor material. The printing event is initiated by the formation of a high-pressure bubble that expands inside the liquid to propel a fast jet that contacts the acceptor, ultimately leading to a droplet deposit. Traditionally, LIFT uses a sequential printing strategy in which a new laser triggering is initiated only after the completion of the current droplet printing event. However, such method is too slow to meet the industry standards for rapid printing, and therefore a multi-jet printing approach is highly desired. This work presents a study on the printing outcomes and general dynamics of multiple, adjacent jets generated through LIFT. Time-resolved imaging reveals that concurrent jets propagating simultaneously towards the acceptor substrate have a strong influence on each other, producing a significant departure from the single jet dynamics. Understanding such jet interaction is crucial for the optimization of high-speed LIFT.

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13:30 **Optical properties of nanocrystalline SiC thin films grown by pulsed laser deposition** JP.XI 25

Authors : V. Craciun1, A.C. Galca2, L. M. Trinca2, G. Socol1, D. Craciun1, E. Lambers3.

Affiliations : 1National Institute for Laser, Plasma, and Radiation Physics, Magurele, Romania 2National Institute for Materials Physics, Magurele, Romania 3Major Analytical Instrumentation Center, University of Florida, Gainesville, FL 32611, USA
Resume : Thin SiC films were grown on (100) Si substrates at temperatures from 400 to 1000 oC under various CH4 pressures by the pulsed laser deposition (PLD) technique using a KrF excimer laser. After deposition, films were in situ annealed at their deposition temperature under 500 mbar of CH4 for 1 hr. X-ray reflectivity investigations showed that films exhibited mass densities similar to SiC single crystal samples, while symmetrical and grazing incidence X-ray diffraction investigations found that films deposited at 800 °C or higher substrate temperatures were nanocristalline. X-ray photoelectron spectroscopy investigations found that films contained in bulk a relatively low oxygen concentration of around 1.0 at. %, while nanoindentation results showed that the deposited SiC films were very hard, with hardness values above 40 GPa for films deposited at temperatures higher than 800 °C. Modeling of spectroscopic ellipsometry data was used to extract the refractive index and extinction coefficient values of these films.

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13:30 **Er and Eu doped TiO2 thin films grown by matrix assisted pulsed laser evaporation from colloidal solutions: structure and optical properties**

Authors : L. Duta,1 C. Nita,1 I. Camps,2 R. Serna,2 M. Borlaf,3 M. T. Colomer,3 R. Moreno,3 A. Pérez del Pino,4 C. Logofatu,5 E. György1,4
Affiliations : 1National Institute for Lasers, Plasma and Radiation Physics, PO Box MG 36, 76900 Bucharest V, Romania 2Laser Processing Group, Instituto de Óptica, CSIC, C/Serrano 121, 28006 Madrid, Spain 3Instituto de Cerámica y Vidrio CSIC, Kelsen 5, 28049, Madrid, Spain 4Instituto de Ciencia de Materiales de Barcelona, Consejo Superior de Investigaciones Científicas (ICMAB-CSIC), Campus UAB, 08193 Bellaterra, Spain 5National Institute for Materials Physics, PO Box MG. 7, 77125 Bucharest, Romania
Resume : Synthesis of TiO2 colloidal nanoparticles (NPs) was efficiently achieved by sol gel route [1]. Our next objective was to use these colloidal solutions to develop thin films for different optical related applications such as antireflective coatings, dye-sensitized solar cells and light emitting devices. In this work we report the growth of Er and Eu doped TiO2 thin films by ultraviolet matrix assisted pulsed laser evaporation (UV-MAPLE). The experiments were performed in vacuum and in a controlled oxygen atmosphere. The Er or Eu doped TiO2 NPs colloidal solutions obtained by sol gel route were frozen in liquid nitrogen and were used as targets. The irradiations were performed with the aid of a KrF* excimer laser source (λ=248 nm, τFWHM≤25 ns, ν=10 Hz). The films have a uniform surface morphology as revealed by atomic force microscopy and field emission scanning electron microscopy. The stoichiometry of the films has been investigated by X-ray photoelectron spectroscopy and their structure by X-ray diffraction. The as-deposited films show efficient photoluminescence in the visible and near-IR spectral regions, indicating that the rare-earth ions are active. The phototoluminescence properties can be further enhanced by post-deposition annealing treatments. Due to their outstanding optical properties, the obtained films have the potential to be used in future light emitting devices. [1] M. Borlaf, M.T. Colomer, F. Cabello, R. Serna, R. Moreno, J. Phys.Chem. B 117 (2014) 1556

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13:30 **Adsorption of copper from aqueous solutions using layered double hydroxides thin films**

Authors : A. Vlad1, R. Birjega1, A. Matei1, C. Luculescu1, M. Dinescu1, R. Zavoianu2, O.D. Pavel2
Affiliations : 1National Institute for Lasers, Plasma and Radiation Physics, 409 Atomistilor Str., 77125 Bucharest- Magurele, Romania 2University of Bucharest, Faculty of Chemistry, Department of Chemical Technology and Catalysis, 4-12 Regina Elisabeta Bd., Bucharest, Romania
Resume : Layered double hydroxides (LDHs) with Mg-Al and Zn-Al were deposited using pulsed laser deposition (PLD). We studied the ability of our films to detect copper cations in aqueous solutions. Copper is known as a common pollutant in water from urban and industrial waste. Clay minerals, including layered double hydroxides reduce the toxicity of copper by adsorbing it. The obtained films were characterized using X-Ray Diffraction, Atomic Force Microscopy, Scanning Electron Microscopy with energy dispersive X-ray analysis, Fourier Transform Infra-Red Spectroscopy and Secondary Ions Mass Spectrometry. Adsorption of copper solution was carried out using Atomic Absorption Spectrometer. The effects of various parameters such as contact times, concentration were investigated. The results in this study indicate that

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LDHs thin films obtained by PLD have potential as an effective adsorbent for removing copper from aqueous solution.

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13:30 **Ge nanoparticle formation in amorphous TiGeO thin films by pulse laser annealing at low fluencies**

Authors : V.S. Teodorescu*, C. Ghica*, A.V. Maraloiu*, M. Vlaicu*, A. Kuncser*, A.M. Lepadatu*, I. Stavarache*, M.L. Ciurea* , N.D. Scarisoreanu**, A. Andrei**, V. Ion**, M. Dinescu**

Affiliations : *National Institute of Material Physics, 105 bis Atomistilor Street, 077125 Bucharest-Măgurele, Romania **National Institute of Plasma Lasers and Radiation, 409 Atomistilor Street, 077125 Bucharest-Măgurele, Romania

Resume : We report on the Ge nanoparticle formation by pulsed laser annealing in TiGeO amorphous films, using the 266 nm radiation of the Nd-YAG laser. The laser irradiation was performed using fluencies between 10 to 30 mJ/cm2 and 10 to 500 laser pulses. The amorphous TiGeO films were deposited by magnetron sputtering on Si(100) wafer substrates with the TiO2/Ge deposition ratio close to one. The total thickness of the film is about 350 nm. The laser irradiations were performed in air perpendicular to the film surface. After laser irradiation, the films structure was studied using SEM, AFM and XTEM and HAAD -STEM microscopy. The morphology of the film surface shows a coherent relief with a periodicity about 200 nm, close but different than the laser wavelength. However, the laser fluence is to low to produces the surface film melting according to the known parameters. The XTEM analysis reveals formation of amorphous spherical Ge nanoparticles near the film surface, with diameters between 5 and 20 nm. The top layer of the irradiated film, meaning about 10 nm thick, contains less Ge, due to the losing of gas GeO which is formed in the film during laser irradiation. At higher fluence the film relief is less coherent and the XTEM imaging reveals the presence of bubbles formed by the gas GeO under the film surface. The film structure remains amorphous but is changed in a depth of about 50 nm only, by Ge diffusion and segregation.

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13:30 **Shadow graph studies of laser-assisted non-thermal structuring of thin layers on flexible substrates by shock-wave-induced delamination processes.**

Authors : P. Lorenz1, Tomi Smausz3, Tamás Csizmadia2, F. Frost1, M. Ehrhardt1, K. Zimmer1, B. Hopp2

Affiliations : 1 Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany; 2 Department of Optics and Quantum Electronics, University of Szeged, H-6720 Szeged, Dóm tér 9, Hungary; 3 MTA-SZTE Research Group on Photoacoustic Spectroscopy, University of Szeged, H-6720 Szeged, Dóm tér 9, Hungary

Resume : The laser-assisted microstructuring of thin films especially for electronic applications without damaging the layers or the substrates is a challenge for the laser micromachining techniques. The thin-film patterning by ablation of the polymer substrate at the rear side has been demonstrated recently and is called 'SWIFD' – shock-wave-induced film delamination patterning. However, the realising of high speed, low damage, and high resolution patterning processes with lasers has a great potential for applications in, e.g., flexible electronics. This study focusses on the temporal sequence of processes that characterize the mechanism of this SWIFD process. For this purpose high-speed shadowgraph experiments were performed in a pump probe experimental set-up using a KrF excimer laser for ablating the rear side of the polyimide substrate and measuring the shock wave generation at laser ablation of the polymer substrate as well as the thin-film delamination in dependence on the laser irradiation parameters. In addition, the SWIFD process was studied on different thin layers on polyimide substrates. The morphology and size of the ablation pit as well as of the thin-film structures were studied by SEM and AFM for various laser irradiation parameters (laser fluence, number of laser pulses, laser beam diameter). The shadowgraph experiments allow the time-dependent identification and evaluation of the shock wave formation, substrate bend, and delamination of the thin film.

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13:30 **Dynamics of the surface nanostructuring of fused silica assisted by laser-induced self-assembling of thin metal layers: Theory and experiment**

Authors : P. Lorenz1, M. Klöppel2, Tomi Smausz4, Tamás Csizmadia3, F. Frost1, M. Ehrhardt1, K. Zimmer1, B. Hopp3

Affiliations : 1 Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany; 2 Institute of Scientific Computation, Department of Mathematics, TU Dresden, 01062 Dresden; 3 Department of Optics and Quantum Electronics, University of Szeged, H-6720 Szeged, Dóm tér 9, Hungary; 4 MTA-SZTE

JP.XI 30

Research Group on Photoacoustic Spectroscopy, University of Szeged, H-6720 Szeged, Dóm tér 9, Hungary
Resume : The introduced laser method demonstrates a novel concept of complex nanostructuring of dielectric surfaces assisted by a laser-induced molten metal layer deformation process where the structuring process is defined by the deformation process of the thin metal layer [1, 2]. The method allows the fast, large-scale, and cost-effective production of randomly distributed surface nanostructures with a lateral dimension down to 10 nm. The dynamics of the metal layer deformation process was studied by time-dependent reflection and transmission measurements. The resultant structures were investigated by atomic force (AFM), optical microscopy, and scanning electron microscopy (SEM). The experimental results were compared with the simulation findings that take into account the heat equation (laser-solid interaction including melting and evaporation) and the Navier-Stokes equations (deformation process of the molten phase). The simulation allows a very good description of the experimental results and will allow the optimization of the structuring results. [1] P. Lorenz et al., Appl. Surf. Sci. 280 (2013) 933. [2] P. Lorenz et al., Appl. Phys. A 111 (2013) 1025.

add to my program (close full abstract)

13:30 **Si doping effects on structural, surface morphology and optical proprieties of GaN grown by MOCVD**

Authors : M. Bouzidi*, Z. Benzarti, I. Halidou, Z. Chine, B. El Jani
Affiliations : Université de Monastir, Faculté des Sciences Unité de recherche sur les Hétéro-Epitaxies et Applications (URHEA), 5000 Monastir, Tunisia. E-mail: * elbouzidimed16@yahoo.com
Resume : We investigated the silicon doping effects on GaN layers grown on sapphire substrate by metalorganic chemical vapor phase deposition (MOCVD). We have used silane (SiH4) to intentionally incorporate silicon during the crystal growth of GaN. The X-ray diffraction (XRD) and scanning electron microscopy (SEM) analyses were used to study the structural and surface morphology of the films. Room temperature photoluminescence spectra of Si doped GaN layers (GaN:Si) exhibited a decrease in the intensity of yellow luminescence (YL) with increasing SiH4 flow rate, which could be due to a decrease in the concentration of gallium vacancy (VGa) or VGa-related complexes. Fundamental optical band gap measured by photoreflectance showed a redshift up to a concentration of electrons of about n = 6×1018 cm-3. Above this value, a sudden blueshift of the band gap energy was observed. This result was interpreted by the competing effects of Burstein-Moss band filling and band gap renormalization. Keywords: GaN:Si, Photoreflectance, Burstein-Moss effect, band gap renormalization, yellow luminescence, XRD, SEM.

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13:30 **Photoisomerization and Quantum Yield in Biomimetic Molecular Switches**

Authors : M Gueye 1, S. Haacke 1, S. Fusi 2, M. Olivucci 2, 3, J. Léonard 1
Affiliations : 1 Institut de Physique et Chimie des Matériaux de Strasbourg, CNRS - Université de Strasbourg, France; 2 Dipartimento di Chimica, Università degli Studi di Siena, Italy; 3 Chemistry Department, Bowling Green State University, Bowling Green, United States; E-mail: Jeremie.Leonard@ipcms.unistra.fr
Resume : Molecular switches based on E/Z photoisomerization produce mechanical work at the molecular scale. Coherent vibrational wave packets are observed only throughout the photoisomerization reaction in rhodopsin (Rho) [1]. Using ultrafast pump-probe transient absorption (TA) spectroscopy such vibrational coherence was recently demonstrated to occur also in small artificial photoswitches based on an indanylidene-pyrroline (IP) chemical skeleton, in solution [3,4]. Theoretical investigations show that the IP derivatives are able to reproduce the excited state (S1) potential energy surface of retinal in rhodopsin [5]. Investigations of the chemical substitutions influence on the photoreaction show sub-picosecond reactions, but vibrational coherence is observed only in those switches, which show the fastest reactions (<0.3 ps). In addition and most remarkably, there is no correlation between the reaction speed, the appearance of vibrational coherence in the photoproduct, and the photoisomerization quantum yield. References [1] R. W. Schoenlein, L. A. Peteanu, R. A. Mathies, C. V. Shank, Science, 254, 412 (1991) [3] J. Briand, et al., Phys. Chem. Chem. Phys. 12, 3178, (2010). [4] J. Léonard, et al, Chem. Eur. J. , 48, 15296, (2012). [5] F. Lumento, et al., Angew. Chem., 119, 418 , (2007) .

JP.XI 32

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13:30 **Improved surface structure and chemical composition of Ge-Sb-Te thin films grown by femtosecond and picosecond PLD**

Authors : G. Dascalu1, O. Pompilian2,3, N. Cimpoesu4, V. Nazabal5, P. Nemec6, P. Hawlova6, B. Chazallon2, S. Gurlui1, C. Focsa2

Affiliations : 1Faculty of Physics, University "Al. I. Cuza", 700506 Iasi, Romania; 2Laboratoire de Physique des Lasers, Atomes et Molecules (UMR CNRS 8523), Universite Lille 1 Sciences & Technologies, 59655 Villeneuve d'Ascq, France; 3National Institute for Lasers, Plasma and Radiation Physics, PO-Box MG-36, Ro-77125 Magurele-Bucharest, Romania; 4Faculty of Materials Science and Engineering, "Gheorghe Asachi" Technical University of Iasi, 700050 Iasi. Romania; 5Institut des Sciences Chimiques de Rennes (UMR CNRS 6226), Universite de Rennes 1, 35042 Rennes, France; 6Faculty of Chemical Technology, University of Pardubice, Studentska 573, 53210 Pardubice, Czech Republic

Resume : Significant advances in non-volatile solid state memory devices were driven by the discovery of Ge-Sb-Te alloys found along the GeTe?Sb2Te3 tie-line. The rapid laser-induced crystallization with large property changes represented the grounds for many research studies. To ensure an ns transition from amorphous to metastable structure, the structural characteristics and other optical properties of the deposited films need to be carefully adjusted. Our work was focused on comparing the structural, chemical and optical properties of Ge-Sb-Te thin films obtained by laser ablation using pulsed lasers which operate in different conditions (pulse duration: ns, fs, ps; repetition rate: 10Hz, 1kHz). In each temporal regime, other experimental parameters were varied such as target-substrate distance, deposition time, laser fluence, wavelength etc. The structural characteristics were studied using profilometry, SEM, EDX, ToF-SIMS, Raman spectroscopy and XRD, while for optical properties we considered the VASE and spectrophotometry techniques. The main observed characteristics were the improved surface morphology and chemical composition of the samples deposited by ps- and fs-PLD.

JP.XI 33

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13:30 **Single Silver Nanowire Nanoantennas Characterized by Far-Field Microscope Polarization Spectroscopy: Interplay Between Dipole and Higher-Order Plasmon Modes**

Authors : Ming Fu 1&2, Lihua Qian, Hua Long, Kai Wang, Peixiang Lu, Yury P. Rakovich, Frederik Hetsch, Andrei S. Susha, and Andrey L. Rogach

Affiliations : 1. Wuhan National Laboratory for Optoelectronics and School of Physics, Huazhong University of Science and Technology, Wuhan 430074, China 2. Photonics and Optoelectronics Group, Department of Physics and CeNS, Ludwig-Maximilians-Universität München, Amalienstrasse 54, D-80799 München, Germany; Wuhan National Laboratory for Optoelectronics and School of Physics, Huazhong University of Science and Technology, Wuhan 430074, China; Wuhan National Laboratory for Optoelectronics and School of Physics, Huazhong University of Science and Technology, Wuhan 430074, China; Wuhan National Laboratory for Optoelectronics and School of Physics, Huazhong University of Science and Technology, Wuhan 430074, China; Wuhan National Laboratory for Optoelectronics and School of Physics, Huazhong University of Science and Technology, Wuhan 430074, China; Centro de Física de Materiales (CSIC-UPV/EHU) and Donostia International Physics Center (DIPC), 20018 Donostia-San Sebastián, Spain; Department of Physics and Materials Science and Centre for Functional Photonics (CFP), City University of Hong Kong, Hong Kong SAR; Department of Physics and Materials Science and Centre for Functional Photonics (CFP), City University of Hong Kong, Hong Kong SAR; Department of Physics and Materials Science and Centre for Functional Photonics (CFP), City University of Hong Kong, Hong Kong SAR

Resume : A comprehensive understanding of the surface plasmon modes and their near-field enhancement in silver nanowires (NWs) is essential for potential application of the plasmonic structures in integrated devices. We investigate experimentally and theoretically the surface plasmon modes in single silver NWs. Our results show that the fluorescence of CdTe quantum dots (QDs) can be enhanced by single Ag NW antennas due to efficient coupling of QDs excitons with collective electron oscillations in NW. Strong fluorescence enhancement can be obtained for the excitation at 800 nm by laser polarized parallel to the NW axis and at 400 nm by laser with polarization perpendicular to Ag NW axis. Furthermore, the fluorescence polarization is changed with different polarized excitation direction of the 800 nm light beam, while it keeps parallel to the Ag NW axis at the 400 nm excitation. Performing the electrodynamics simulations using the finite element method (FEM), can provide important insights into the different excitation polarization dependent fluorescence behavior of the sample illuminated with different wavelength. On this basis, we show that the observed differences are attributed to the fact that the near-IR and near-UV laser beams couple to fundamentally different plasmon modes of the Ag NW.

JP.XI 34

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13:30 **Photothermal Laser Processing of Hybrid Gold/Titania Nanoparticle Films**

Authors : Lina Schade 1,2, Steffen Franzka 1,2, Kevin Dzialkowski 1,2, Sebastian Hardt 2,3, Hartmut Wiggers 2,3, Galina Marzun 1,2, Phillipp Wagener 1,2, Nils Hartmann 1,2
Affiliations : 1 Fakultät für Chemie, Universität Duisburg-Essen, 45117 Essen, Germany; 2 CENIDE – Center for Nanointegration Duisburg-Essen, 47048 Duisburg, Germany; 3 Institut für Verbrennung und Gasdynamik, Universität Duisburg-Essen, 47048 Duisburg, Germany

Resume : Titania nanoparticles (TiO2-NPs) are highly transparent in the visible wavelength range. For selective photothermal processing laser sources with wavelengths in the UV range are most suitable [1]. Here, we consider a way to process TiO2-NPs at a wavelength in the visible range. Anatase TiO2-NPs (diameter: 8-10 nm) are loaded with gold nanoparticles (Au-NPs, diameter: 35 nm, 1wt%). Photothermal laser processing of thin films of these NPs with a thickness of about 500 nm on soda-lime glass is addressed. Laser processing in ambient air is carried out using a micro-focused cw laser setup operating at a wavelength of 355 nm with a 1/e laser spot size of 0.6 µm and at a wavelength of 532 nm with a 1/e laser spot size of 0.7 µm. In conjunction with scanning electron microscopy, this approach provides a highly reproducible and convenient means in order to modify the local film structure and study the dependence of the resulting film morphology on the laser parameters. Sintering of the NPs at both wavelengths is observed. This opens up an opportunity to fabricate porous, hybrid Au/TiO2 films with laterally varying nano- and microstructure for dye-sensitized solar cells or photocatalyic applications. [1] L. Schade, S. Franzka, S. Hardt, H. Wiggers, N. Hartmann, Appl. Surf. Sci. (2012), DOI: 10.1016/j.apsusc.2012.11.077

JP.XI 35

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13:30 **Optical properties of (70-x-y)TeO2-20WO3-10Y2O3-xEr2O3-yYb2O3 glasses**

Authors : P.R. Prezas, M.P.F Graça, M.J. Soares, J. Suresh Kumar
Affiliations : Department of Physics &I3N, University of Aveiro, 3810-193 Aveiro, Portugal

Resume : TeO2 based heavy metal glasses with molar composition (70-x-y) TeO2-20WO3-10Y2O3-xEr2O3-yYb2O3, where x = 0 and 0.5 mol% and y = 0, 0.5, 1, 2 and 4 mol%, were prepared by the melt quenching technique. The samples revealed to be transparent at room temperature and thermally stable. This vitreous system was found to be promising for potential applications in optical amplification, in particular in erbium doped fiber optical amplifiers (EFDA), Raman amplifiers and also in spectral conversion for applications in photovoltaic technology. Raman spectra of samples, with laser excitation of 532 nm, showed a band distribution related to Te-O and W-O bond vibrations. The structural effects of the minor components, Y2O3, Er2O3 and Yb2O3 can be regarded as small perturbations. The addiction of WO3 results in a higher bandwidth relatively to SiO2 based glasses and even other TeO2 based glasses, making this vitreous system promising for Raman optical amplification. The use of UV laser excitation of 325 nm induced surface modifications on the samples. The optical analysis showed an increase of the intensity of the upconversion emissions with the increase of the content of the Yb3+ as sensitizer ions. The Er3+ emission around 1540 nm has a full width at half maximum of about 100 nm in temperature range of 70-300 K, which is a potential value relatively to those reported for other glass systems, considering its application in optical amplification.

JP.XI 36

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13:30 **MAPLE prepared heterostructures with arylene vinylene polymer:fullerene active layer for photovoltaic applications**

Authors : A. Stanculescu1, G. Socol2, A. M. Catargiu3, L. Vacareanu3, M. Socol1, O. Rasoga1, C. Breazu1, N.Preda1, F. Stanculescu4
Affiliations : 1.National Institute of Materials Physics, 105 bis Atomistilor Street, P.O. Box MG-7, 077125, Bucharest-Magurele, Romania; 2.National Institute for Laser, Plasma and Radiation Physics, PO Box MG-36, 077125, Bucharest-Magurele, Romania; 3.P. Poni Institute of Macromolecular Chemistry, 41 A Gr. Ghica Voda Alley, 700487-Iasi, Romania; 4.University of Bucharest, Faculty of Physics, Str. Atomistilor nr.405, P.O. Box MG-11, Bucharest-Magurele, 077125 Romania

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Resume : An active layer formed by a mixture, "blend" of organics, a donor component and an acceptor, can offer an alternative to conventional bi-layer heterojunction organic solar cell characterized by the limited conversion efficiency determined by the limited interfacial contact area between the donor and acceptor layer. This paper presents some studies of the organic heterojunctions realised on glass/ITO and Si substrates, from a mixture of new

synthesised arylene vinylene polymer, [poly[N-(2-ethylhexyl) 2.7 carbazolyl vinylene] or [poly[N-(2-ethylhexyl) 2.7 carbazolyl 1.4-phenylene ethynylene] as donor, and fullerene, C60, characterised by high electron mobility as acceptor, blended in a ratio of 1:2.22 and 1:2.85 respectively. The organic films have been deposited by MAPLE using the 248 nm radiation of a KrF* excimer laser and chloroform as solvent for the preparation of the target in the following experimental conditions: fluence of 250mJ/cm2 and number of pulses of 20000 or 30000. We have characterised the mixed layer by spectroscopic (UV-VIS, FTIR, PL) and microscopic (AFM) methods. The effect of a transparent conductor buffer layer of poly(aniline-co-aniline propane sulfonic acid) or poly(3,4-ethylenedioxythiophene) poly(styrenesulfonate) between ITO and the active layer on the electrical properties of the heterostructure has been also analysed confirming that MAPLE could be an adequate method for the preparation of active layer based on bulk heterojunction for solar cells.

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13:30 **CdS thin films prepared by laser assisted chemical bath deposition**

Authors : L. V. Garcia1, M.I. Mendivil1, G. Garcia Guillen1, D. Avellaneda1, G.A. Castillo1, T.K. Das Roy1, B. Krishnan1, 2, S. Shaji1,2
Affiliations : 1. Facultad de Ingenieria Mecanica y Electrica, Universidad Autonoma de Nuevo Leon, Av. Pedro de Alba s/n, Ciudad Universitaria, San Nicolas de los Garza, Nuevo Leon, Mexico, 66450. 2. CIIDIT- Universidad Autonoma de Nuevo Leon, Apodaca, Nuevo Leon, Mexico.

Resume : Cadmium sulphide (CdS) is a well known n-type semiconductor with useful optoelectronic properties in solar cells. In this work, we report the preparation and characterization of CdS thin films by laser assisted chemical bath deposition (LACBD). CdS thin films were prepared from a chemical bath containing cadmium chloride, triethanolamine, ammonium hydroxide and thiourea under various deposition conditions. The experiments were developed with insitu irradiation of the bath during the deposition using a continuous laser of wavelength 532 nm, varying the power density. Good quality thin films were obtained during deposition of 10, 20, 30 and 40 min. The changes in morphology, structure, composition, optical and electrical properties of these thin films were analyzed by Atomic force microscopy (AFM), X-Ray diffraction (XRD), X-Ray photoelectron spectroscopy (XPS) and UV-Vis spectroscopy. The films obtained by LACBD were nanocrystalline, photoconductive and presented interesting morphologies. The results obtained show that LACBD is an effective synthesis technique to obtain CdS thin films with good optoelectronic properties.

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13:30 **Light emission from Er-doped thin films produced by pulsed laser ablation of a SiAlON target**

Authors : I. Camps1, R. Serna1, J.M. Ramírez2, B. Garrido2, M. Perálvarez3, J. Carreras3, N. P. Barradas 4, E. Alves 5,6, L.C. Alves 4,6.
Affiliations : 1Laser Processing Group, Instituto de Óptica, CSIC, C/Serrano 121, 28006 Madrid, Spain; 2MIND-IN2UB, Departament d'Electrònica, Universitat de Barcelona, c/Martí i Franqués 1, 08028 Barcelona, Spain; 3 IREC, Fundació Privada Institut de Recerca en Energia de Catalunya; 4 C2TN - Centro de Ciências Tecnológicas e Nucleares, Portugal; 5 IPFN - Instituto de Plasmas e Fusão Nuclear, Universidade de Lisboa, Estrada Nacional 10 (km 139,7), 2695-066 Bobadela LRS Portugal; 6 Laboratório de Aceleradores e Tecnologias de Radiação, Portugal.

Resume : Silicon oxynitride (SiON) materials have been object of research as they offer a suitable technological platform for the development of integrated optoelectronic devices such as light emitting devices (LEDs) or high speed silicon optical modulators. This is due to their excellent properties that include a large refractive index that can be tuned from that of SiO2 (1.45) to that of Si3N4 (2.01), high transparency in the visible-near infrared range, good electrical properties and compatibility with the current Si-technology. More recently, in the search for efficient light emitting materials with superior performance and large integration capability has motivated the study of more complex matrices such as aluminum-doped silicon oxynitrides. Among the several advantages provided by this quaternary host, the possibility of tuning the electrical and optical properties, the enhanced light emission from luminescent species and the decrease in the maximum phonon energy become major key points that stimulate the ongoing research of these materials. In this work, we report on the photoluminescence (PL) response from thin films produced by pulsed laser deposition (PLD) in vacuum (400 mPa) at room temperature, by focusing an ArF excimer laser on two separate targets: a ceramic SiAlON (Si 25.2 - Al 19.5 - O 10 - N 43.5 - Y 1.7 at %) and a metallic Er target. During the process, the Er is distributed in the films forming doping layers with different interlayer spacing.

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The composition of the films is different compared to that of the target, showing a remarkable decrease in the Al content (up to 3 at %) that varies depending on the deposition conditions. The as grown films show Er-related emission peaking at 1533 nm. This PL emission is further enhanced by post-deposition annealing treatments up to 850ºC. The PL excitation spectra analysis evidences that the Er ions are excited via energy transfer from the matrix. The role of the PLD conditions on the emission properties will be investigated in order to achieve maximized PL emission.

add to my program (close full abstract)

13:30 **Influence of Ni content on the properties of Ni-YSZ thin films obtained by Pulsed Laser Deposition** JP.XI 40

Authors : R. Pascu1, S. Somacescu2, C. Hornoiu2, G. Epurescu1, B. Mitu1, M. Dinescu1
Affiliations : 1 National Institute for Laser, Plasma and Radiation Physics, Magurele, Bucharest, Romania 2 „Ilie Murgulescu" Institute of Physical Chemistry, Bucharest, Romania

Resume : The use of Ni-YSZ thin films as anode system in Solid Oxide Fuel Cells is ultimately depending on its capability to modify its electrical properties in the presence of oxydizing or reducing atmosphere, at the operation temperature. This is mainly connected to the amount of nickel in the material, as well as to its uniform distribution in the dielectric host. In this work, the laser ablation technique was utilized for obtaining Ni-YSZ thin films with various amount of nickel. The depositions were perfomed by using an ArF excimer laser at 193 nm which irradiated a commercial YSZ target partially covered with Ni sectors (up to 50%). Oxygen atmosphere was used for avoiding substochiometric compound formation, and for better reactivity on the substrate level, an additional RF discharge was assisting the deposition, as well. Si and Si/Pt substrates, placed at 5 cm in front of the target, were heated up to 600 degreesC during PLD process. A thorough investigation regarding material morphology, structure and chemical composition was performed by means of AFM, SEM, XRD and SNMS techniques. The oxidation states of Y, Zr and Ni were determined by XPS analysis. The electrical conductivity of the materials in the temperature range from RT to 800 degrees C both in oxidizing and reducing atmospheres are reported.

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13:30 **FABRICATION OF NOVEL MESO-PHENYL UNSYMMETRICAL SUBSTITUTED PORPHYRIN THIN FILMS BY MAPLE FOR GAS SENSING APPLICATIONS** JP.XI 41

Authors : A.-M. Iordache1, R. Cristescu2, E. Fagadar-Cosma3, A. Popescu2, C. Popescu2, V. Grumezescu2, A.A. Ciucu4, S. Iordache1, A. Balan1, I. Stamatin1, I.N. Mihailescu2, and D.B. Chrisey5
Affiliations : 1University of Bucharest, 3Nano-SAE Research Center, PO Box MG-38, Bucharest-Magurele, Romania 2National Institute for Lasers, Plasma & Radiation Physics, Lasers Department, P.O. Box MG-36, Bucharest-Magurele, Romania 3Institute of Chemistry Timisoara of Romanian Academy, Department of Organic Chemistry, 300223, Timisoara, Romania 4University of Bucharest, Faculty of Chemistry, Bucharest, Romania 5Department of Physics and Engineering Physics, Tulane University, New Orleans, LA, USA

Resume : In the last decade, the biogene amines have catched the researchers' interest due to their direct relation to the meat freshness and thus, the rapid detection of volatile organic compounds (VOC). In the present study, we report on the deposition of novel meso-phenyl unsymmetrical substituted porphyrin, 5-(4-carboxyphenyl)-10,15,20-triphenylporphyrin (CPTPP) thin films by matrix assisted pulsed laser evaporation (MAPLE) onto silicon substrates with screen-printed transparent conducting oxide electrodes, aiming to design a fluorecent-chemosensor for biogene amines detection. FTIR spectroscopy and Raman spectrometry have confirmed that the chemical structure of MAPLE-deposited thin films was preserved for fluences within the range 200-400 mJ/cm2. AFM examination has shown that the thin films had a uniform and continuous morphology for 300 mJ/cm2 laser fluence. Cyclic voltammograms on screen printed electrodes have demonstrated that CPTPP is appropriate as a single mediator for various biogene amines (histamine, cadaverine, putresceine) with high yield in fluorescence and electrochemical signal. We have shown that MAPLE deposition of CPTPP thin films can replicate both the bulk structure and serve as a soft technique in deposition of porphyrin thin films and patterns.

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13:30 **MAPLE-FABRICATED THIN FILMS COMPOSED OF 5 NM ANTIBIOTICS FUNCTIONALIZED MAGNETITE NANOSTRUCTURES WITH ANTI-PATHOGENIC PROPERTIES** JP.XI 42

Authors : Rodica Cristescu1, Valentina Grumezescu1,2, Alina Maria Holban3, Bogdan

Stefan Vasile2, Laurentiu Mogoanta4, George Dan Mogosanu5, Alexandru Mihai Grumezescu2, Gabriel Socol1, I.N. Mihailescu1, Anton Ficai2, Roxana Trusca6, Florin Iordache7, and Douglas B. Chrisey8
Affiliations : 1Lasers Department, National Institute for Lasers, Plasma & Radiation Physics, P.O. Box MG-36, Magurele, Bucharest, Romania 2Department of Science and Engineering of Oxidic Materials and Nanomaterials, Faculty of Applied Chemistry and Materials Science, University Politehnica of Bucharest, 1–7 Polizu Street, 011061 Bucharest, Romania 3Microbiology Immunology Department, Faculty of Biology, University of Bucharest, 1–3 Portocalilor Lane, Sector 5, 77206 Bucharest, Romania 4 Research Center for Microscopic Morphology and Immunology, University of Medicine and Pharmacy of Craiova, 2 Petru Rareş Street, 200349 Craiova, Romania 5 Department of Pharmacognosy & Phytotherapy, Faculty of Pharmacy, University of Medicine and Pharmacy of Craiova, 2 Petru Rareş Street, 200349 Craiova, Romania 6S.C. Metav-CD S.A., 31Rosetti Str., 020015 Bucharest, Romania 7Institute of Cellular Biology and Pathology of Romanian Academy, "Nicolae Simionescu", Department of Fetal and Adult Stem Cell Therapy, 8, B.P. Hasdeu, Bucharest 050568, Romania 8Department of Physics and Engineering Physics, Tulane University, New Orleans, LA, USA
Resume : This study aimed for the evaluation of anti-microbial effect and biocompatibility of newly fabricated antibiotics functionalized magnetite nanostructures, of 5 nanometers average diameter, prepared as bulk material by Matrix Assisted Pulsed Laser Evaporation (MAPLE). Prepared thin films were characterized by High-Resolution Transmision Electron Microscopy, Scanning Electron Microscopy, Infrared Microscopy and X-ray Diffraction. In vitro biological assays have been performed in order to evaluate the influence of fabricated thin film on the Gram positive and Gram negative biofilm development as well as their in vitro biocompatibility for up to five days of incubation (qualitative and quantitative methods) with eukaryotic cells. The in vivo biocompatibility experiments were performed on holoxenic mice. The obtained 5 antibiotics functionalized magnetite nanostructures-based thin film have proved to be efficient to prevent microbial development and contamination of implanted prothesis, as demonstrated by the inhibitory activity on mature biofilm development. Furthermore, these thin film nanostructured surfaces proved a good biocompatibility both in vivo and in vitro, demonstrating their potential to be used for clinical purpose. Taken together, these results have a great impact, opening new perspectives for the anti-infective therapy.

add to my program (close full abstract)

13:30 **MnGeSb: (Fe, Co) films deposited by PLD on various substrates**

Authors : M.I. Rusu1, R. Savastru1, C.N. Zoita1, A. Kiss1, C.P. Lungu2, C. Porosnicu2, O.Monnereau3, L. Tortet3, A. Tonetto4, R. Notonier4, C.E.A. Grigorescu1
Affiliations : 1National Institute R&D Optoelectronics INOE 2000, PO BOX MG-5, RO 077125, Magurele – Ilfov, Romania, 2National Institute R&D Lasers, Plasma and Radiation Physics, 409 Atomistilor Str., Magurele, Jud. Ilfov, 77125, Romania 3MADIREL, Universite de Provence, Faculte de Saint Jerome, Marseille, France 4Aix Marseille Universite Federation de Chimie de Marseille ifr 1739 Pole Pratim, Marseille, France
Resume : The electronic properties of semiconductor thin films are closely related to their structure. Semiconductors that exhibit room-temperature ferromagnetism are central to the development of semiconductor spintronics. This work concerns the deposition and subsequent characterization of films in the system MnGeSb: (Fe, Co). The films have been simultaneously deposited on Si, GaAs, InAs and Al2O3 substrates at moderate substrate temperatures (Tmax= 200oC) using a PLD 2000 Workstation (PVD Products Ltd.). The targets were home-made bulk alloys grown by the vertical gradient freeze technique.. Films of 50-400nm thickness have been obtained. The morphology, carrier type and concentration are investigated in relation with the films thickness and substrate material. Structural and optical characterizations were done by XRD, SEM, EDX, micro-Raman spectroscopy, spectroscopic ellipsometry and small-angle X-ray scattering (SAXS). AFM measurements show a clear influence of the substrate material on the morphology of the films. The Hall effect measurements were carried out at room temperature using an Ecopia HMS-3000 Hall Measurement System. showing that PLD Co-doped films are n-type, with a carrier concentration of the order1021 cm-3 and mobilities of the order 102 cm2/Vs.

JP.XI 43

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13:30 **POLYACETYLENE: STUDY OF THE TEMPERATURE DISTRIBUTION DURING ISOMERISATION REACTION INDUCED BY LASER EFFECT AND BY DIFFERNTIELLE SCANNING CALORIMETRIE (D.S.C)**

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Authors : L. Messai1, Z. Skanderi2*, F. Mechachti2, A. Djebaili2
Affiliations : 1 Laboratory of Physical chemistry- University of Tebessa-12000- Algeria 2

Laboratory of chemistry and environmental chemistry L.C.C.E - University of Batna-Algeria

Resume : This work presents a numerical resolution of heat distribution equation of pulsed laser beam impact on a sample of polyacetylene characterized by multichannal Raman spectroscopy. The method is based on finite elements theory which allowed the determination of: (i) The temperature of laser impact zone , (ii) The propagation zone of isomerization of a polyacetylene sample. A computer program was been developed for this purpose. Concerning the D.S.C study: Different PA was used, we report the results of two polyacetylene samples prepared successively (i) at the surface of the catalytic solution, called horizontal PA, and (ii) on the surface of wet wall by catalytic solution , called vertical PA . The samples were studied in the temperature range from 30 °C to 280 °C and subjected respectively to heating rates of 5, 10, 20, 40 and 80 °C / min. We recorded the temperatures corresponding to the maximum of the exothermic peak (T max) of the isomerization reaction. It is observed that the points related to the two samples are placed on the same Arrhenius line. The study allowed the determination of the activation energy and the collision factor of the isomerization reaction, these are Ea = (31.00 □ 0.18) Kcal / mole and A = (2.24 □ 0.45 *1013) /s. These results are found to be close to those obtained in literature by Ito and Bernier. Key Words: Polyacetylene - isomerization - DSC - kinetics - multichannal Raman spectroscopy

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13:30 **Effect of the deposition conditions on the structural and morphological properties of nanostructured Wo3 thin films deposited by PLD**

Authors : M. Dumitru, M. Filipescu, V. Ion, D. Colceag, M. Dinescu
Affiliations : National Institute for Laser, Plasma & Radiation Physics (INFLPR), Magurele, Romania

Resume : Tungsten trioxide (WO3) is a wide band gap n-type metal oxide semiconductor with outstanding electrochromic and gas sensing properties. The influence of a the deopsition parameters on the growth of nanostructured WO3 via PLD must still be thoroughly investigated. Laser working wavelength, the eventually addition of RF plasma discharge, the substrate (Si(100)) temperature and the pressure during the deposition as well as the proportion of the O2 and Ar in the background atmosphere were the parameters explored in order to optimize the conditions for the deposition of nanostructured WO3 exhibiting high crystallinity and interesting morphological properties. A ceramic target was used for the deposition.Structural characterization was performed by X-ray diffraction analysis.The morphology of the film surface was examined by atomic force microscopy. Optical properties of samples were measured by spectroscopic ellipsometry.

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13:30 **Propagation of Short Pulses in Nonlinear Dispersive Media**

Authors : O.Paseka, A.Suhorukov
Affiliations : Lomonosov Moscow State University

Resume : We present novel effects for few-cycle pulses propagation and interaction in cubic nonlinear media with the dispersion. A theory of compression of a few-cycle pulse with quadratic phase modulation has been developed within the SVP (slowly varying profile) method. The equation for the electric field was numerically solved varying the quadratic phase modulation index, number of oscillations, and input pulse width. The optimal modulation index was found, at which a pulse can be compressed to one oscillation period and the fundamental limits are shown. When the modulation index exceeds the optimal value, the width at the compression point increases. The theory of a chirped pulse compression up to one-period optical oscillations is advanced. The optimum value of the phase modulation index for the maximal compression achievement is found. Also in the report the process of self-compression of few-cycle ultrashort femtosecond pulses (without phase modulation) is examined in cubic nonlinear medium with dispersion. The process of self-compession to one-two period pulse is simulated. And the equation for the electric field was numerically solved for different conditions (number of oscillations, input pulse width, nonlinear and dispersive indexes of medium). The process of ultra broadening of spectrum in these cases is discussed and examined. The equations for self-compression in nonlinear medium limits are found and compared to equation for linear medium.

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13:30 **Picosecond ultrafast pulsed laser deposition of oxides: the model system of SrTiO3**

Authors : M. Pervolaraki*, C. N. Mihailescu and J. Giapintzakis
Affiliations : Nanotechnology Research Center and Department of Mechanical and Manufacturing Engineering, University of Cyprus, 75 Kallipoleos Avenue, P.O. Box 20537, 1678 Nicosia, Cyprus

Resume : Ultrafast pulsed laser deposition (UFPLD) has been suggested as a suitable method to eliminate particulates usually found on the surface of thin films grown by conventional PLD [1]. When low-energy pulses with pulse width of ~ 10 ps and repetition rates in the kHz to MHz regime are used, an improvement in the film quality is expected due to the low number of atoms evaporated by each pulse. The high repetition rate increases the deposition rate compensating for the small number of ablated species due the low pulse energy. Recent reports on the UFPLD of oxides [2, 3] have shown the existence of a fine repetition rate threshold between ablation and thermal evaporation of the target, resulting to stoichiometric rough films and non-stoichiometric smooth films, respectively. The repetition rate threshold between ablation and evaporation modes is determined by a combination of the UFPLD experimental conditions and the physical properties of the target, proving that the "recipe" for stoichiometric, particle-free thin films is not trivial. In this study, SrTiO3 films were fabricated by UFPLD using repetition rates in the range of 0.2 to 8.2 MHz at 1064 nm. The effect of laser repetition rate and intensity was investigated by topological, structural and stoichiometric evaluation of the as-produced thin films. References: 1. A.V. Rode, B. Luther-Davies, E.G. Gamaly, J. Appl. Phys. 85, 4222 (1999) 2. T. Salminen, • M. Hahtala, • I. Seppälä, T. Niemi and M. Pessa, Appl. Phys. A 98, 487 (2010) 3. E. Thelander and B. Rauschenbach, J. Phys.: Conf. Ser. 356, 012015 (2012)

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13:30 **Electrical and thermal properties of ta-C and a-C:Ag nanocomposite thin films produced by pulsed laser deposition**

Authors : M. Parvolaraki*, G. I. Athanasopoulos and J. Giapintzakis
Affiliations : Nanotechnology Research Center and Department of Mechanical and Manufacturing Engineering, University of Cyprus, 75 Kallipoleos Avenue, P.O. Box 20537, 1678 Nicosia, Cyprus

Resume : Recently a-C nanocomposites have attracted significant interest as a means to tune physical properties of carbon-based coatings for solar harvesting applications and other applications. The introduction of Ag inclusions in the ta-C matrix can cause graphitization and consequent broadening of the optical absorption [1]. Density functional theory (DFT) calculations have predicted that the level of graphitization depends on the distribution of Ag inclusions in ta-C composites [2]. Non-hydrogenated ta-C and a-C:Ag nanocomposite films were deposited using 248 nm PLD and a base pressure of 2 x 10-5 mbar. High laser fluences were employed to ensure high kinetic energy of the carbon species thus promoting sp3 bonding. The evaluation of the transport properties of pristine and nanocomposite thin films is essential for their integration into devices. The temperature dependence of electrical resistivity and thermal conductivity of both ta-C and a-C:Ag nanocomposite films was measured using the four-probe technique and the differential 3ω method, respectively. 1. H. Zoubos et al., Sol. Energ. Mat Sol. C 117, 350 (2013) 2. G. A. Tritsaris et al., J. Appl. Phys. 112, 103503 (2012) Acknowledgement: Financial support from the Strategic Infrastructure Project NEW INFRASTRUCTURE/STPATH/0308/04 of DESMI 2008, which is co-financed by the European Regional Development Fund, the European Social Fund, the Cohesion Fund, and the Research Promotion Foundation of the Republic of Cyprus, is greatly acknowledged.

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13:30 **Electrocatalytic activity of carbon nanofoam in alkaline media**

Authors : A. Dalamagkas(1), D. Vernardou(1), N. Katsarakis(1,2,3), M. Pervolaraki(4*), J. Giapintzakis(4)
Affiliations : (1)Center of Materials Technology and Photonics, School of Applied Technology, Technological Educational Institute of Crete, 710 04 Heraklion, Crete, Greece. (2)Electrical Engineering Department, Technological Educational Institute of Crete, 710 04 Heraklion, Crete, Greece (3)Institute of Electronic Structure and Laser, Foundation for Research & Technology-Hellas, P.O. Box 1527, Vassilika Vouton, 711 10 Heraklion, Crete, Greece (4)Nanotechnology Researcher Center and Department of Mechanical and Manufacturing Engineering, 75 Kallipoleos Av., P.O. Box 20537, 1687 Nicosia,Cyprus

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Resume : Carbon nanomaterials have dominated important advances in electrocatalysis. They can be used either as supports for immobilizing active

species or as metal-free catalysts. This behavior is due to their high specific surface area as well as chemical and electrochemical inertness. In this paper, carbon nanofoam of different thickness was fabricated by picosecond ultrafast pulsed laser deposition at room temperature. The structural and morphological characteristics of the samples were evaluated by X-ray diffraction, Raman spectroscopy and field-emission scanning electron microscopy, respectively. Regarding the electrochemical measurements, they were performed in a three-electrode electrochemical cell using 0.25 M NaOH with and without the presence of 0.5 M methanol and ethanol at a scan rate of 20 mV s-1. The effect of the thickness on the electrocatalytic activity of the nanofoams in alcohol is highlighted.

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13:30 **Functional properties of BFO nanostructures produced by laser ablation**

Authors : N. D. Scarisoreanu1, R. Birjega1, V. Ion1, F. Craciun3, V. Teodorescu2, T. Lippert4 and M. Dinescu1
Affiliations : 1NILPRP, P.O. Box MG-16, RO-77125, Bucharest, Romania. 2NIMP-National Institute of Materials Physics, 077125 Bucharest-Magurele, Romania 3CNR-Istituto dei Sistemi Complessi, Area della Ricerca Roma-Tor Vergata, Via del Fosso del Cavaliere 100, I-00133, Rome, Italy. 4Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland

Resume : Multiferroic BFO-based materials are intensively studied for their wide range of applications, from spintronics and multistate memories to photocatalysis. We have synthesized BFO nanoparticles by laser ablation in different liquids (deionized water, alcohols) using an Nd-YAG laser working at different wavelengths (266 and 355 nm) and fluences (1.4- 3 J/cm2). The average particle size was estimated by transmission electron microscopy (TEM) and the optical properties by spectroscopic ellipsometry (SE) and UV-Vis spectrometry (ultraviolet?visible). To evaluate their functional multiferroic and photocatalytic properties, the BFO nanoparticles have been deposited as thin films by MAPLE (Matrix Assisted Pulsed Laser Evaporation). The influence of experimental parameters such as the solvent type, laser wavelength or thickness of the MAPLE deposited BFO thin films on the local piezoelectric response, optical, multiferoic and photocatalytic properties has been studied using techniques such as XRD, HRTEM, SE, UV-VIS, PFM or dielectric/ferroelectric spectroscopy. A comparison with PLD deposited layers properties is also performed.

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13:30 **Preliminary results of multitarget off-axis CW laser ablation for carbon nanotubes synthesis**

Authors : C.R. Luculescu, I. Morjan, E. Popovici, A.G. Ilie
Affiliations : National Institute for Lasers, Plasma and Radiation Physics (NILPRP), Atomistilor 409, Magurele, ROMANIA

Resume : We are proposing a new setup for laser ablation technique with the ultimate purpose to synthesize high purity single-walled carbon nanotubes. Our proposed setup has some advantages such as: -the plasma plumes are colliding in the early phase because the targets are tilted; -the independent control of catalyst both quantitatively and temporally by adjusting the second laser parameters; -the adjustability of deposition parameters is higher; -not difficult to implement; -can be continuous (by using CW lasers) and also to be scalable to a commercial production; -high versatility for the experimental setup permits many configurations to be checked. With these observations in mind we designed the deposition setup in such a way to assure, the long time of flight for plasma precursors, to keep the relatively high temperature in the flight zone and to assure a large versatility and flexibility for the experiments. We obtained the nanotube soot, that contains both single- and multi-walled nanotubes, and we try to optimize the synthesis parameters in order to increase the purity.

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13:30 **Modeling The Effect of Substrate Surface Roughness On The Impact and Flattening Process of plasma sprayed Al2O3–33 wt.% TiO2 coating**

Authors : ILHEM. R. KRIBA1*; K. BENOUMSAAD1; A. DJEBAILI2
Affiliations : 1 Plasma Laboratory - Faculty of Sciences – Department of Physics-University of Batna- Algeria 2 Laboratory of chemistry and environmental chemistry L.C.C.E - University of Batna- Algeria,

Resume : Titanium and titanium alloys have been used in a number of applications in industry ranging from aircraft components, chemical processing facilities to gas turbine engines due to their high strength to weight ratio, high corrosion resistance and relatively high melting temperature. However, further application of titanium and titanium alloys is considerably restricted by their low

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surface hardness, high friction coefficient and poor wear resistance. Therefore, the surface characteristics of titanium and titanium alloys need to be improved. Thermal spray coating is one of the most common ways to improve the surface characteristics of materials. The plasma-sprayed Al2O3 and Al2O3–TiO2 ceramic coatings have been extensively used in many applications as surface coating to protect components against wear and corrosion due to their thermal, chemical and mechanical stability. Recently, nanostructured Al2O3–13 wt.%TiO2 coating demonstrate novel and attractive properties such as bond strength, toughness, abrasive wear and thermal shock resistance. In this paper, numerical model is developed using the finite volume method, based on Navier-Stokes equations and (VOF) method to simulate the impact, spreading and flattening of the Al2O3 –13 wt.%TiO2 droplets impacting onto a solid surface . The model simultaneously takes into account the fluid flow and heat transfer in the liquid particle and the surrounding gas, and the heat transfer in the substrate. To understand the effect of solidification on the droplet impact dynamics and splat morphology, the simulations were run with smoothed and roughened surfaces considering different roughness magnitude. The results show a substantial build up of temperature at the surface and large temperature gradients throughout the thickness, which are due to the differences in the melting point, specific heat and latent heat of fusion of alumina and titania, as well as the difference in their particle sizes. Also, the increase in magnitude of the mean substrate roughness promotes splat instability (jetting and/or satellite break-up) and formation of radial fingers. It was also observed that the increase in general surface roughness may result in the lower spreading ratio (Dfinal / Dinitial) of thermally sprayed ceramic particles. The spreading process of a droplet is governed not only by the inertia and viscous forces, but also by the thermal contact resistance in the substrate surface.

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13:30 **Large-Scale PLD with High Power Lasers**

Authors : Ralph Delmdahl, Jim Greer
Affiliations : Coherent LaserSystems GmbH & Co. KG, Hans Boeckler-Str. 12, 37079 Göttingen, Germany; PVD Products, Inc., Wilmington, MA 01887-1188, USA

Resume : Owing to its inherent processing advantages, namely stoichiometry preserving atomic layer growth and high material yield, pulsed laser deposition (PLD) as one of the most promising routes toward coated conductor volume manufacturing regularly spearheads reported hit lists of achievable end-to-end coated conductor performance parameters such as critical current (Ic) and critical current times length (Ic x L) values [1]. By now, long-length fabrication of coated conductors by means of pulsed laser deposition at industrial throughput rates has been mastered by only a handful of multinational institutions worldwide. The respective pulsed laser deposition equipment of these producers is largely customized and proprietary in nature as it incorporates many years of internal engineering efforts and application experience. As one scales the PLD process up to long length coated conductors there are a variety of issues that need to be addressed in order to obtain reproducible, high quality tapes with high tape feed rate. These include sufficient laser power and laser beam stability, adequate design of the optical beam delivery including a technique to keep the laser beam entrance window clean for the duration of a run, a robust substrate heater, and large size ablation target as well as proper target rastering strategy for large targets [2]. Standardized commercial solutions will be reducing time to market for new players. Excimer lasers have a long history in PLD research on superconducting YBCO thin films where they are routinely operated at wavelengths of 248 and 308 nm. As the excimer laser ablation of the YBCO target occurs at a relatively high energy density of the order of 2 J/cm2 with spot sizes of a few millimeters, comparably high laser output energies of above 200mJ/pulse are typically employed. From the laser perspective upscaling the deposition rate and thus ultimately the tape feed rate commands both, the increase of the pulse energy and of the laser pulse frequency [3]. Since too high of an energy density results in adverse effects such as droplet formation, scaling up deposition rate via pulse energy increase generally implies a multi-plume design of the PLD system. Increasing the laser pulse frequency linearly increases the deposition rate provided that an appropriate laser-target scan algorithm is used which preserves the target's surface structure and evenly distributes the ablated material on the tape [4]. Today coated conductor volume manufacturing via PLD relies on solid-state switched based excimer laser platforms delivering a stabilized output power range of 100 W to 540 W. Solid-state switching technology constitutes a major advancement in industrial excimer laser systems, as solid-state switches in contrast to thyratron switches are maintenance free and have demonstrated a

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practically unlimited lifetime. State-of-the-art high-power excimer lasers routinely achieve maintenance-free operating times of 10,000 hours in thin film deposition and annealing applications. Flow-loop systems optimize the laser gas flow in the discharge region. With careful design using wind tunnel simulation, gas speed and uniformity has been optimized enabling homogeneous beam cross sections over the entire tube life. Current high power excimer laser platforms typically operate at pulse–to-pulse stabilities of ~0.5%, rms over a typical gas life of 30 million laser pulses at multi-hundred Hertz laser pulse frequency. Advanced self-learning replenishment algorithms add very small portions of halogen gas to the laser gas mixture without affecting energy stability of the laser during the injection phase. The replenishment rate depends on the laser operating time, laser input energy and laser performance parameters such as the high voltage level or temporal pulse width. The algorithms maintain the high voltage level and, therefore, maintain all essential beam parameters of the high power excimer laser stable throughout each gas life run. Stable and high power from the excimer laser is but one prerequisite for long-tape coated conductor deposition. Of equal importance is the PLD apparatus itself. The multi-plume, multi-lane approach has emerged as the standard parallel approach to growing coated conductors at high speed. The substrate tape is wound on sets of large-diameter rollers and moves through the deposition zone many times until the desired layer thickness has been achieved. Tapes of up to 12 mm width with programmable feed rate of up to 100m/h are supported. A multi-zone substrate heater thereby ensures a constant tape temperature of up to 850°C. Plumes are created by synchronous rastering with the laser beam. This distributes the energy on the target and leads to large and homogeneous deposition area. In order to keep the material flow directed and maintain stable plume conditions over time, X-Y raster scanning (avoiding trenching) in combination with target rotation (avoiding cone formation) is applied. Repeating the X-Y-Θ motion many times ensures that every point on the target surface is exposed to the laser spot from a full 360° over the course of the deposition process. For the first time, commercial PLD production systems are now available as turn-key solutions transforming high laser power into high average deposition rates under stable conditions. Both metal oxide buffer and superconducting layer can be deposited on up to 1000 m long coated conductor tapes.

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13:30 **Cerium and Europium doped ZnO thin films fabricated by Pulsed Laser Deposition**

Authors : M. Novotny1, P. Fitl2, J. Bulir1, E. Maresova2, P. Hruska3, A. Guille4, S. Guy4, J. Drahokoupil1, L. Fekete1, J. Lancok1

Affiliations : 1) Institute of Physics, Academy of Sciences of the Czech Republic, Na Slovance 2, 182 21 Prague, Czech Republic 2) Institute of Chemical Technology, Technicka 5, 166 28 Prague 6, Czech Republic 3) Charles University in Prague, Faculty of Mathematics and Physics, V Holesovickach 2, 180 00 Prague, Czech Republic 4) Institut Lumière Matière, UMR5306 Université Lyon 1-CNRS, Université de Lyon 69622 Villeurbanne cedex, France

Resume : Wurtzite ZnO possesses a wide band gap of 3.37 eV and a large exciton binding energy of 60 meV at room temperature. ZnO has been extensively studied because of its potential applications in various fields, such as gas sensor, solar cells, photodetectors, light emitting diodes and laser systems. Rare earth doped ZnO has attracted much attention as a luminescent material for both fundamental research and applications. Cerium and europium doped ZnO thin films were grown by Pulsed Laser Deposition (Nd:YAG, λ= 266 nm, τ = 6 ns) from Ce2O3:ZnO (1% Ce) and Eu2O3:ZnO targets, respectively, in oxygen or nitrogen ambient. ZnO films were deposited on fused silica and Si (100) substrates at substrate temperature of 300°C and at room temperature. Optical properties were analyzed by optical spectroscopy, spectrophotometric measurement and spectral ellipsometry. Structural properties were characterized by XRD. The corresponding variations in the morphology and microstructural properties were measured using AFM. Chemical composition and structural properties were examined by XPS.

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13:30 **Effects of the anisotropy of pulsed energy beam deposition on ZnO thin film properties**

Authors : M. Nistor 1, E. Millon 2, W. Seiler 3, J. Perrière 4-5

Affiliations : 1 National Institute for Lasers, Plasma and Radiation Physics (NILPRP), L22 P.O. Box. MG-36, 77125 Bucharest-Magurele, Romania; 2 GREMI, UMR 7344 CNRS-Université d'Orléans, 45067 Orléans Cedex 2, France; 3 PIMM, UMR CNRS 8006 Arts et

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Resume : Pulsed energy beam deposition methods like pulsed laser deposition (PLD) or pulsed electron beam deposition (PED) are very anisotropic processes leading to non-homogeneities in the deposited thin films. Indeed, film thickness, composition and structure are function of the precise position on the substrate with respect to the normal to the target. In this work we have investigated the composition, structure, optical and electrical properties of ZnO thin films grown by PLD and PED as a function of position on the substrate by means of Rutherford Backscattering Spectrometry, X-ray diffraction analyses, optical transmittance and electrical measurements. The energy of ablated species having an important role on the thin film growth, time-resolved angular distribution of plume ions measurements have also been performed with ion probes mounted at various angles with respect to the normal. These results will be presented comparatively for PLD and PED methods as well as the influence of the composition, structure and energy of ablated species on the optical and electrical properties of ZnO films.

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13:30 **How to optimize short and ultrashort pulse laser interaction with glass surfaces in cutting regimes?**

Authors : D. Rostohar, N.M. Bulgakova, R.Bicistova, J. Brajer
Affiliations : HiLASE Project, Institute of Physics ASCR, Na Slovance 2, 18221 Prague, Czech Republic

Resume : We report on experimental and theoretical studies of interaction of ultrashort pulse laser radiation with glass materials in regimes which are important for many industrial applications such as laser cutting, drilling, functionalization of material surfaces, etc. Experiments on determining single-pulse damage thresholds have been carried out for fused silica and BK7 glasses irradiated with ns lasers at 1064 wavelengths of 3 ns duration. For similar irradiation conditions, numerical modeling has been performed, based on the rate equations describing charge carrier generation and the energy balance equations for electron and lattice subsystems of irradiated materials. Direct comparison between numerical and experimental data has enabled to verify the model parameters and to set a criterion of laser-induced damage in terms of free electron density and energy absorbed during the pulse. Furthermore, numerical studies were spread to a wider range of irradiation conditions, including fs irradiation regimes and a pump-probe technique. They have demonstrated that laser energy absorption can efficiently be controlled in terms of tuning pulse durations, the separation time between pulses, and the ratio between peak laser intensities. A possibility to enhance laser coupling with transparent solids by bi-wavelength irradiation is also explored numerically.

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13:30 **LASER MICRO MACHINING OF THIN SUBSTRATES FOR MICROELECTRONICS APPLICATIONS**

Authors : S. Kaya-Boussougou1, G. Savriama1,2, A. Petit1, E. Millon1, J.-C. Houdbert2, L. Barreau2 C. Boulmer-Leborgne1, N. Semmar1
Affiliations : 1GREMI-UMR 7344, CNRS/Université d'Orléans, 14 rue d'Issoudun, BP 6744, F-45067 Orléans cedex2, France 2 STMicroelectronics, 16 rue Pierre et Marie Curie, BP 7155, F-37071 Tours Cedex2, France

Resume : This work is dealing with the use of a femtosecond laser beam to process various insulating substrates employed in microelectronic packaging such as flexible polymers, composite mica multilayers and glass. Typical thickness of these substrates is in the range of few hundred micrometers (100 to 500 µm) and exhibit unsuitable properties by mechanical scribing. Due to the ultra-short pulse duration (less than 110 fs), the expected affected zone (HAZ) should be much less than thicknesses. This last point is crucial to achieve a fully industrial process. Mica, PET 125, PEN and Kapton are also mostly transparent, and the fs laser beam is modulated from 800 to 266 nm to optimize the scribing process. The laser parameters as frequency (up to 1000 Hz), mean powers (up to 3.5 W) and number of passes are investigated for optimizing the scribing in regard to the grooves depth, the HAZ, and speed of process. scanning electronic microscopy and optical microscopy are employed for analyses the local structure after laser scribing. UV-Visible ellypsometry is also used to obtain the optical properties (reflectivity and optical indexes) namely in the wavelength of interest (800, 400 and 266 nm). Non linear absorption is finally considered to understand the physical mechanisms behind fs laser beam interaction with those substrates responsible of depth scribing limitation.

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13:30 **The metallic interface between insulating NdGaO3 and SrTiO3 perovskites**

Authors : Chen Li, Qinfang Xu, Zheng Wen, Shantao Zhang, Aidong Li, Xiaoning Zhao and Di Wu*
Affiliations : National Laboratory of Solid State Microstructures, Nanjing University, Nanjing, 210093, China

Resume : Perovskite NdGaO3 films, 2–20 unit cells in thickness, have been deposited epitaxially on {001} TiO2-terminated SrTiO3 substrates at different O2 pressures by pulsed laser deposition monitored in situ by reflective high energy electron diffraction. The {001} NdGaO3/SrTiO3 interface becomes metallic as the NdGaO3 overlayer is more than 4 unit cells in thickness. The sheet carrier density is above 10^-13 cm^-2 and temperature-independent from 300 down to 7 K, similar to those reported in LaAlO3/SrTiO3 and LaGaO3/SrTiO3 heterostructures. Deposition and in situ post-annealing at higher O2 pressure show limited effects on the interfacial transport characteristics. These indicate that oxygen vacancies may not have a predominant contribution to the observed interfacial conduction in NdGaO3/SrTiO3 heterostructures deposited at high oxygen pressure. Similar q-2DEG has also been observed on the {111} NdGaO3/SrTiO3 hetero-interface. Since NdGaO3 has been widely used in deposition of high-temperature superconductors and manganite perovskites, our results may pave the way to combine the interface q-2DEG to other electron-correlated phenomenafor novel all-oxide electronic devices.

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13:30 **La0.7Sr0.3MnO3/BaTiO3/La0.7Sr0.3Mn0.8Ru0.2O3 multiferroic tunnel junctions**

Authors : Xiangbiao Qiu, Chen Li, Aidong Li, Di Wu*
Affiliations : Department of Materials Science and Engineering; National Laboratory of Solid State Microstructure

Resume : With the advances in pulsed laser deposition (PLD), high quality perovskite heterostructures with atomic deposition precision can be achieved. This has already made it possible to obtain stable polarization switching in ultrathin ferroelectric films. Multiferroic tunnel junctions, composed of two ferromagnetic metal layers separated by an ultrathin ferroelectric barrier, have recently attracted much attention for its potential applications in four-state memories. In this report, epitaxial La0.7Sr0.3MnO3/BaTiO3/La0.7Sr0.3Mn0.8Ru0.2O3 heterostructures have been fabricated on SrTiO3 (001) substrates by PLD monitored in situ by reflective high energy electron diffraction. The heterostructures is characterized by X-ray diffraction, atomic force microscopy and piezoelectric force microscopy. The tunnel junctions were fabricated by photolithography and ion milling. The four-state tunneling resistance is observed by applying electric and magnetic fields. The results may be useful to novel all-perovskite electronics.

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13:30 **Incommensurate Modulation and Luminescence in the CaGd2(1−x)Eu2x(MoO4)4(1−y)(WO4)4y (0≤ x ≤ 1, 0 ≤ y ≤ 1) Red Phosphors**

Authors : Maria Raskina, Vladimir A. Morozov, Katrien Meert, Artem M. Abakumov, Joke Hadermann
Affiliations : Chemistry Department, Moscow State University, 119991 Moscow, Russia; EMAT, University of Antwerp, Groenenborgerlaan 171, Antwerp B-2020, Belgium; Lumilab, Department of Solid State Sciences, Ghent University, B-9000 Ghent, Belgium

Resume : CaGd2(1−x)Eu2x(MoO4)4(1−y)(WO4)4y (0≤ x ≤ 1, 0 ≤ y ≤ 1) solid solutions with scheelite-type structure (ABO4) were synthesized by a solid state method, and their structures were investigated using a combination of transmission electron microscopy techniques and powder X-ray diffraction. Within this series all complex molybdenum oxides have (3 + 2)D incommensurately modulated structures with superspace group I41/a(α,β,0)00(−β,α,0)00, while the structures of all tungstates are (3 + 1)D incommensurately modulated with superspace group I2/b(αβ0)00. In both cases the modulation arises because of cation-vacancy ordering at the A site. These solid solutions can be considered as a model system where the incommensurate modulation can be monitored as a function of cation's nature while the number of cation vacancies at the A sites remain constant upon the isovalent cation replacement. All compounds' luminescent properties were measured, and the optical properties were related to the structural properties of the materials. CaGd2(1−x)Eu2x(MoO4)4(1−y)(WO4)4y phosphors emit intense red light dominated by the 5D0−7F2 transition at 612 nm, along with other transitions from the 5D1 and 5D0 excited states, and may be promising new light-emitting

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materials for photonic applications, including near UV LEDs. The intensity of the 5D0−7F2 transition reaches a maximum at x = 0.5 for y = 0 and 1.

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13:35 **Laser Induced Forward Transfer For Front Contact Improvement in Silicon Heterojunction Solar Cells**

Authors : M. Colina, A. Morales-Vilches, C. Voz, I. Martín, P. Ortega, G. López, R. Alcubilla
Affiliations : Polytechnic University of Catalonia- Electronic Engineering Department - Micro and nanotechnologies Group.

Resume : In this work the Laser Induced Forward Transfer (LIFT) technique is investigated to create n-doped regions on p-type c-Si substrates. The doping source consisted in a phosphorous-doped hydrogenated amorphous silicon layer grown by Plasma Enhanced Chemical Vapor Deposition (PECVD) onto a transparent substrate. Transfer of the doping atoms occurs when a sequence of laser pulses impinging onto the doped layer propels the material towards the substrate. The laser irradiation not only transfers the doping material but also produces a local heating that promotes its diffusion into the substrate. The laser employed was a 1064 nm, lamp-pumped system, working at pulse durations of 100 and 400 ns. In order to obtain a good electrical performance a comprehensive optimization of the applied laser fluency and number of pulses was carried out. Subsequently, arrays of n+p local junctions were created by LIFT and the resulting J-V curves demonstrated the formation of good quality n+ regions. These structures were finally incorporated to improve the front contact in conventional silicon heterojunction solar cells to investigate their effect on the photovoltaic performance of the device.

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13:35 **Laser Induced Forward Transfer of shaped solid polymer donors using a beam spatially modulated via a Digital Multimirror Device**

Authors : D. J. Heath*, B. Mills, M. Feinaugle, J. A. Grant-Jacob, R. W. Eason
Affiliations : Optoelectronics Research Centre, University of Southampton, Southampton, SO171BJ

Resume : Laser-induced forward transfer (LIFT) has emerged in the last decade as a practical technique for printing a range of solid-phase materials for applications that span photonics, electronics, displays and biomedicine [1,2]. Usually the shape of the printed pixels is determined by either the profile of the LIFTing laser pulse used (often an apertured Gaussian beam), or via an aperture in the beam path (to create a square pixel for example). The ability to LIFT pixels with arbitrary and complex shapes, e.g. letters, icons, pictures or other unique patterns, that can be varied on a shot-to-shot basis is desirable. Here we extend the work by Pique [3], who recently demonstrated the use of a nanosecond laser in conjunction with a digital multimirror device (DMD) to control the spatial intensity profile of the incident laser pulses for LIFTing of silver nano-ink pastes. We show experimental results for femtosecond LIFT of a ~500nm-thick solid polymer (PMMA) donor, to produce intact LIFTed pixels of typical dimension ~30um, with line widths of <5um that show (for example) hollow regions of order ~10um. We will discuss our most recent results for solid-phase LIFT of DMD-shaped pixels, and report our conclusions on limitations for this technique as a general method of LIFTing complex shaped objects.

JP.XI 62

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13:35 **Laser printing of multilayered structures for OTFT applications**

Authors : C. Constantinescu (1), L. Rapp (1), A.K. Diallo (2), C. Videlot-Ackermann (2), P. Cremillieu (3), R. Mazurczyk (3), F. Serein-Spirau (4), J.P. Lère-Porte (4), P. Delaporte (1), A.P. Alloncle (1)
Affiliations : (1) Aix-Marseille Université, LP3, UMR CNRS 7341, 13288, Marseille, France; (2) Aix Marseille Université, CINaM, UMR CNRS 7325, 13288, Marseille, France; (3) Institut des Nanotechnologies de Lyon, UMR 5270, Ecole Centrale de Lyon, 36 av. Guy de Collongue, 69130, Ecully, France; (4) Equipe Architectures Moléculaires et Matériaux Nanostructurés, UMR 5253 CNRS, Institut Charles Gerhardt, Ecole Nationale Supérieure de Chimie de Montpellier, 8 rue de l'Ecole Normale, 34293 Montpellier Cedex 05, France;

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Resume : Laser-based technology used in transferring micrometer sized pixels, from donor to receiving substrates, has been previously demonstrated for organic and inorganic materials by laser-induced forward transfer. Here, we report on the one-step laser printing of multilayered organic-based field effect transistors, using thin films of diPhAc-3T as semiconductor, parylene-C as dielectric and Ag as gate electrode, respectively. The laser, a 50 ps pulsed Nd:YAG device operating at 355 nm, was used to print transistor pixels arrays at ambient temperature. The pixels (350 µm sized-squares, and 500-700 nm in

thickness), fabricated in top gate-bottom contact configuration, were investigated for their current-voltage characteristics immediately after printing. The morphology and structure were investigated by optical, electronic, and atomic force microscopy. Electrical characterizations demonstrated that the transistor is fully functional with hole mobilities to 4 x 10^-4 cm^2/V.s, threshold voltage Vt near -10 V and Ion/Ioff ratio near to 10^4 - 10^5. The efficient cohesion between the three different layers offers an exceptionally high physical resistance to laser pulses, while maintaining the electrical properties.

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13:35 **Pulsed Laser Deposition of Yb:Y2O3 Planar Waveguide Lasers**

Authors : T. L. Parsonage, S. J. Beecher, K. A. Sloyan, J. I. Mackenzie, R. W. Eason
Affiliations : Optoelectronics Research Centre, University of Southampton, Highfield, Southampton, SO17 1BJ, UK

Resume : Rare earth-doped sesquioxides, particularly yttria (Y2O3), scandia (Sc2O3) and lutetia (Lu2O3), are very promising materials for high power laser applications due to their excellent combination of thermal, optical and spectroscopic properties. These simple cubic crystals have been successfully doped with rare earth elements such as Yb, Tm and Er, but are challenging to grow as bulk crystals, due to their high melting points (~2400°C). Using pulsed laser deposition, we have grown both single and multilayer Yb-doped crystalline yttria waveguides on 1 cm2 YAG substrates. A multilayer sample with a 3 µm Y2O3 layer either side of a 6 µm Yb:Y2O3 doped region gave a maximum output power of 1.2 W at 1030 nm, for ~10.5 W of diode pump power. This waveguide design provides significantly higher gain for the fundamental waveguide mode than for higher order modes, enabling efficient multimode pumping whilst favouring diffraction limited output. The maximum observed slope efficiency was 22% (with respect to absorbed power), using a simple quasi-monolithic plane-plane resonator cavity with a 30%R output coupler. With no active cooling, even at these high pump powers, no sign of thermal effects in the waveguide have been observed, confirming the excellent thermal properties of this material. We will discuss these first results together with further experiments that will be performed with an optimised cavity length to achieve higher output power, lower threshold and greater slope efficiency.

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13:35 **Aluminum metal versus aluminum oxide fabricated by nanosecond pulsed laser deposition**

Authors : Esther Rebollar1*, Mikel Sanz1, Daniel E. Martínez-Tong2, Mohamed Oujja1, José F. Marco1, Tiberio A. Ezquerra2, Marta Castillejo1
Affiliations : 1Instituto de Química Física Rocasolano, IQFR-CSIC, Serrano 119, 28006 Madrid, Spain; 2Instituto de Estructura de la Materia, IEM-CSIC, Serrano 121, 28006 Madrid, Spain

Resume : Pulsed laser deposition (PLD) is a versatile technique which allows the production of thin films with tailored properties. We studied the effect of laser fluence on the morphology, composition, structure and electric conductivity of deposits generated by pulsed laser ablation of a metallic aluminum target in vacuum using a Q-switched Nd:YAG laser (1064 nm, 15 ns). Upon irradiation for one hour at a repetition rate of 10 Hz, deposits on glass consisted of smooth layers of several tens of nanometers, as revealed by atomic force microscopy. Crystallinity, surface chemical composition and conductivity of deposits were determined by X-ray diffraction, X-ray photoelectron spectroscopy and broadband dielectric spectroscopy respectively. Irradiation at fluences around 2 J/cm2, resulted in deposition of amorphous aluminum oxide films. Differently, at higher fluences above 7 J/cm2, the deposits are constituted by metallic aluminum films. Monitoring of the composition and dynamics of the ablation plume was carried out by optical emission spectroscopy which revealed differences in composition under the two fluence regimes. In particular, highly ionized species are more abundant in the plumes generated at higher fluences. The results are discussed by invoking the relations between composition and dynamics of the ablation plume and the properties of deposits, and demonstrate the possibility of control by PLD of the properties of deposits and their either metal or dielectric character.

JP.XI 65

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13:35 **Hydrodynamics of adjacent bubbles in LIFT of silver nanoparticle inks at high velocity**

Authors : E. Biver (1), L. Rapp (1), A. P. Alloncle (1), P. Serra (2), Ph. Delaporte (1)
Affiliations : (1) Aix-Marseille Université, CNRS, LP3 UMR 7341, 13288, Marseille, France; (2) Departament de Física Aplicada i Òptica, Universitat de Barcelona, Martí i Franquès 1, E-08028 Barcelona, Spain

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Resume : The laser-induced forward transfer (LIFT) process can become competitive with other industrial deposition techniques only if its throughput is drastically increased. To this end, we use a galvanometric mirrors system which scans the beam of a fast UV picosecond laser, focusing successive pulses on a silver nanoparticles ink-coated donor substrate. Laser pulses interact with the liquid film and generate adjacent cavitation bubbles that push the ink away from the substrate and form jets. We visualize the ejections with a time-resolved imaging system to study the dynamics of multi-jets regime. Pulses far away from each other produce unperturbed jets. But when the pulses are brought closer, the cavitation bubbles start to interact, which modifies the ejection dynamics and results in significant change of the bubble shape. The ink is ejected faster and in different directions depending on the spacing between pulses. Each bubble modifies the previous one and displaces it away. We present all these effects and discuss them, considering how a cavitation bubble expands in an ink film modified by a previous bubble.

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16:00 **PLENARY SESSION**

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PROGRAM VIEW : 2014 Spring
MY PROGRAM : 2014 Spring

Symposium : J

Laser interaction with advanced materials: fundamentals and applications

26 May 2014 | 27 May 2014 | 28 May 2014 | **29 May 2014** | 30 May 2014

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start at	Subject	Num.
	Laser Processing of nanostructures for optolectronics, photovoltaic and biological applications : M. Dinescu	
08:30	**Annealing of amorphous silicon using c.w. visible lasers (Invited)** **Authors :** S. Mailis, G. Martinez, G. Zisis, Y. Franz, N. Healy, A. C. Peacock **Affiliations :** Optoelectronics Research Centre, University of Southampton, Highfield, Southampton, SO17 1BJ, U.K. **Resume :** The strong absorption of c.w. laser radiation in the green/blue spectral region has been used to thermally anneal and locally crystalize small volumes of amorphous silicon (a-Si) which has been thermally insulated from the environment. We will present experimental results for two distinct cases where this method has been used for producing high quality c-Si and secondly for allowing additional optoelectronic functionality to be built into the material. More specifically we will discuss laser-annealing results obtained in cylindrical and planar geometries; in a-Si-core optical fibers and in a-Si thin films deposited on fused silica slabs and on the polar faces of LiNbO3 single crystals. In both geometries crystallization of a-Si has been achieved, in some cases producing crystallites with enormous aspect ratios. In the case of a-Si core fibers we have not only achieved a significant improvement of the optical quality of the silicon material, but also observed some tuneability of its optoelectronics properties. LiNbO3 on the other hand is one of the cornerstone platforms of nonlinear/integrated optics. By transferring the materials processing advances made in our silicon fibers to LiNbO3, we can envisage a platform that exploits the superior optical and electronic properties of both materials for the development of high performance optoelectronic devices. Our preliminary results are very encouraging and we believe that this combination promises many exciting future applications.	J.XII 1
	add to my program (close full abstract)	
09:00	**ENHANCED LIGHT SCATTERING IN Si NANOSTRUCTURES PRODUCED BY PULSED LASER IRRADIATION.** **Authors :** P. M. Sberna1,2, G. G. Scapellato2, N. Piluso3, I. Crupi2, S. Boninelli2, M. Miritello2, E. Bruno1,2, V. Privitera2, S. Mirabella2, F. Simone1 **Affiliations :** 1 Università degli Studi di Catania – Dipartimento di Fisica e Astronomia, Via S. Sofia 64, Catania I-95123, Italy; 2 MATIS-IMM-CNR, Via S. Sofia 64, Catania I-95123, Italy; 3 CNR-IMM, Sezione di Catania, Stradale Primosole 50, Catania I-95121, Italy. **Resume :** Light management has recently become more and more important in order to improve efficiency in solar cells. Useful light management can be pursued also by utilizing random structures, as disordered clusters, with great advantages in terms of broadband and wide-angle response. In this scenario, nanostructured group IV semiconductors show peculiar light-matter interactions not present in bulk materials, promoting them as interesting subjects for light trapping applications. Processing by ultra high intensity and short pulsed laser sources represents an advantageous and cheap method for nanostructured materials synthesis. In this work nanostructures were produced by pulsed (12 ns) Nd:YAG (λ = 532 nm) laser irradiation of amorphous silicon thin films deposited by rf magnetron sputtering on silica substrate. Scanning and transmittance electron microscopy were used evidencing that by varying the laser energy fluences (425-1130 mJ/cm2) distinct morphologies of Si NS appear, going from interconnected structures to isolated clusters. Film breaking	J.XII 2

occurs through a laser-induced dewetting process. Raman scattering is enhanced in all the obtained Si NS, with the largest enhancement in interconnected Si structures (enhancement factor of 50[1]), pointing out an increased trapping of light due to multiple scattering. The reported method is fast, scalable and cheap, and can be applied for light management in photovoltaics. [1] P. M. Sberna et al. Appl. Phys. Lett. 103, 221902 (2013)

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09:15 **Nonlinear Laser Fabrication of Biofunctionalized Interfaces** J.XII 3

Authors : Anja Schroeter, Steffen Franzka, Nils Hartmann
Affiliations : Department of Chemistry, Center for Nanointegration Duisburg-Essen (CENIDE), University of Duisburg Essen, Essen, Germany

Resume : Laser patterning of self-assembled monolayers represents a key step in many biofabrication schemes, e. g. in order to build up sensor arrays. The lateral resolution, however, usually is limited by optical diffraction. A means to enhance the lateral resolution takes advantage of nonlinear effects. Recent work in nonlinear laser patterning of self-assembled monolayers is presented. In photothermal processing a focused cw laser beam is used to locally heat the substrate surface and thermally initiate chemical reactions. For this reason, photothermal processing is highly nonlinear in laser power density and facilitates sub-wavelength patterning. Femtosecond laser processing, in turn, provides promising perspectives in sub-wavelength patterning of transparent platforms via multiphoton absorption processes. Because of their exceptional stability, nonlinear laser processing of silane-based monolayers is most effective. In particular, photothermal laser processing at a wavelength of 532 nm and a 1/e spot diameter of 1.8 microns allows one to fabricate functional surface structures with lateral dimensions well below 100 nm. Such structures are used as templates to build up micro- and nanoarrays via local immobilization of proteins, DNA and other biomolecules.

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09:30 **Ultrafast Carrier Dynamics in PbS Quantum Dot Films Capped with Chalcogenidometalate Ligands** J.XII 4

Authors : Demetra Tsokkou1,2, Paris Papagiorgis2, Loredana Protesescu3, Maksym V. Kovalenko3, Stelios A. Choulis4, Constantinos Christofides1, Grigorios Itskos2 and Andreas Othonos1
Affiliations : 1 Department of Physics, Research Center of Ultrafast Science, University of Cyprus, 1678 Nicosia (Cyprus); 2 Department of Physics, Experimental Condensed Matter Physics Laboratory, University of Cyprus,1678 Nicosia (Cyprus); 3 Institute of Inorganic Chemistry, Department of Chemistry and Applied Biosciences, ETH Zürich, CH-8093 Zürich and Empa-Swiss Federal Laboratories for Materials Science and Technology, CH-8060 Dübendorf (Switzerland); 4 Molecular Electronics and Photonics Research Unit, Department of Mechanical Engineering and Materials Science and Engineering, Cyprus University of Technology, 3603 Limassol (Cyprus)

Resume : Colloidal quantum dots (QDs) are decorated by organic hydrocarbon molecules that provide solubility and passivation, but inhibit electronic transport. Recently, a novel approach has been demonstrated where the long, volatile organic ligands have been replaced with short, conductive inorganic chalcogenidometalates to improve charge transfer between QDs. Characterization by ultrafast spectroscopic techniques provides important insight into the fundamental properties of such QD films, probing carrier relaxation and recombination processes with subpicosecond temporal resolution. Presently there is limited work on the impact of ligands on the relaxation processes of such QD systems. Ultrafast transient absorption was employed to study the carrier dynamics of PbS QD films capped with control oleic-acid and arsenic sulfide. In oleate-capped QDs following ultraviolet excitation, carriers relax to the QD band edge states and recombine at sub-nanosecond scales via Auger recombination and surface states, whereas at longer timescales radiative recombination is apparent. In inorganic-capped QDs ligand exchange process introduces arsenic sulfide states above the QD band edge that act as efficient carrier traps and significant carrier trapping occurs before carrier thermalization. As a consequence, radiative and Auger recombination from band edge states are suppressed. Based on our studies detailed band diagrams that incorporate the relaxation and recombination mechanisms are proposed.

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09:45 **New approaches in optics: optical properties of noble metal nanoparticles and nanostructures and application to bio-photonics** J.XII 5

Authors : P A Atanasov1, N N Nedyalkov1, A Og Dikovska1, Ru Nikov1, R Nikov1, A Nikolov1, K Hirano2, H Shimizu2, M Terakawa2, M Obara2
Affiliations : P A Atanasov1; N N Nedyalkov1; A Og Dikovska1; Ru Nikov1; R Nikov1; A

Nikolov1; K Hirano2; H Shimizu2; M Terakawa2; M Obara2 1Institute of Electronics, Bulgarian Academy of Sciences, Tzarigradsko Shausse 72, Sofia 1784, Bulgaria 2School of Integrated Design Engineering, Keio University, 3-14-1, Hiyoshi, Kohoku-ku, Yokohama-shi, 223-8522, Japan
Resume : Optical properties of noble metal (Au and Ag) nanoparticles and nanostructures produced by laser annealing of thin metal films or produced by laser ablation of solid targets in fluid (distilled water) are described in order to its application in the field of biophotonics, where the absorption and scattering spectra of the light are of great importance. The theoretical methods of investigations in these studies are based on the generalized multiple Mie theory and the Finite-Difference Time-Domain method. The increase of the electromagnetic filed in the vicinity of the gold nanoparticles with different dimensions placed on different substrates and illuminated by laser pulses are presented. Systems of gold and silver nanoparticles, in the form of 2D clusters in water are studied. The absorption and scattering spectra in the far field are studied as function of processing conditions, aging, its dimensions or distance between them. The optical properties of gold nanoparticles ensembles, placed into the cancer cells are also presented. The results obtained are applied in the field of bio-photonics: photo-thermal therapy of cancer cells, bio-visualization and as plasmonic optical tweezers.

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10:00 **Cofee Break**

Laser processing of carbon and 2D related materials : S. Mailis

10:30 **Nonlinearly Pulsed Fiber Lasers Incorporating Graphene Efficiently Synthesized by Intensely Pulsed White Light**

Authors : Won-Jun Kim (1&2), Junsu Lee (3), Ju Han Lee (3), Jung Ah Lim (1), Dae-Soon Lim (2), Won-Kook Choi (1), Yong-Won Song (1)
Affiliations : (1) Future Convergence Research Division, Korea Institute of Science and Technology, Seoul 136-791, South Korea. (2) Department of Materials Science and Engineering, Korea University, Seoul 136-708 Republic of Korea. (3) School of Electrical and Computer Engineering, University of Seoul, Seoul 130-743, South Korea.
Resume : Overcoming the drawbacks given by conventional methods, we designed and demonstrated a highly efficient synthesis of graphene employing intensely pulsed white light (IPWL) that photoinduces depth-controlled heating rapidly to avoid the substrate damage. The approach provided the synthesis at the interface of Ni-catalyst layer and the substrate, thereby forming the graphene layer directly on a targeted substrate after etching the catalyst without deleterious transfer process. Moreover, since the carbon atoms can be supplied from polymer layer and/or impurities hosted into the catalyst, any external carbon source was not required. In realizing a nonlinear saturable absorber that functioned as mode-locker to form short laser pulses, graphene synthesized by IPWL was incorporated in a fiber-optic component. Ni-catalyst of 50 nm was deposited onto the end surface of a fiber ferrule, and IPWL was irradiated during <60 s with the fluence of ~ 30 J/cm2 under ambient condition. After etching out the catalyst layer, the crystallinity of graphene was checked by Raman. The graphene deposited ferrule was sandwiched by an additional one for laser-graphene interaction. By managing the intracavity power level, chromatic dispersion, and polarization state, we successfully obtained short pulse laser output that has operating center wavelength, repetition rate, and estimated pulse duration of 1571.7 nm, 14.03 MHz, and 3.4 ps, respectively. Higher harmonic pulsation was also achieved.

J.XIII 1

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10:45 **Biosensors for food analysis fabricated by Laser Induced Forward Transfer**

Authors : M. Chatzipetrou1, E. Touloupakis2, M. Massaouti1, G. Tsekenis3, I. Zergioti1
Affiliations : 1 National Technical University of Athens, Physics Department, Iroon Polytechneiou 9, 15780 Zografou, Athens, Greece 2 Instituto per lo Studio degli Ecosistemi Sezione di Firenze Via Madonna del Piano n. 10 50019 Sesto Fiorentino, Firenze 3 Biomedical Research Foundation of the Academy of Athens, Soranou Ephessiou 4, 11527 Athens, Greece

J.XIII 2

Resume : Laser Induced Forward Transfer (LIFT) technique is an advanced tool for the direct immobilization of biomolecules on the transducers for fabrication of biosensors. In this work, we present two different types of biosensors for food quality analysis, an enzymatic and an aptameric biosensor, and we also discuss

the mechanisms involved in the process. The enzymatic biosensor is based on the oxidization of polyphenols in the presence for laccase. Polyphenols are plant-derived natural products with various beneficial properties for the human body and their detection in liquid food samples such as olive oil, wine and milk is a monitoring quality factor. Laccase was directly immobilized on graphite Screen Printed Electrodes using LIFT. Catechol was detected using amperometry down to 150nM. In comparison with similar biosensing devices, these results indicate improved operational features, in terms of sensitivity and detection limit, of the biosensor. The specificity of the biosensor, was tested with two more phenolic compounds, dopamine and phenol, and a limit of detection 10μM and 1mM was found respectively. The advantages of this biosensor rely on the direct immobilization of the laccase enzyme, without using toxic reagents that often interfere with, or attenuate, the signal of the analytical device. The physical mechanism of the laser immobilization was also investigated and is strongly correlated to the fluid dynamics during the transfer process. In addition, the fabrication of a biosensor where aptamers are used as bio-recognition elements is presented and in this paper we present the fabrication of an aptameric biosensor for the detection of mycotoxins, commonly found in samples of different food systems.

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11:00 **Revealing the ultrafast process behind the photoreduction of graphene oxide**

Authors : Daniel S. Badali, Regis Y.N. Gengler, Dongfang Zhang, Konstantinos Dimos, Konstantinos Spyrou, Dimitrios Gournis, R.J. Dwayne Miller

Affiliations : Badali; Gengler; Zhang; Miller; Max Planck Institute for the Structure and Dynamics of Matter, Center for Free Electron Laser Science, University of Hamburg, Luruper Chaussee 149, Hamburg 22761 Germany Dimos; Spyrou; Gournis; Department of Materials Science and Engineering, University of Ioannina, GR-45110 Ioannina, Greece

Resume : Because of its unique electronic and structural properties, graphene has brought two-dimensional materials to the foreground of material science and nanoelectronic research. As such, reliable methods to produce graphene in an efficient and green manner are in demand. In recent years one of the most promising of such techniques has been the irradiation of aqueous dispersions of graphene oxide with ultraviolet laser light. Although this has been observed in a variety of experimental conditions, the exact mechanism of the reduction from graphene oxide to graphene has remained elusive until now. To this end, we have performed a series of ultrafast transient absorption measurements which have exposed the chemistry of this process: rather than direct photoreduction, the reduction is mediated by solvated electrons which have been liberated from water molecules by the ultraviolet light. These experiments reached the fundamental time scale of the ultraviolet photoreduction of graphene oxide in solution, which is revealed to be in the picosecond regime. Characterization of the final product confirms the removal of oxygen containing groups and the restoration of the honeycomb carbon network of graphene.

J.XIII 3

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11:15 **Graphene-based textured surface by pulsed laser deposition as a robust platform for surface-enhanced Raman spectroscopy applications**

Authors : T. Tite, A.-S. Loir, C. Donnet, S. Reynaud, J. -Y. Michalon, F. Vocanson, V. Barnier and F. Garrelie

Affiliations : T. Tite, A.-S. Loir, C. Donnet, S. Reynaud, J. -Y. Michalon, F. Vocanson, and F. Garrelie : Université de Lyon, F-69003, Lyon, France, Université de Saint-Étienne, Laboratoire Hubert Curien (UMR 5516 CNRS), 42000 Saint Étienne, France V. Barnier : École Nationale Supérieure des Mines de Saint-Étienne, Laboratoire Georges Friedel UMR 5307, 158 cours Fauriel, 42023 Saint-Etienne, France

Resume : Despite its outstanding properties, pristine graphene has many shortcomings, and for practical applications it is needed to alter its surface and electronic properties. New routes are envisaged such as patterning/texturing and chemical functionalization [1]. Of our particular interest, graphene sheets decorated with nanoparticles (NPs) are new hybrids materials that can be used as catalysts, supercapacitors and biosensors. It was reported that graphene decorated Au or Ag NPs can effectively enhance Raman signals of absorbed organic molecules that makes it a useful surface-enhanced Raman scattering (SERS) substrate [2]. However, nowadays alternative preparation methods are still needed. Recently, it was proposed to convert amorphous carbon (a-C) into graphene [3]. However, to date the applications remain largely unexplored. In the present study, we report the synthesis of large scale textured few-layer (fl) graphene films by pulsed laser deposition (PLD), and highlight its potential applications as a SERS device. The formation of fl-graphene was confirmed by Raman spectroscopy, and surface morphology was inspected by scanning

J.XIII 4

electron microscopy. Au NPs were deposited on the fl-graphene to investigate its SERS activity. Rhodamine 6G, p-aminothiophenol, and active molecules of commercial insecticides such as deltamethrin and methyl parathion were detected with high sensitivity. The method used is simple, fast and cost effective. [1] V. Georgakilas et al., Chem. Rev., 112, 6156 (2012). [2] W. Xu et al., Small 9(8), 1206 (2013). [3] C. M. Orofeo et al., Nano Res. 4(6), 531 (2011).

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11:30 **Pulsed Laser Processing of Two-Dimensional Materials**

Authors : I. Paradissanos(1,2), M. Sigletou(1,2), K. Savva(1,2), C. Alexaki(1,2), C. Petridis(3), G. Kioseoglou(2), E. Kymakis(3), C. Fotakis(1,2), E. Stratakis(1,2*)
Affiliations : 1) Institute of Electronic Structure and Laser, Foundation for Research & Technology Hellas, (IESL-FORTH), P.O. Box 1527, Heraklion 711 10, Greece 2) University of Crete, 710 03 Heraklion, Crete, Greece. 3) Technological Educational Institute (TEI) of Crete, Heraklion, 71003, Greece * stratak@iesl.forth.gr, phone: 00302810391274, fax: 0030-2810391305

Resume : This paper will present our recent work on the pulsed laser processing of two-dimensional (2D) materials. In particular, we report on the morphological effects induced upon the interaction of ultrashort laser pulses with various layered crystals. Experiments show that for fluences slightly above the damage threshold, a rippled morphology is attained. Besides this, rapid and facile methodologies for the laser assisted generation of graphene, molybdenum disulfide and boron nitride nanosheets, as well as their decoration with metallic nanoparticles (NPs), will be demonstrated. The former can be attributed to a femtosecond laser assisted exfoliation process, while the fairly good dispersion of nanosheets suggests that large surface areas are available for chemical reactivity. On the other hand, decoration of nanosheets with NPs can be realised through excimer laser irradiation of colloidal dispersions of 2D flakes in the presence of NPs dispersed in solution. Potential applications of pulsed laser synthesized and modified materials in electronics, particular to bulk heterojunction organic solar cells are demonstrated and discussed.

J.XIII 5

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11:45 **Interface-coupled relaxation dynamics in carbon nanotube-Si hybrid solar cells**

Authors : S. Ponzoni, G. Galimberti, L. Sangaletti, P. Castrucci, S. Del Gobbo, M. Morbidoni, M. Scarselli, S. Pagliara
Affiliations : I-LAMP and Dipartimento di Matematica e Fisica, Università Cattolica, 25121 Brescia, Italy; I-LAMP and Dipartimento di Matematica e Fisica, Università Cattolica, 25121 Brescia, Italy; I-LAMP and Dipartimento di Matematica e Fisica, Università Cattolica, 25121 Brescia, Italy; Dipartimento di Fisica, Università di Roma Tor Vergata, 00133 Roma, Italy; 3 Solar & Photovoltaics Engineering Research Center, King Abdullah University of Science & Technology, Thuwal, Kingdom of Saudi Arabia; Dipartimento di Fisica, Università di Roma Tor Vergata, 00133 Roma, Italy; Dipartimento di Fisica, Università di Roma Tor Vergata, 00133 Roma, Italy; I-LAMP and Dipartimento di Matematica e Fisica, Università Cattolica, 25121 Brescia, Italy

Resume : In these last years, carbon nanotubes (CNTs) have emerged as new building blocks for constructing light-energy harvesting and charge transport assemblies in photovoltaic devices [1,2,3]. Recently, among the hybrid systems based on carbon nanotubes, CNTs/n-doped Silicon (CNTs/Si-n) interface has revealed as a suitable configuration for making solar cells showing an overall efficiency larger than 12% [4]. However, a complete understanding of the role of carbon nanotube in CNTs/Si-n heterojunction is missing, even if it is mandatory for the improvement of the solar cell efficiency. In this framework, performing time resolved optical spectroscopy, we try to shed light on the steps immediately following the arrival of the light on CNTs/Si-n solar cell. Tuning the pump photon energy across the Silicon absorption edge, we are able to track the photoexcited carriers relaxation in the CNTs layer and to reveal the hole injection from Si to CNTs driven by the drift current at the heterojunction interface. The results here reported show that transient optical spectroscopy could be a powerful technique for measuring the processes occurring immediately after the photogeneration of electron-hole pairs in an heterojunction solar cell. [1] Chem. Rev. 110, 1348 (2010). [2] J. Phys. Chem. C 111, 2834, (2007). [3] Science 320, 1170 (2008). [4] Nano Lett. 13, 95 (2013).

J.XIII 6

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12:00 **Lunch**

Laser processing for advanced materials applications : R. Haglund

14:00 **Astrophotonic Applications of Ultrafast Laser Inscription (Invited)**

Authors : Dr Robert R. Thomson
Affiliations : Scottish Universities Physics Alliance, Institute of Photonics and Quantum Sciences (IPaQS), School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, UK, EH14 4AS

Resume : "Astrophotonics" is the burgeoning field where photonic concepts (e.g. fibre Bragg-gratings & Arrayed Waveguide Gratings) are applied to astronomical instrumentation, with the aim of developing instruments that are smaller, lighter, lower-cost and, above all, provide greater scientific output than those based on more traditional optical technologies (For an excellent intro see the May 2012 issue of Physics Today, "Molding the flow of light" by Bland-Hawthorn and Kern). But although astrophotonics can certainly benefit from the decades of photonics research that has already taken place, in many cases astrophotonic technologies require the development of entirely new photonic capabilities. A good example of this is the "photonic-lantern", a remarkable new class of guided wave device that uniquely facilitates the low-loss coupling of incoherent celestial multimode light into single-mode photonic devices. Such devices were first fabricated using optical-fibre techniques which, although offering superb performance, are expensive and slow to fabricate – an issue if photonic-lanterns are ever to be mass manufactured for applications in large astronomical instruments. In this talk, I will describe how we (and others) have applied ultrafast laser inscription to the fabrication of mass-producible low-loss three-dimensional "integrated" photonic-lanterns and other unique photonic components for applications in next generation astronomical instruments.

J 1

add to my program (close full abstract)

14:30 **Optical forces in nanostructure-enhanced plasmonic tweezers**

Authors : D.G. Kotsifaki1, M.Kandyla1, P.G. Lagoudakis2
Affiliations : 1Theoretical and Physical Chemistry Institute, National Hellenic Research Foundation, 48 Vasileos Constantinou Avenue, 11635 Athens, Greece. 2School of Physics and Astronomy, University of Southampton, Southampton, SO17 1BJ, UK.

Resume : The momentum exchange between light waves and matter is a fundamental process for many applications, such as optical tweezers. Following recent advances in nanophotonics, optical manipulation by evanescent fields instead of conventional propagating fields has been successfully demonstrated with promising results. In this work, we report on the enhancement of optical trapping forces induced by the plasmonic field of laser-nanostructured substrates. We employed a home-built optical trapping setup, using either a CW infrared (1070 nm) N-light fiber laser or a femtosecond Ti:sapphire laser system with a tunable emission wavelength of 750 nm ? 1080 nm followed by an optical parametric oscillator with an output wavelength of 1000 nm ? 1300 nm. We trapped and measured the optical forces on dielectric nanoparticles (400 nm diameter), suspended on top of laser nanostructured silicon substrates with quasi-periodic sharp spikes (height ~200 nm), coated by thin metallic layers (Ag or Cu/Au). We observe the formation of metallic nanoparticles instead of a smooth metallic layer on the substrates, which is favored by the nanometric roughness of the surface of laser-structured silicon. We show that the optical trapping force is enhanced by a factor of 12 near the substrate surface and the quality factor of the trap presents an exponential decay with the distance from the substrate, which follows the decay of the near field of the coated nanospikes. The quality factor increases for wavelengths approaching the plasmon resonance of the nanostructured substrate. We conclude that the combination of quasi-periodic silicon nanostructures with metallic nanoparticles results in electromagnetic near-field enhancement of the trapping force due to the excitation of localized surface plasmons on the substrate. Financial support of this work by the General Secretariat for Research and Technology, Greece (project Polynano-Kripis 447963) is gratefully acknowledged.

J.XIV 2

add to my program (close full abstract)

14:45 **Aluminum plasmonic nanostructures in the UV for luminescence enhancement - From Al thin film to Al nanoparticles**

Authors : N. Abdellaoui, A. Pereira, A. Pillonnet, A. Berthelot, B. Moine, M. Novotny, Th. Labbaye, E. Kovacevic, J. Berndt
Affiliations : N. Abdellaoui;A. Pereira;A. Pillonnet;A. Berthelot;B. Moine Institut Lumière Matière, UMR5306 Université Lyon 1-CNRS, Université de Lyon 69622 Villeurbanne cedex, France. M. Novotny Institute of Physics of the ASCR, v.v.i., Na Slovance 2, 182

J.XIV 3

21, Prague, Czech Republic. Th. Labbaye;E. Kovacevic;J. Berndt GREMI, UMR7344 CNRS and Université d'Orléans, Orléans, France

Resume : Pulsed laser deposition (PLD) is an efficient method for innovative composite material research, such as plasmonic structures with metal/phosphor mixed architectures controlled at the nanoscale [1]. Theoretical studies on these plasmonic structures show promising results for many potential applications e.g. colored displays, optical telecommunication fibers and photovoltaic spectral conversion layer. Europium is known as a good red emitter with quantum yield near to 1 [2], but its UV absorption can still be improved. Aluminum has recently been suggested as alternative plasmonic material in the UV considering the limitation of silver or gold in this wavelength range [3]. PLD permits the design of various metallic nanostructures as well as multilayers with a controlled distance between luminophor and metallic layers. In this study, the Al growth process is first discussed as a function of the substrate properties. We demonstrate that an appropriate surface preparation (e.g. surface functionalization with low temperature plasmas) makes possible the formation of ultrathin Al films as well as Al nanoparticles. Conventional analysis (absorption spectroscopy, TEM, STEM) and in situ electrical resistivity measurements are used to control the properties of the nanostructured films. Coupling with red Eu:Y2O3 phosphor reveals luminescence enhancement dependent on the design. The variety of Al features observed in the experiments open new possibilities for optoelectronic devices working Pulsed laser deposition (PLD) is an efficient method for innovative composite material research, such as plasmonic structures with metal/phosphor mixed architectures controlled at the nanoscale [1]. Theoretical studies on these plasmonic structures show promising results for many potential applications e.g. colored displays, optical telecommunication fibers and photovoltaic spectral conversion layer. Europium is known as a good red emitter with quantum yield near to 1 [2], but its UV absorption can still be improved. Aluminum has recently been suggested as alternative plasmonic material in the UV considering the limitation of silver or gold in this wavelength range [3]. PLD permits the design of various metallic nanostructures as well as multilayers with a controlled distance between luminophor and metallic layers. In this study, the Al growth process is first discussed as a function of the substrate properties. We demonstrate that an appropriate surface preparation (e.g. surface functionalization with low temperature plasmas) makes possible the formation of ultrathin Al films as well as Al nanoparticles. Conventional analysis (absorption spectroscopy, TEM, STEM) and in situ electrical resistivity measurements are used to control the properties of the nanostructured films. Coupling with red Eu:Y2O3 phosphor reveals luminescence enhancement dependent on the design. The variety of Al features observed in the experiments open new possibilities for optoelectronic devices working in the UV range. [1] A. Pillonnet, A. Berthelot, A. Pereira, O. Benamara, S. Derom, G. Colas des Francs, and A.-M. Jurdyc "Coupling distance between Eu3+ emitters and Ag nanoparticles" Appl. Phys. Lett. 100, 153115, 2012. [2] J.K. Berkowitz, and J.A. Olsen, "Investigation of luminescent materials under ultraviolet excitation energies from 5 to 25 eV", J. Lum. 50, 111, 1991. [3] P.R West, S. Ishii, G.V. Naik, N.K. Emani, V.M. Shalaev and A. Boltasseva "Searching for better plasmonic materials", Laser & Photonics Reviews, 795-808, 2010.

add to my program **(close full abstract)**

15:00 **Subsurface laser nano-structuring of plasmonic, stratified metal/dielectric media**

Authors : N. Kalfagiannis1, A. Siozos2, D. Bellas2, G. Vourlias3, K. Bazioti3, G.P. Dimitrakopulos3, W.M. Cranton1, E. Lidorikis2, P. Patsalas3, D.C. Koutsogeorgis1,*
Affiliations : 1School of Science and Technology, Nottingham Trent University, Nottingham, NG11 8NS, United Kingdom; 2Department of Materials Science and Engineering, University of Ioannina, Ioannina, GR-45110, Greece; 3Department of Physics, Aristotle University of Thessaloniki, Thessaloniki, GR-54124, Greece

J.XIV 4

Resume : Several previous studies have demonstrated controlled (size and shape) fabrication of metal nanoparticles (NPs) by laser annealing (LA) of an uncapped metal thin film. In this work we LA stacks of bilayers of metal/dielectric thin films with 193nm and 248nm, producing nano-structures with plasmonic behavior, whereby the metal nanoparticles remain embedded in the dielectric. Therefore we present a novel engineering approach that is capable of subsurface modification, transforming metal layers capped by dielectrics into durable coatings with tunable plasmonic response. Multilayers consisting of alternate layers of AlN and Ag were fabricated by RF magnetron sputtering on Si wafers and on flexible biaxially oriented polypropylene (BOPP) substrates. The bilayer thickness was kept constant at 15 nm and we varied the

individual layer thicknesses of Ag and AlN. Upon LA and by varying the processing parameters, we delivered Ag nano-spheres of various size distribution embedded in a hard, inert and durable ceramic material; suitable for applications under harsh environment. We quantitatively analyze the effects of LA (number of pulses, laser wavelength and fluence) and simulate the temperature profile of the structures. Our findings qualify these metal nanostructure arrays as potential candidates for core nanostructures in plasmonic devices.

add to my program (close full abstract)

15:15 **Laser Excitation and Detection of One-Dimensional Localized and Leaky Wedge Waves**

Authors : Peter Hess1, Pavel Pupyrev2,3, Alexey M. Lomonosov1,2,3, and Andreas P. Mayer2

Affiliations : 1Institute of Physical Chemistry, University of Heidelberg, 69120 Heidelberg, Germany. 2HS Offenburg ? University of Applied Sciences, 77723 Gengenbach, Germany. 3General Physics Institute, RAS, Moscow, Russian Federation.

Resume : Laser-based excitation and detection of one-dimensional (1D) guided wedge waves propagating along the apex of a solid wedge were performed. The characteristic features of guided wedge waves were determined for several anisotropic silicon wedges with different symmetry properties. The pump-probe laser setup allowed the selective excitation of localized and of leaky or pseudo-wedge waves and of two-dimensional (2D) surface acoustic waves. Leaky or pseudo-wedge waves could be discovered for the first time in anisotropic silicon wedges. The strongly localized wedge waves are the slowest elastic waves, whereas the phase velocity of the supersonic pseudo-wedge waves is higher than that of the surface and slow shear bulk waves. Numerical calculations of the phase velocities were performed on the basis of the Laguerre function method. The theoretical results are in very good agreement with the measured velocity values. With the laser experiments it was possible to observe directly the decay of the wedge waves into the bulk material and to see the coupling of the pseudo-wedge wave with the surface acoustic wave on the wedge faces by laser-probe-beam deflection. Wedge waves are expected to open new possibilities for nondestructive evaluation (NDE) of solid edge systems owing to the dispersion effect, observed for imperfect edge geometries, and nonlinear effects due to the high concentration of stress and strain near the apex of the wedge. While surface and pseudo-surface acoustic waves already have found important industrial applications for linear wedge waves several feasibility studies have been performed in recent years, practical applications, however, are still missing.

J.XIV 5

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15:30 **Photonic nanojets from engineered nanospheres for the fabrication of ultra-high -density porous membranes**

Authors : D. Grojo (1), G. Baravaglio (2), L. Boarino (2), C. Constantinescu (1), P. Delaporte (1), N. De Leo (2), M. Laus (3), A. Lionti (1), L. Sandeau, N. Sandeau (4), K. Sparnacci (3)

Affiliations : (1) Aix-Marseille University, CNRS, LP3 UMR 7341, F-13288, Marseille, France; (2) INRIM, NanoFacility, Division Electromagnetism, I-10135 Torino, Italy; (3) Department of Science and Technology, University of Eastern Piedmont Amedeo Avogadro, I-15121 Alessandria, Italy; (4) Aix-Marseille University, CNRS, Centrale Marseille, Institut Fresnel, UMR 7249, 13013 Marseille, France

Resume : A photonic nanojet is an extremely narrow local field that spurts from the rear surface of a transparent sphere with size exceeding the wavelength. With sphere downscaling to the sub-wavelength level, the effect progressively vanishes and the intense field becomes highly localized. Our experiments show that there are two ways in which photonic nanojets can be obtained with sub-micrometer diameter spheres. The first and obvious option is to decrease the wavelength. Using a 193-nm wavelength nanosecond laser, we illuminate spheres with well-controlled diameters from 260 nm. The spheres are assembled into monolayers at the surface of oxidized silicon substrates so that ablation with the nanojets produces periodically-porous silica membranes. The second way relies on nanosphere engineering. Using a modified Stöber method, we synthesize core-shell gold-silica nanospheres. What is essential in our sphere design is to use a light-blocking core to increase the apparent length of the scattered field. We produce and image photonic nanojets at 400-nm wavelength. We show that photonic nanojets similar to those observed with micrometer scale conventional dielectric spheres can be obtained with engineered spheres of only 320-nm diameter. Photonic nanojets from nanoscale

J.XIV 6

spheres must allow ultra-high-density periodic light matter interactions opening routes for new laser nanofabrication and optical diagnostic technologies.

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Poster Sesion J: Laser surface nano & microstructuring. Laser transformations. Photo-induced phenomena and characterization. : V. Craciun, Ph. Delaporte, M. Nistor & M. Pervolaraki

16:00 **The Influence of phosphorus content on magneto-optical properties in (Ga,Mn) (As,P) layers .** JP.XV 1

Authors : H. Riahi, W. Ouerghui, L. Thevenard, M. Maaref, C. Gourdon and A.Lemaitre.

Affiliations : - Laboratoire, Matériaux, Molécules et Applications. IPEST- La Marsa -2070 -Tunis-Tunsie - Institut de Nanosciences de Paris, Université de Pierre Marie Curie. Unité mixte de recherche 7588-CNRS-UPMC-France. - Laboraoire de Photonique et Nanostructures. CNRS, marcoussis -France.

Resume : Ferromagnetism in quaternary layers containing for a fixed percentage of manganese x=0.01 and for varying P densities (y=0.07 and y =0.09) with perpendicular easy axis is investigated by the technique of magneto -optical Kerr effect (PMOKE). We used this technique to estimate two conjugate parameters- Kerr rotation and ellepticity by using a piezo-birefringent modulator. In addition this technique can be used to measure magneto-optical hysteresis loops for several wavelengths. With the help of this technique, we can estimate the value of Curie temperature (Tc). The Kerr rotation and ellepticity are strongly depending on the photon energy and temperature, exhibiting two larges positive peaks at ~1.82 (eV) and 1.93 (eV) respectively. These two peaks decreased in intensity with increasing temperature and phosphorus concentration.

add to my program (close full abstract)

16:00 **Temperature effects on the radiative recombination in InAlAs/AlGaAs quantum dots** JP.XV 2

Authors : A. Ben Daly1,2, F. Bernadot2, T. Barisien2, C. Testelin2 , M. Maaref1 and A. Lemaitre3

Affiliations : 1Laboratoire Matériaux-Molécules et Applications, Institut Préparatoire aux Etudes Scientifiques et Techniques, BP 51,2070 la Marsa, Université de Carthage, Tunis, Tunisia 2 Institut des NanoScience de Paris, UPMC Univ Paris06, CNRS UMR 7588, 4 Place Jussieu, 75252 Paris cedex05,France 3Laboratoire de Photonique et Nanostructures, CNRS, Route de Nozay, F-91460 Marcoussis, France

Resume : The influence of the temperature has been studied in self-assembled InAlAs/AlGaAs quantum dotsn using photoluminescence (PL) and time-resolved PL (TRPL). The time decay traces obtained by gating around the resonant peak at different temperature can be interpreted as a carrier lifetime or a capture time depending on which is the slowest. The integrated barrier and wetting layer luminescence is shown to be much weaker than the dot luminescence which suggests a short capture time.

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16:00 **Improving the laser damage resistance of oxide thin films and multilayers via tailoring ion beam sputtering parameters** JP.XV 3

Authors : Mustafa Burak Cosar, Alp Eren Sinan Ozhan

Affiliations : Aselsan Inc. Microelectronics, Guidance and Electro-Optics Division, Cankırı Yolu 7. Km, 06750 Akyurt, Ankara, Turkey

Resume : Ion beam sputtering is one of the widely used methods for manufacturing laser optics components due to its advantages such as uniformity, reproducability, suitability for multilayer coatings and dielectric materials with high packing densities. In this study, single Ta2O5 layers and Ta2O5/SiO2 heterostructures were deposited on glass substrates by ion beam sputtering. We focused on the effect of deposition conditions like substrate cleaning, assistance by 12 cm diameter ion beam and oxygen partial pressure on the laser-induced damage threshold of Ta2O5 single layers. Afterwards, the obtained information is employed to design and produce a Ta2O5/SiO2 multilayer structure demonstrating low laser-induced damage without a need for a post treatment procedure.

add to my program (close full abstract)

16:00 **Laser-induced periodic, symmetrical SiGe, Si islands with single crystal and high aspect ratio on Si substrate** JP.XV 4

Authors : Dongfeng Qi, Yihong Xu, Songyan Chen,* Cheng Li, Hongkai Lai, Wei Huang, and Jun Li

Affiliations : Department of Physics, Semiconductor Photonics Research Center, Xiamen University, Xiamen 361005, People?s Republic of China
Resume : We report the synthesis of SiGe and Si islands on Si substrate after pulse laser irradiation. Firstly, single crystal SiGe islands with an average aspect ratio of 0.96 are prepared by pulse laser irradiation of amorphous Ge film or SiGe on Si substrate. Furthermore, periodic and symmetrical Si islands can be fabricated on a nanoholes arrays Si wafer. Because these sub-200-nm nanoholes can be fabricated at high densities using conventional optical lithography over an entire wafer, these results will have significant implications for spectroscopy and nanophotonics.

16:00 **EUV ablation of polymers**

Authors : C. Liberatore1,2, A. Bartnik4, K. Mann3, M. Müller3, L. Pina2, L. Juha1, J. J. Rocca5, A. Endo1, T. Mocek1
Affiliations : 1HiLASE Project, Institute of Physics ASCR, Prague, Czech Republic; 2Czech Technical University, Prague, Czech Republic; 3Laser Laboratorium Göttingen (LLG), Göttingen, Germany; 4Institute of Optoelectronics (IOE) ,Military University of Technology, Warsaw, Poland; 5Department of Electrical and Computer Engineering, Colorado State University, Fort Collins, CO 80523, USA
Resume : Preliminary investigation is presented on short-wavelength ablation mechanism of PMMA and poly(1,4-phenylene ether ether-sulfune) by EUV radiation at 13.5 nm using a table-top laser produced plasma from a gas-puff target at LLG, in Göttingen and at 46.9nm by a 10-Hz desktop capillary-discharge EUV laser at the Institute of Physics, in Prague. Ablation test on PPEES was not obtained at 13.5 nm. This can be explained considering that at 46.9 nm the ablation threshold should be much lower than at 13.5 nm and that during the exposure at 13.5 nm, the near surface region is not so "overexposed/overheated" as in the previous case (at 46.9 nm), so that single-photon radiolytical processes would play an important role in material ablation, making visible the difference in radiation stability of PPEES and PMMA. To analyze the limit of the ablation process, a comparison between these data and the ones to be obtained by a 10Hz laser-plasma extreme ultraviolet (EUV) source at the Institute of Optoelectronics (IOE) at the Military University of Technology in Warsaw is presented. The EUV source is based on a double-stream gas-puff target irradiated with 1064 nm/0.74J/4ns pumping beam. Polymer samples are irradiated in a focal plane of the EUV collector or at some distance downstream the focal plane. A detailed discussion on the limit of the ablation process will be exposed at the conference.

JP.XV 5

16:00 **Laser Light Polarization Dependence of Carbon Raman spectroscopy**

Authors : Stephane NEUVILLE
Affiliations : TCE
Resume : Raman laser-light polarization dependence have been observed with micro-Raman on so called "D disorder" Raman peak which is characteristic of graphene A type edge structure. This laser light polarization dependence is not observed on the "G "and "2D" peaks of graphene bulk material. Only a reduced laser light polarization dependence is observed for the so-called "D disorder" peak (or band) of DLC composite material containing sp2 clusters (which can be assimilated to imbedded graphene nano-flakes). We suggest explaining this effect in considering the local aspects of our newly discussed extension of the double resonance Raman scattering theory and with the coupling between in-plane and out-of-plane graphene phonon modes which exist in the bulk of graphene material. This coupling of phonon modes can also exist on sp2 clusters edges when those are interlinked to some surrounding matrix material, meanwhile it cannot exist on free graphene edges, and with which we suggest the so called "D disorder" peak possible to provide information on how sp2 cluster edge atoms are bonded to their surrounding matrix. Further on considering the binary and ternary symmetry of corresponding phonon vibration modes, we suggest also some possible resonance between out-of-plane vibration modes and harmonic overtone of in-plane mode, with which the 2D peak to be laser light polarization independent and to give account for the Raman peak observed at 1250 cm-1 which is also characterizing graphene and we propose the iLOLA Raman designation.

JP.XV 6

16:00 **Disappearance of Fano asymmetry in the Raman spectra of delocalized hole system CuAlO2-xSx**

Authors : Nilesh Mazumder (1), Rajarshi Roy (1), Dipayan Sen (1), Uttam Kumar Ghorai (2) and Kalyan Kumar Chattopadhyay (1, 2).

JP.XV 7

Affiliations : 1. Physics Department, Jadavpur University, Kolkata, 700032, India 2. School of Materials Science and Nanotechnology, Jadavpur University, Kolkata, 700032, India

Resume : Strong Fano asymmetry corresponding to the Eg Raman mode of p-TCO CuAlO2 disappears upon sulfur doping at oxygen site. Analysis of electron localization function (ELF) reveals that delocalized charge carriers along S-Al direction [Realizing Direct Gap, Polytype, Group IIIA Delafossite: Ab Initio Forecast and Experimental Validation Considering Prototype CuAlO2; Nilesh Mazumder, Dipayan Sen, Uttam K. Ghorai, Rajarshi Roy, Subhajit Saha, Nirmalya S. Das and Kalyan K. Chattopadhyay; Journal of Physical Chemistry Letters, 2013, 4, 3539-3543] are affecting the phonon-electronic continuum interaction associated with the vibration of AlO6 octahedra. Increase in the polaron binding energy reduces the polarization fluctuation and exhibiting Fano anti-resonance in the Raman spectra of polytype CuAlO1.98S0.2.

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16:00 **ELECTRODYNAMIC ENERGY IN SPHERICAL NANOPARTICLES LAYERED**

Authors : Porodko Liliia NAN Ukraine Chuiko institute of surface chamistry 17 General Naumova,Kyiv, Ukraine
Affiliations : Porodko Liliia

Resume : In the electrostatic approximation considered layered spherical nanoparticle in-teraction with electromagnetic radiation. The distribution of the fields in the layers with the application of translational matrix is shown. Determined the intensity of energy re-leased due to the presence of losses. The problem considered in radial symmetry. For a homogeneous field acting along one of the axes of symmetry in globular particle squared electric intensity is expressed in two terms proportional to Legendre polynomi-als. Nanoparticles have unique optical properties, and because of their size opening up broad prospects for their use in various fields of science and technology. Now re-searchers attracted much attention so-called bimetallic nanoparticles composed of sil-ver and gold core shell, or vice versa. By changing the content of gold and silver in these particles it is possible to control the frequency plasmons in surfactant and inten-sity of absorption. This is because the frequency of the surface plasmon of gold and sil-ver significantly separated in the optical range and the absorption of silver nanoparti-cles is much more than gold. Keywords: nanoparticles; radial symmetry; translational matrix; integral trans-formations

JP.XV 8

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16:00 **Production of silver nanoparticles by laser ablation under ambient conditions**

Authors : M. Boutinguiza1, R. Comesaña2, F. Lusquiños1, A. Riveiro1-3, J. del Val1, J. Pou1
Affiliations : 1 Applied Physics Department, University of Vigo EEI, Lagoas-Marcosende, 9. Vigo, 36310, SPAIN 2 Materials Engineering, Applied Mechanics and Construction Dpt., University of Vigo, EEI, Lagoas-Marcosende, Vigo, 36310, SPAIN. 3 Centro Universitario de la Defensa, Escuela Naval Militar, Plaza de España 2, 36920 Marín, SPAIN.

Resume : Silver nanoparticles have attracted much attention as a subject of investigation due to their well known properties, such as good conductivity, antibacterial and catalytic effects, etc. They are used in many different areas, such as medicine, industrial applications, scientific investigation, etc. There are different techniques for producing Ag nanoparticles, chemical, electrochemical, sonochemical, etc. These methods often lead to impurities together with nanoparticles or colloidal solutions. In this work laser ablation under ambient conditions (LAAC) is used not only to produce silver nanoparticles but also to deposit them on a substrate. Production and deposition of silver nanoparticles are integrated in the same step to reduce the process. The obtained particles are analysed and the nanoparticles formation mechanism is discussed. The obtained nanoparticles were characterized by means of transmission electron microscopy (TEM), high resolution transmission electron microscopy (HRTEM) and UV/VIS absorption spectroscopy. The obtained nanoparticles consisted of Ag nanoparticles showing spherical shape with diameters ranging from few to 70 nm. The ablated Ag nanoparticles were deposited directly on a glass to form a coating whose composition was confirmed by the use of Glancing incidence X-ray diffraction (GXRD).

JP.XV 9

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16:00 **Laser joining of AA6013 and Ti-6Al-4V with Si film prepared by RF magnetron sputtering**

Authors : A.C. Oliveira, R. Riva, C.B. Mello, N.M.A. Athanazio, R.M. Oliveira
Affiliations : Federal University of São Paulo; Institute for Advanced Studies; National Institute for Space Research; Institute for Advanced Studies; National Institute for Space Reseach

JP.XV 10

Resume : The use of laser beam to joining dissimilar metal has been considered to applications in structural components of aircrafts. A common phenomenon involved Ti/Al joint is the presence of brittle intermetallic compound (IMC) in the interface region. The introduction of Si element in the junction region has shown significant influence on interfacial reaction mechanism, promoting the change of IMC type, depressing the growth of brittle IMC and improving the joint mechanical properties. In this work, Si was deposited on Ti-6Al-4V substrates by ionized magnetron sputtering powered by 300V/90mA DC and 50 W RF sources with work pressure of 0.6 Pa and argon ambient, and deposition time between 1 h and 2 h. After, Ti-6Al-4V and AA6013 sheets were joined by a Yb:fiber laser welding system. Butt joint conditions were maintained constants (laser average power, 1200 W, process speed, 3.0 m/min, and laser offset toward Al alloy, 0.3 mm). EDS line scanning evaluated the elemental distribution at the joint interface with and without the introduction of Si. A decreasing of intermetallic layer is observed in joints with Si film deposited on the Ti-6Al-4V when compared to welded joint without Si. The thickness of interfacial IMC layer, formed by TiAl3, with Si film is about five times lower than the interfacial IMC layer of welded joint without the film, reaching the mean value of 2 µm. Further studies will associate the results to influence of IMC layer on the fracture behavior of the joint.

add to my program **(close full abstract)**

16:00 **Laser Annealing of Plasma-Damaged Silicon Surface**

Authors : T. Sameshima and M. Hasumi
Affiliations : Tokyo University of Agriculture & Technology

Resume : We report infrared laser annealing of the silicon surface damaged by Ar plasma irradiation. The surface of n-type 500-micrometer-thick silicon substrates with surfaces coated with 100 nm-thick thermally grown SiO2 layers were irradiated with 13.56 MHz capacitance coupled Ar plasma at 50 W for 120 s. Ar plasma irradiation markedly decreased the light induced minority carrier effective lifetime from 1.7x10^-3 (initial) to 1.7x10^-5 s. Moreover, the capacitance response at 1 MHz alternative voltage as a function of the bias voltage (C-V) measurement reveled that Ar plasma irradiation caused a density of interface traps of 8.0x10^11 cm^-2eV^-1 and a large hysteresis of voltage of 2.0 V in C-V characteristics. Those results mean that Ar plasma caused substantial carrier recombination and carrier trap defect states at the silicon surfaces. The top surface of the samples were subsequently heated with contentious wave 940-nm-semiconductor laser irradiation at 3.6x10^4 W/cm^2 for 4 ms at room temperature in air. The light induced minority carrier effective lifetime was markedly increased to 1.7x10^-3 s, which was the same as the initial value. The density of interface traps was decreased to 8.1x10^9 cm^-2eV^-1. Moreover, the hysteresis of voltage was also decreased to 0.1 V in C-V characteristics. Laser heating effectively decreased the densities of plasma induced carrier recombination and trap states. Those experimental demonstrations suggest that laser rapid heating is useful for decrease damage induced by plasma irradiation, whose process is inevitable for semiconductor device fabrication.

JP.XV 11

add to my program **(close full abstract)**

16:00 **Applying transformations Surface Nitriding Plasma and Immersion Ion Implantation in Plasma in Steels SAE 4340, 300M and Maraging 300 afther Laser Weld**

Authors : Cardoso A. S. M. 1, Abdalla A. J. 1, Lima M. S. F. 1, Baggio-Sheid V. H. 1, Miyakawa M.1, Silva M. M.2, Ueda M. 3.
Affiliations : 1Instituto de Estudos Avan?ados (IEAv/DCTA): Trevo Cel Amarante, 1, Putim, 12228-970, S?o Jos? dos Campos (SP - Brasil); 2Instituto de Tecnol?gico de Aeron?utica (ITA/DCTA): Pra?a Marechal Eduardo Gomes, 50, Vila das Ac?cias, 12.228-900, S?o Jos? dos Campos (SP ? Brasil); 3Instituto Nacional de Pesquisas Espaciais (INPE): Avenida dos Astronautas, 1.758, Jd. da Granja, 12227-010, S?o Jos? dos Campos (SP - Brasil).

JP.XV 12

Resume : Surface modification by ion bombardment is a well-established technique for improving hardness, wear, friction, and corrosion resistance in steel. Thermochemical treatments by plasma nitriding (PN) are line-of-sight processes, in which energetic ion beams are targeted to the sample. However, large and complex-shaped targets require some manipulation to achieve a homogeneous implantation. Alternatively, plasma immersion ion implantation (PIII) and plasma source ion implantation (PSII) are less time and energy consuming techniques. In this work, surface treatment of the SAE 4340, 300M and Maraging 300 steels by PN and PIII techniques were evaluated aiming to obtain high lifetime . Microscopy, Vickers hardness, X-ray diffraction techniques

and Saltcorrosion were used to evaluate the steels surfaces. After the plasma nitriding treatment, a white and brittle nitride layer was observed and cross-sectional measurements of the Vickers hardness revealed a thicker diffuse layer in both metals. The nitride layer after the PIII treatment in the 4340 steel was only detected by surface analyses (microscopy and X-ray diffraction) and cross-sectional Vickers hardness confirmed a thinner diffusion layer in both steels. The XRD analysis and corrosion tests permitted the verification of the layer formation of nitrides in the steels surfaces. That nitride layer has served like protection all materials studied here, with different results in base metal and in weld bead, when compared to respectives steels welded the fiber, without and with treatments in different processes.

add to my program (close full abstract)

16:00 **Redox Multiphoton Polymerization for 3D Nanofabrication**

Authors : Argyro Giakoumaki, Elmina Kabouraki, Paulius Danilevicius, David Gray,Maria Vamvakaki, Maria Farsari
Affiliations : IESL-FORTH, N. Plastira 100, 70013, Heraklion, Crete, Greece

Resume : We report for the first time on the redox multiphoton polymerization of an organic-inorganic composite material, in which one of the components, a vanadium organometallic complex, also acts as a photoinitiator [1]. The composite employs multiphoton absorption to self-generate radicals by photo-induced reduction of the metal species from Vanadium (V) to Vanadium (IV). We exploit this material for the fabrication of fully 3D structures by multiphoton polymerization with 200 nm resolution, employing a femtosecond laser operating at 800 nm, in the absence of a photoinitiator. Nonlinear absorption measurements indicate that, the use of an 800 nm laser initiates the photopolymerization due to three-photon absorption of the vanadium alkoxide. The laser power required to induce this three-photon polymerization is comparable to what is required for inducing two-photon polymerization in materials using standard two-photon absorbers, most likely due to the high content of vanadium in the final composite (up to 50% mole). [1]Kabouraki, E., A. N. Giakoumaki, et al. (2013). "Redox Multiphoton Polymerization for 3D Nanofabrication." Nano Letters 13(8): 3831-3835.

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16:00 **Formation and characterization of two-dimensional regular patterns fabricated employing multiple exposure holographic lithography**

Authors : Dainius Virganavicius, Ausrine Jurkeviciute, Nerijus Armakavicius, Linas Simatonis, Agne Ciuciulkaite, Tomas Tamulevicius, Mindaugas Andrulevicius, Sigitas Tamulevicius
Affiliations : Institute of Materials Science of Kaunas University of Technology, Savanoriu Ave. 271, LT-50131 Kaunas, Lithuania

Resume : Holographic lithography (HL) is emerging as a high throughput technique for structuring full wafer scale surface areas with regular patterns from sub-micrometer to nanometer scale periodicities in a single exposure. The biggest limitation of HL is that only periodic patterns can be produced. Despite this drawback HL has been shown to be applicable for structuring photonic crystals, nanowires, porous membranes, magnetic dots, etc. In this work 1D and 2D periodic microstructures in thin positive and negative tone photoresist (on float glass and silicon substrates) were fabricated employing original two-beam multiple exposure HL setup (442 and 405 nm CW lasers). Applying different angles of rotation in between two or three sequential exposures enabled obtaining higher contrast of fringes compared to multiple beam HL approach. Produced patterns were analysed employing optical and scanning electron microscopes (SEM) and compared with the simulated optical field distributions. Intensities of the diffraction maxima of the produced structures were measured and their spatial distributions were compared with fast Fourier transforms of optical microscope dark field micrographs. SEM micrographs were used to determine point lattice types and rotational symmetry of the fabricated structures. Regular structures with periodicities of 1.1-1.2 um and 2D point lattices of rhombus, triangular and square point lattices with different rotational symmetries were fabricated.

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16:00 **Synthesis and Characterization of Eu3+ doped CeAg(WO4)2**

Authors : Chaoyu You, F. Fernandez-Martínez
Affiliations : Department of Industrial Chemistry and Polymers Superior Technical School of Industrial and Design Engineering , Polytechnic University of Madrid, Madrid-28012, Spain.

Resume : Eu3+ doped cerium silver tungstate, Eu3+:CeAg(WO4)2, have been synthesized using stoichiometrics amounts of starting materials heated at 750ºC

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in ceramic crucible in air atmosphere by the solid-state method. After cooling to room temperature, the samples were reground in an agate mortar and heated again at 800ºC for 12 h to complete the reaction, and then quenched to room temperature in air. The crystal structure and purity of the sample were tested by X-ray diffraction. The X-ray pattern was measured using Cu Kα radiation (λ=1.540598 Å) with a Siemens D5000 diffractometer equipped with a graphite monochromator. Data were collected at 300 K over an angular range of 10º ≤ 2θ ≤ 120º, scanning in steps of 0.05º, and a counting time of 6 s per step. The results were analyzed by the Rietveld profile refinement method, using FULLPROF program (December 2013 version). The refinement was performed in the tetragonal S.G. I 41/a (No. 88) and the starting values for the unit cell and positional parameters were those reported for the AgCe(WO4)2. Furthermore, initially differential thermal analysis (DTA) and thermal gravimetric (TG) are used to obtain the temperature and reaction process. Its is worth noting that the Eu3+:CeAg(WO4)2 compound has been obtained despite the relatively high instability of the trivalent Ce ion. This behaviour could be explained from the redox properties of Ag2O in the solid state reaction at high temperature in air, which stabilises the trivalent valence state. This behavior is necessary to obtain these compounds in contrast to not obtained equivalent compounds with alkaline cations. In order to study possible distortion of polyhedral, vibrational spectroscopy, FTIR and Raman are in progress.

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16:00 **Comparison of laser ablation with spark discharge technique used for nanoparticle production**

Authors : Andrey Voloshko, J-Ph. Colombier, Tatiana. E. Itina
Affiliations : Hubert Curien Laboratory, 18 rue du Prof. Benoit Lauras, Bat. F, 42000 Saint-Etienne, France

Resume : Both spark discharge (SD) and laser ablation (LA) techniques can be used for nanoparticle production. The major advantage of spark discharge is in the possibility of using several facilities in parallel to increase the yield of nanoparticles. To better control over this process, the mechanisms involved in both SD and LA should be examined. Here, we consider different stages involved in these processes and analyze the resulting plasma parameters. Furthermore, conditions required for nanoparticle formation are verified. First, spark discharge is considered. The results of a detailed numerical modeling are presented. The model consists of several parts: (i) streamer formation and propagation for a short gap spark discharge at atmospheric pressure. In this part, ionization kinetics and energy balance are calculated; (ii) as soon as a breakdown occurs, plasma column is formed. Joule heating of plasma and the formation of cathode layer are considered; (iii) Electrode heating and erosion take place due to ion bombardment and heat exchange with the hot plasma column. Then, laser ablation is considered. Here, again several stages are described as follows: (i) Laser energy absorption by the target; (ii) Material heating and evaporation; (iii) Plasma plume formation and its expansion in a background gas. Finally, we check conditions required for nucleation, condensation and coagulation of nanoparticles and compare both techniques.

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16:00 **Investigation of thermal and morphological effects after ultrashort pulsed laser irradiation of double-layered metals**

Authors : George D.Tsibidis, Panagiotis Kapizionis, E.Stratakis
Affiliations : Foundation for Research & Technology—Hellas, Institute of Electronic Structure and Laser, (FORTH-IESL), P.O. Box 1527, Heraklion 711 10, Greece

Resume : Research in double-layered metal thin films has received considerable attention due to their important technological applications, in particular in photo/micro-electronic devices and micro-electro-mechanical switches. The present work investigates the morphological changes induced in a Cu-Ti double layered film following irradiation with ultrashort laser pulses in melting conditions. It is observed that, under specific irradiation schemes, a rippled morphology on the top layer can be attained, while the morphological characteristics of ripples can be tuned upon variation of laser parameters. To account for the observed ripple characteristics, the thermal response of a Cu-Ti double-layer film is theoretically explored using a revised two-temperature model is employed to account for the contribution of nonthermal electron distribution. It is shown that excitation of surface plasmons and their interference with the laser beam along with a melting-resolidification procedure can give rise to a rippled morphology and explain its variations with irradiation parameters. Theoretical results aim to provide significant insight into the physical mechanism that characterize electron dynamics and can facilitate

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production of controllable ultra-high strength Cu-Ti alloys with promising applications.

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16:00 **Tunable characteristic of electromagnetically induced transparency via liquid crystal in a terahertz metamaterial**

Authors : Ting-Tso Yeh, Chan-Shan Yang, Ci-Ling Pan and Ta-Jen Yen
Affiliations : Department of Materials Science and Engineering, National Tsing Hua University; Department of Physics, National Tsing Hua University

Resume : Metamaterials being composed of sub-wavelength and periodic metallic inclusions has attracted immense attention because of their unprecedented electromagnetic properties which do not exist in nature, especially metamaterial-analogue electromagnetic induced transparency (EIT), which introduces a transparency window by coupling a super-radiant and a sub-radiant atom of the metamaterial together. To realize a flexible device in the THz gap, we integrate the EIT with a tunable material, the voltage-controlled liquid crystal (LC). The LC (MDA-00-3461) possess the largest birefringence at the THz gap. With the aids of the birefringence in the LCs, we can tune the responses of the EIT-appended tunable metamaterial by applying different voltages. The tunability in term of the resonant frequency is equal to 6.2 % in our case, which to our best knowledge, is the greatest tunability of the resonant frequency ever in the field of LC-driven tunable THz devices. Additionally, the tunabilities of 55.8 % (from 0.43 to 0.19) and 47.7 % (from 7.59 ps to 3.97 ps) in terms of the amplitude of the transparency window and the group delay time, respectively, are achieved. Such great tunabilities are comparable to the current LC-driven tunable THz devices so that we pave the way to future applications such as a light storage medium, a dynamic optical switch and compact versatile control system of an optical path. In the future, we will experimentally demonstrate the EIT-appended tunable metamaterial

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16:00 **Formation of self-organized LIPSS by irradiation with an ultra fast white light continuum**

Authors : Sebastian Uhlig, Olga Varlamova, Markus Ratzke, Juergen Reif
Affiliations : Brandenburgische Technische Universitaet Cottbus-Senftenberg

Resume : Typical LIPSS structures were produced on silicon (periods between 500 … 650 nm), brass, copper, and stainless steel (period around 400 nm) by irradiation with pulses from an ultra fast (100 fs) white light continuum, spreading in wavelength from 400 … 750 nm. The ripples periods depend, clearly, on both, the material and the irradiation dose (number of pulses), increasing with increasing dose on silicon, decreasing on stainless steel. Given the CONTINUOUS excitation spectrum with very moderate power in narrow spectral intervals, it appears unlikely to attribute the structure formation to any interference effect. Instead, the results are in full agreement with our dynamic model of self-organized structure formation.

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16:00 **Arrays of metal nanostructures by methods combining colloidal lithography and laser processing**

Authors : C. Constantinescu, K.L.N. Deepak, P. Delaporte, N. Sandeau*, O. Utéza, D. Grojo
Affiliations : Aix-Marseille Université / CNRS, LP3 UMR 7341, 13288, Marseille, France; *Aix-Marseille Université / CNRS, Centrale Marseille, Institut Fresnel, UMR 7249, 13013 Marseille, France

Resume : We propose two microsphere-laser joint methods to produce long-range arrays of well-shaped metal nanostructures. First method is a microsphere monolayer assisted laser-induced forward transfer (LIFT) method that allows the parallel printing of metal nanodroplets. The second one is a hybrid methodology: microsphere lithography as initial step, and excimer laser metal dewetting to control the shape of the deposited nanostructures. In our experiments, transparent microsphere monolayers on high-purity suprasil substrates are covered with thermally evaporated Ag films of controlled thickness. When back-illuminated using laser pulses (355-nm wavelength, 50-ps duration) the laser interaction with the microsphere near-field mask produces periodic local detachments of the films that can be collected on a receiving substrate. The results allow discussing the challenges associated with downsizing of the LIFT technique to the nanoscale. When removing the spheres by physico-chemical means, the deposition directly leaves behind arrays of nanosize silver triangles that can be furthermore laser processed. A specific study is presented here on the reshaping of these nanostructures by annealing with an excimer laser (193-nm wavelength, 15-ns duration). In previous work,

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we prepared nanodot arrays using microsphere-assisted laser fabricated mesoporous membranes. These two alternative methods will add to the panel of available microsphere-assisted technologies to prepare surface nanomaterials.

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16:00 **The Photoluminescence of Erbium doped 0.93(Bi0.5Na0.5TiO3)–0.07($BaTiO_3$) ceramics**

Authors : C.M. Lau, K.W. Kwok
Affiliations : The Hong Kong Polytechnic University

Resume : Erbium doped 0.93(Bi0.5Na0.5TiO3)–0.07($BaTiO_3$) ceramics have been prepared by using solid state method. The dielectric, piezoelectric and the photoluminescence properties have been studied. The ceramics show not only up-conversion luminescent emission at visible light region but also down-conversion luminescent emission at near-infrared and mid-infrared regions under 980nm excitation. For visible light emission, they exhibit an intense emission at 548nm (green) and two weak emissions at 532nm (green) and 660nm (red) corresponding to 4S3/2 →4I15/2, 2H11/2 →4I15/2, and 4F9/2 →4I15/2 transitions respectively. For infrared emissions, they exhibit a strong broad band emission from 1.4?m to 1.7?m in near-infrared region and a weak broad band emission from 2.6?m to 2.9?m in mid-infrared region, which refer to 4I13/2 →4I15/2 and 4I11/2 →4I13/2 transitions respectively. The results reveal the photoluminescence intensity generally increase with erbium concentration. The optimum doping level and the change of photoluminescence properties base on the internal structure and doping concentration have been investigated. The ceramics also exhibit good ferroelectric properties, therefore, they should have great potential for multifunctional optoelectronic applications.

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16:00 **Light Reflection and Extinction by Metal-Polymer Composites Prepared by Ion Implantation**

Authors : Y.A. Bumai1, N.I. Dolgikh2, R.I. Khaibullin3, A.A. Kharchenko2, M. G. Lukashevich2, V.B. Odzhaev2
Affiliations : 1 Belarussian national technical university, 220030, Minsk, Belarus; 2 Belarusian State University, 220030, Minsk, Belarus; 3 Kazan Physical-Technical Institute, RAS, 420029, Kazan, Russian Federation

Resume : Transparent for visible light polymers such as polyimide (PI) and polyethyleneterephthalate (PET) have been implanted with 40 keV Ag and Ni ions to high fluences (2.5•10^16?1.5•10^17 cm^-2) resulting in formation of metallic nanoparticles in the near-surface layer of about 60 nm thick. Reflection and transmission spectra in the wavelength range of 200 to 1100 nm have been measured. Formation of silver inclusions in the polymers in contrast to nickel ones leads to an increase of reflectivity with maximum at 620 nm for both PI and PET composites due to surface plasmon resonance (SPR) in silver nanoparticles. Reflectivity maximum observed from rear side of the samples has shifted to longer wavelengths showing non-uniform distribution of the nanoparticle sizes over the depth. The reflectivity peaks with weak intensities at 205 nm, 260 nm and 210 nm, 254 nm, 311nm for the virgin PET and PI films respectively have been detected in ultraviolet range. After implantation the peaks have increased for rear side and disappeared for implanted one that is explained by full carbonization of implanted layer and polymer modification beyond the ion projected range. By fitting of reflection and extinction spectra of the implanted polymers using two layer model the refractive indexes of modified layers have been determined to be in the range of 1,3 - 2,8 at 620 nm. Using Mie theory mean metallic inclusion sizes are estimated to be in the range of 5-20 nm depending on fluence.

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16:00 **Surface oxynitring of titanium metal by laser irradiation under controlled gas mixtures: influence of the O2/N2 partial pressure ratio**

Authors : F. Torrent (a), P. Berger (b1,b2), L. Lavisse (a), B. Dourthe (a), J. M. Jouvard (a), M. C. Marco de Lucas (a)
Affiliations : (a) Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB), UMR 6303 CNRS-Université de Bourgogne, 9 Av. A. Savary, BP 47 870, F-21078 Dijon Cedex, France (b1) CEA / DSM / IRAMIS / NIMBE , CEA - SACLAY, F-91191 Gif sur Yvette, France (b2) SIS2M, UMR CEA-CNRS 3299 CEA - SACLAY, F-91191 Gif sur Yvette, Franc

Resume : Nitriding processes are particularly sensitive to contaminants, especially water or oxygen. The strong affinity of titanium towards oxygen can limit the insertion of nitrogen and give rise to the formation of titanium oxynitride surface layers as a function of the composition of the reactive atmosphere. Titanium oxynitride layers have been reported to improve the tribological properties of titanium parts. Moreover, titanium oxynitride layers can

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be a promising route to improve the bioactivity and wear resistance of biomedical titanium metal. The purpose of this work is to study the influence of the O2/N2 partial pressure ratio on the composition and the structure of the surface layers formed by surface laser treatment of titanium metal under controlled gas mixtures. Laser treatments were carried out with an IR nanosecond Nd: YAG laser in a specific chamber where different mixtures of oxygen, nitrogen and argon were introduced. The composition of the surface layers was studied by Nuclear Reaction Analysis (NRA). X-ray diffraction and microRaman spectroscopy were used to study the microphases distribution in the formed surface layers. It will be shown that the insertion of nitrogen is limited by both the presence of oxygen in the gas mixture and the laser treatment parameters, whereas the insertion of oxygen is mainly controlled by its partial pressure in the gas mixture.

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16:00 **Tribological performance of femtosecond laser-induced periodic surface structures on metals**

Authors : J. Bonse (1), R. Koter (1), M. Hartelt (1), D. Spaltmann (1), S. Pentzien (1), S. Höhm (2), A. Rosenfeld (2), J. Krüger (1)
Affiliations : (1) BAM Bundesanstalt für Materialforschung und -prüfung, Unter den Eichen 87, D-12205 Berlin, Germany; (2) Max-Born-Institut, Max-Born-Straße 2a, D-12489 Berlin, Germany

Resume : Laser-induced periodic surface structures (LIPSS, ripples) were generated on stainless steel and titanium alloy surfaces upon irradiation with multiple linear polarized femtosecond laser pulses (pulse duration 30 fs, central wavelength 790 nm). The experimental conditions (laser fluence, spatial spot overlap) were optimized in a sample-scanning geometry for the processing of large surface areas covered homogeneously by the nanostructures. The irradiated surface regions were subjected to optical microscopy (OM), white light interference microscopy (WLIM) and scanning electron microscopy (SEM) revealing sub-wavelength spatial periods. The nanostructured surfaces were tribologically tested under reciprocal sliding conditions against a sphere of hardened 100Cr6 steel at 1 Hz using paraffin oil and engine oil as lubricants. After 1000 sliding cycles at a load of 1.0 N, the corresponding wear tracks were characterized by OM and SEM. For specific conditions the laser-generated nanostructures endured the tribological treatment. Simultaneously, a significant reduction of the friction coefficient was observed in the laser-irradiated (LIPSS-covered) areas when compared to the non-irradiated surface, indicating the potential benefit of laser surface structuring for tribological applications.

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16:00 **Plasmonic origin of near-wavelength laser-induced periodic surface structures on silicon: double-pulse experiments and theory**

Authors : T.J.-Y. Derrien (1), J. Krüger (1), T.E. Itina (2), S. Höhm (3), A. Rosenfeld (3), J. Bonse (1)
Affiliations : (1) BAM Bundesanstalt für Materialforschung und -prüfung, Berlin, Germany; (2) Laboratoire Hubert Curien, Saint-Etienne, France; (3) Max-Born-Institut, Berlin, Germany

Resume : The formation of laser-induced periodic surface structures (LIPSS, ripples) upon irradiation of silicon with multiple irradiation sequences consisting of femtosecond laser pulse pairs (pulse duration 150 fs, central wavelength 800 nm) is studied numerically using a rate equation system along with a two-temperature model accounting for one- and two-photon absorption and subsequent carrier diffusion and recombination processes [1]. The temporal delay between the individual equal energy fs-laser pulses was varied between 0 and 5 ps for quantification of the transient carrier densities in the conduction band of the laser-excited silicon. Additionally, cumulative effects were considered to account for multiple irradiation sequences. The results of the numerical analyses reveal the importance of carrier generation and relaxation processes in fs-LIPSS formation and quantitatively explain the two time constants of the delay dependent decrease of the rippled area observed experimentally [2]. Evidence is presented that (i) a threshold carrier density must be exceeded transiently turning the semiconductor to a metallic state and that (ii) interference between a surface plasmon polariton and the laser radiation is required to trigger the fs-LIPSS formation. [1] T.J.-Y. Derrien, J. Krüger, T.E. Itina, S. Höhm, A. Rosenfeld, J. Bonse, Opt. Express 21, 29643-29655 (2013). [2] S. Höhm, A. Rosenfeld, J. Krüger, J. Bonse, Appl. Surf. Sci. 278, 7-12 (2013) .

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16:00 **One-step laser pyrolysis synthesis of TiO2 nanoparticles embedded in carbon-silica shells / matrix**

Authors : 1.Claudiu Fleaca, Monica Scarisoreanu, Ion Morjan, Catalin Luculescu, Ana-Maria Niculescu, Florian Dumitrache, 2.Eugeniu Vasile, 3.Virginia Danciu, Mihaela Popa
Affiliations : 1. NILPRP , Atomistilor str.no.409, Magurele Bucharest , Romania 2. METAV R&D C.A Rosetti str. no.31 and Polytechnica University of Bucharest Independentei no.313, Bucharest, Romania 3. Babes-Bolyai University , Faculty of Chemistry and Chemical Engineering Arany Janos str, no 11, Cluj Napoca Romania

Resume : We report the direct synthesis of titania nanoparticles covered /embedded in carbon/silica layers/matrix using oxidative laser pyrolysis technique. The vapors of TiCl4 and [(CH3)3Si]2O (HMDS) were used as precursors while C2H4 was employed as laser energy transfer agent (sensitizer) and air as oxidant. In the first experimental series, the Ti precursor was introduced through the inner nozzle, whereas the Si precursor was separately injected by an annular coflow. For the second experimental series, the HMDS and TiCl4 flows were interchanged simultaneously with the progressively diminishing of the Ti precursor flow. The color of the powders resulted from the first configuration was grey, whereas from the second configuration was dark blue. XRD reveals the presence of anatase/rutile crystalline phases. In the first series the anatase percent in the mixture with rutile increases from 39 to 78% with the increasing of supplementary air flow introduced through the 2nd nozzle. The second series powers show a higher anatase content (85-90%) simultaneously with an increasing of the Si atomic percent (from ~ 8 to 18%). The presence of carbon revealed by the EDS can be visualised in HR-TEM images (as turbostratic shells surrounding the TiO2 nanoparticles). The raw powders were annealed in air at 450°C followed by the preliminary testing of their photocatalytic properties.

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16:00 **Laser cutting of AZO / Ag / AZO thin films**

Authors : Antonio Terrasi1, 2, Isodiana Crupi2, Stefano Boscarino1, 2, Giacomo Torrisi3, Giorgia Scapellato2, Salvatore Mirabella2, Giovanni Piccitto1, Francesca Simone1
Affiliations : 1Dipartimento di Fisica e Astronomia, Università di Catania, via S. Sofia 64, 95123 Catania, Italy; 2MATIS IMM-CNR, via S. Sofia 64, 95123 Catania, Italy; 3Distretto Tecnologico Sicilia Micro e Nanosistemi, via Strada VIII 5, 95121 Catania, Italy; 4CNR-IMM, via Strada VIII 5, 95121 Catania, Italy

Resume : The increasing demand for transparent conductive electrodes (TCE) in optoelectronic devices, flat-panel displays, organic light emitting diodes and photovoltaic cells has pushed to find new structures and materials to this aim. Dielectric-metal-dielectric (DMD) multilayer structures [1, 2] are good candidates compared to standard TCEs electrodes because of the enhanced conductivity, high optical transmission, lower temperature process, reduced thickness and, consequently, significant cost reduction and improved mechanical flexibility. However, DMD multilayers are still far from being implemented on thin film photovoltaic device technology. A crucial aspect is the TCE film patterning (scribing) for electrical isolation. This is done by a laser ablation removing the thick, typically 0.7 to 1 µm, TCE front contact deposited on glass. In this work we show how the energy density threshold for laser scribing is significantly reduced when the standard AZO single layer is replaced with a 10 times thinner AZO/Ag/AZO multilayer structure, still having good electrical and optical properties [3]. Thin films of 40/10/40 nm of AZO/Ag/AZO were grown on soda lime substrates by RF magnetron sputtering at RT. Nd:YAG laser treatments were done by a single pulse (12 ns) at 1064 nm. The fluence was varied in the range 1.15 to 4.6 J/cm2. Our experimental results, supported by computer simulation, provide clear evidences of the key role played by the silver interlayer in lowering the laser power to obtain electrical isolation within the laser spot. [1] Kim S. et al. J. Photon Energy 2:021215 (2012). [2] Crupi I. et al. Thin Solid Films 520, 4432 (2012). [3] Crupi I. et al. Nanoscale Res Lett 8:392 (2013).

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16:00 **Optical and structural properties of Eu3+ doped silicophosphate glasses.**

Authors : F. BEN SLIMEN ; N. GAUMER ; S. CHAUSSEDENT
Affiliations : Laboratoire de Photonique d'Angers - LUNAM - Université d'Angers - France

Resume : Silicophosphates (SiO2-P2O5) glasses doped with Eu3+ ions have been synthesized by the sol–gel process with different Si/P/Eu molar ratios. Optical properties of these glasses were investigated by means of emission spectra and lifetime measurements. The fluorescence line narrowing (FLN) technique has been used in order to explore the local structure around the Eu3+ ions in this host and to understand the role of phosphate as a codopant. As it is

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the case for aluminum, the ability of phosphate to avoid the rare-earth clustering can be explained by its propensity to modify the local order around the rare-earth ion through a structuring effect. The analysis of our FLN and decay measurements is consistent with this interpretation.

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16:00 **Preparation of nanostructured ZrO2 films as supports for Au catalysts for low-temperature CO oxidation**

Authors : A. Og. Dikovska1, G. B. Atanasova2, P. K. Stefanov2, P. A. Atanasov1
Affiliations : 1 Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee, Sofia 1784, Bulgaria 2 Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev str., bl. 11, 1113 Sofia, Bulgaria

Resume : Carbon monoxide (CO), in its quality of a major toxic air pollutant usually emitted by products of combustion processes from industrial, transportation and domestic activities, has always been among the central issues in the environmental protection field. Gold (Au) is a metal with no reactivity in bulk; however, in the form of nanoparticles it exhibits high activity for several reactions. It has already been shown that gold nanoparticles supported on oxides can assist oxidation of CO. It has further been shown that the reactivity of gold depends on both the nanoparticle size and on the support used. The progress in synthesizing porous, nanosized, and nanostructured oxide materials allows one to use such structures as a support medium in catalytic reaction. The aim of this work is to fabricate zirconium oxide (ZrO2) nanostructures on steel substrates by pulsed laser deposition (PLD). The morphology of the ZrO2 nanostructures is related to the morphology of the layer (metal or oxide) pre-deposited on the steel substrates. Subsequently, Au nanoparticles are deposited on the ZrO2 nanostructures. The catalytic behavior of Au supported on ZrO2 is investigated with a view of low-temperature CO oxidation. The catalytic activity of the Au/ZrO2 system is related to the gold particle size and the zirconium oxide support's porosity.

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16:00 **Online monitoring of laser induced periodic surface structures formation on polymer films by grazing incidence small angle x-ray scattering**

Authors : E. Rebollar1*, I. Martín-Fabiani2, Á. Rodriguez-Rodriguez2, M.C. García-Gutiérrez2, D. R. Rueda2, G. Portale3, T. A. Ezquerra2, M. Castillejo1
Affiliations : 1Instituto de Química Física Rocasolano, IQFR-CSIC, Serrano 119, 28006 Madrid, Spain; 2Instituto de Estructura de la Materia, IEM-CSIC, Serrano 121, 28006 Madrid, Spain; 3Netherlands Organization for Scientific Research, DUBBLE@ESRF, European Synchrotron Radiation Facility, Grenoble, France

Resume : We report on the formation of laser induced periodic surface structures (LIPSS) upon irradiation with the fourth harmonic of a Nd:YAG laser (266 nm, pulse duration 7 ns) followed online by synchrotron Grazing Incidence Small Angle X-ray Scattering (GISAXS). Spin coated films 100-200 nm thick of different polymers were irradiated at repetition rates between 1 and 10 Hz employing laser fluences below the corresponding ablation threshold. In situ measurements were performed at the BM26B at the ESRF in order to study the evolution of the structural features online upon repetitive irradiation and to obtain information about the mechanisms involved in LIPSS formation. Laser irradiation was performed at normal incidence with the laser polarization parallel to the propagation of the X-ray beam. LIPSS parallel to the polarization direction and with final periods close to the laser wavelength were obtained, as confirmed by atomic force microscopy. The number of pulses needed for the onset of LIPSS formation and for achieving the optimal order of the structures varies for the different polymers. It has been verified that both absorption coefficient and the glass transition temperature of the polymer are crucial magnitudes for the onset of LIPSS formation. The real time monitoring allows online optimization of both laser fluence and repetition rate for LIPSS formation.

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16:00 **Time-resolved spectroscopy of excitons in CdSe nanoplatelets**

Authors : I. Dmitruk, G. Klimusheva, A. M. Dmytruk, A. G. Lyashchova, T. A. Mirnaya, V. N. Asaula
Affiliations : Institute of Physics of National Academy of Sciences of Ukraine, Faculty of Physics, Taras Shevchenko National University of Kyiv; Institute of Physics of National Academy of Sciences of Ukraine; Institute of Physics of National Academy of Sciences of Ukraine; Institute of Physics of National Academy of Sciences of Ukraine; V. I. Vernadsky Institute of General and Inorganic Chemistry of National Academy of Sciences of Ukraine

Resume : Dynamics of excitons in two-dimensional CdSe nanoplatelets (NPLs) is studied by means of time-resolved absorption and photoluminescence spectroscopy. CdSe NPLs are chemically synthesized in thermotropic ionic liquid

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crystalline (LC) phase of cadmium octanoate that was used as a nanoreactor. The nanocomposite samples are obtained by rapid cooling of the LC phase to the room temperature. Observed doublet structure in absorption spectra of the nanocomposites is characteristic for the two-dimensional NPLs. The thicknesses of the CdSe NPLs are 1.6 nm, 1.9 nm, and 2.3 nm as determined from the absorption spectra, and correspond to 4, 5 and 6 CdSe monolayers, respectively. Induced simultaneous bleaching of the doublet components observed under femtosecond laser excitation, as well as photoluminescence spectra and their kinetics are found compatible with the model of excitons with heavy and light hole valence bands confined in nanoplatelets. Obtained data allowed us to estimate hole interband relaxation rate and suggest new Auger-type process responsible for additional luminescence line.

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16:00 **Planar chiral metamaterials with enhanced optical activity in gammadions-shaped from visible to near infrared region**

Authors : Min-Han Lee, Chu-En Lin,Ta-Jen Yen
Affiliations : Department of Materials Science and Engineering, National Tsing Hua University

Resume : Metamaterials are artificial materials with extraordinary electromagnetic properties which do not exist in nature. One application of metamaterials from GHz to infrared is "planar chiral metamaterials" (PCMs). Recently, researchers of PCMs show great interest in visible region due to their huge optical activity (OA). In fact, natural chiral materials suffer from poor specific rotation angle (SRA), so PCMs in optical frequencies have greater potential applications. Several brand new gammadions-shaped patterns were proposed according to our hypothesis, these complex structures will possess greater OA and surpass simple form of gammadions in the past. We started our study from simulations and e-beam lithography fabrications, and then we used polarimeter to analyze the SRA (deg/mm). Simulation of our corrugated gammadions-shaped PCMs with Ti/Au layers were carried out by CST Microwave StudioTM. Both Simulation and experimental results reveal that SRA depends on the linewidth of the desired pattern under constant metal thickness and exhibits different behavior with previous simple type. In this research, the measured SRA of these brand new gammadions-shaped patterns achieved 2.2×105 deg/mm and was as twice as the previous works. In conclusion, we designed and fabricated these complex metal gammadions-shaped PCMs which are highly optical-active and are superior to simple forms. These complex PCMs may be turned into promising candidates for optical application in the near future.

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16:00 **Structural and electrical characterization of laser-annealed nano-crystalline Si for solar cell applications**

Authors : I. Theodorakos1, Y.S. Raptis1, V. Vamvakas2, D. Tsoukalas1, I. Zergioti1
Affiliations : 1 Physics Department, National Technical University of Athens, Heroon Polytechniou 9, 15780 Zographou, Athens, Greece 2 Heliosphera, Industrial Area of Tripolis, 8th Building Block, 5th Road, GR-221 00 Tripolis, Greece

Resume : In this work, a picosecond DPSS laser was employed for the annealing and the partial crystallization of an amorphous silicon layer, in order to improve its solar cell efficiency. These experiments were conducted as an alternative/complementary to PECVD method for fabrication of micromorph tandem solar cell. The laser annealing was attempted at 1064 nm and 8 ps pulse duration in order to obtain the desired crystallization's depth and ratios. Irradiations were applied in the sub-melt regime, in order to prevent significant diffusion of p- and n- dopants to take place within the structure. The laser experimental work was combined with simulation of the annealing effect, in terms of temperature distribution evolution, in order to predetermine the optimum annealing conditions. From the simulations results, a temperature profile, appropriate to yield the desired recrystallization, was obtained with the use of ps pulses. The annealed material was studied, as far as it concerns its structural properties, by XRD, SEM and micro-Raman techniques, providing consistent information on the characteristics of the nanocrystalline material produced by the laser annealing experiments. It was found that, with the use of ps pulses, the resultant polycrystalline region shows crystallization's ratios similar to a PECVD developed poly-Silicon layer, with slightly larger nano-crystallite's size. Electrical characterization, by means of IV measurements, of tandem cells prepared by laser annealing was In this work, a picosecond DPSS laser was employed for the annealing and the partial crystallization of an amorphous silicon layer, in order to improve its solar cell efficiency. These experiments were conducted as an alternative/complementary to PECVD method

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for fabrication of micromorph tandem solar cell. The laser annealing was attempted at 1064 nm and 8 ps pulse duration in order to obtain the desired crystallization's depth and ratios. Irradiations were applied in the sub-melt regime, in order to prevent significant diffusion of p- and n- dopants to take place within the structure. The laser experimental work was combined with simulation of the annealing effect, in terms of temperature distribution evolution, in order to predetermine the optimum annealing conditions. From the simulations results, a temperature profile, appropriate to yield the desired recrystallization, was obtained with the use of ps pulses. The annealed material was studied, as far as it concerns its structural properties, by XRD, SEM and micro-Raman techniques, providing consistent information on the characteristics of the nanocrystalline material produced by the laser annealing experiments. It was found that, with the use of ps pulses, the resultant polycrystalline region shows crystallization's ratios similar to a PECVD developed poly-Silicon layer, with slightly larger nano-crystallite's size. Electrical characterization, by means of IV measurements, of tandem cells prepared by laser annealing was feasible after achieving a large-scale homogeneously laser-annealed area. These measurements are compared with those from PECVD prepared tandem cells and pre-annealing amorphous samples.

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16:00 **Laser Induced Fracture of Thin Glass**

Authors : A.Collins1, D.Milne2, G.M. O'Connor1
Affiliations : [1]National Centre for Laser Applications, National University of Ireland, Galway, Ireland. 2M-Solv Ltd, Langford Locks, Kidlington, Oxford, United Kingdom.

Resume : Efficient structuring of thin glass is of significant industrial interest due to the increasing popularity of touch screen displays, microfluidic, microoptic and photovoltaic applications. Glass has a good chemical resistance, high optical transparency and moderate flexibility for thicknesses <200µm. This laser based study is inspired by mechanical cutting of 100µm thick flexible glass which showed that a high standard of cutting is possible with a quality scribing tool. A scribing wheel was used to scribe the glass. The wheel applied a pressure of 6GPa causing a stress induced crack to open in the glass. The challenge of replicating this process using a laser based thermomechanical process is investigated. A laser scanned over the glass surface can cause temperature gradients in the glass substrate. Depending on the magnitude of the gradient the thermal stress caused opens a crack. Computational simulations have provided finite element analysis of the temperature and thermal stress developing dynamically. Results show a 25ns CO2 laser can, after several pulses, induce sufficient thermal stress (>500MPA) in a glass substrate to cause fracture. The effect of the beam shape, wavelength, pulse energy, pulse duration and external cooling on the glass thermal stress will be investigated and verified experimentally. An SEM can characterise the edge quality and a two point bend test can characterise the strength of the cut sample.

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16:00 **Sub-surface modification of silicon using ultrashort lasers on periodically pre-structured samples**

Authors : Thibault J.-Y. Derrien, Rémi Torres, David Grojo, Tatiana Itina, Thierry Sarnet
Affiliations : Laboratory of Lasers, Plasmas and Photonic Processes (LP3). UMR CNRS 7341 - Aix-Marseille University. Parc Scientifique et Technologique de Luminy. Case 917. 163, avenue du Luminy 13 288 Marseille Cedex 9, France

Resume : Ultrashort laser-induced modification of silicon is a process of great interest for future three-dimensional microelectronics, photodetectors and photovoltaics. Within the study of laser-induced nanostructures, sub-surface modifications of silicon have been observed by several authors. It has been proposed that the crystalline silicon is transformed into metastable polymorphic phases that could be attributed to stresses or high pressure waves [1]. Recently, it has been demonstrated that the surface morphology along with the femtosecond laser excitation of charge carriers plays an important role in the spatial modulation of the laser deposited energy [2]. In this work, we present a new possible explanation for this sub-surface modification based on an inhomogeneous absorption energy profile described by Mie scattering theory along with the free-carrier excitation. Finite Difference Time Domain (FDTD) simulations and Transmission Electron Microscopy (TEM) analysis suggest that the fs-laser-irradiated pre-structured surface acts as an assembly of microlenses which enhances the laser energy density at a micrometric range below the surface level and thus induce the local change of phase. The possibility of sub-surface modifications along with the transient change of the optical properties is thus demonstrated below the surface of nanostructured silicon. [1] M.J. Smith,

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E. Mazur et al, J. Appl. Phys. 110, 053524 (2011) [2] T. J.-Y. Derrien. Ph.D. thesis, Aix Marseille Université (Feb. 2012)

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16:00 **Molecular Orientation and Its relation to Mobility of Pentacene Films**

Authors : Chiung-Yi Chen, Deniz P. Wong, Yi-Fan Huang, Hsiang-Ting Lien, Pei-Lin Lee and Li-Chyong Chen
Affiliations : Center for Condensed Matter Sciences, National Taiwan University, Taipei, 10617, Taiwan; Institute of Atomic and Molecular Sciences, Academic Sinica, Taipei, 10617, Taiwan

Resume : Pentacene is one of the oligomer conducting materials used in small molecule organic optoelectronic devices. In this report, we are interested in the dependence between molecular orientations and mobility of pentacene on different substrates. The morphology, crystal phase and molecular vibration mode are identified by AFM, XRD and Raman spectroscopy, respectively. From XRD result, the (022) peak indicates a horizontal alignment with the graphene substrate, compared with (001) peaks which orients vertically on dielectric substrate. Raman spectra of pentacene on graphene substrate show a long axis vibration mode that does not appear on the dielectric substrate. In addition, we are trying to determine why pentacene molecules orient itself at certain direction with respect to graphene by doing polarization Raman spectroscopic measurements. Finally, the mobility correspond to different molecular orientation have demonstrated through conducting-AFM. These results provide a direct evidence that pentacene orients in the perpendicular direction with respect to the dielectric substrate, whereas it is parallel on graphene substrate. The effects of strong molecule−substrate such as standing-up and lying-down molecules on different substrates have also been discussed based on the fact that they enable to determine the charge transport and mobility properties. By understanding the fundamental properties of a material system, we may be able to make improvements for future applications.

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16:00 **Achieving invisibility and illusion optics by dielectric-annulus-based metamaterials**

Authors : Jian-Hui Lin, Tsung-Yu Huang
Affiliations : National Tsing Hua University, Department of Materials Science and Engineering

Resume : We proposed an experimentally available invisible innovative cloak which can cloak objects, at the same, it still enables visions and movements of the objects. The innovative cloak is composed of twelve layers of dielectric-annulus-based metamaterials in order to reduce the ohmic losses from metallic metamaterials and also to avoid the influence cause by the manual misalignment when discrete dielectric metamaterial resonators are used. The entire cloak structure was simulated by CST Microwave Studio. The simulation result showed the ability of the innovative cloak to reconstruct the electric field wavefronts behind the cloak and to reduce the backscatterings in the reflected direction. In addition to the cloaking effect, we demonstrated that illusion optics can also be achieved based on the structure of this dielectric-annulus-based metamaterial cloak.

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16:00 **Free carrier density related piezoelectric property in pulsed-laser-grown Pd-doping ZnO film**

Authors : Wang Rui ,Qin Wei Wei,, Li Tao, Gao Zhi Qiang, Hu Xue Feng, Xu Meigui, Huang Shengming, Liang Qi, and Wei Zhang,*
Affiliations : a State Key Laboratory of Material-oriented Chemical Engineering and School of Chemical Engineering, Nanjing Tech University, Nanjing, Jiangsu 210009, PR China b School of Physical Science, Hefei University of Technology, Hefei, Anhui 230009, PR China

Resume : The fundamental principle of ZnO nanogenarator is to utilize the environmental mechanical energy, which is available from irregular vibrations and human activity with a wide spectrum of frequencies and time-dependent amplitudes. The prototyping of a recent nanogenarator by means of ZnO piezoelectric nanowire (NW) arrays have demonstrated to able to drive micro-sensor and in micro-power range. However so far the power output from NW nanogenarator is still below micro watt, which is far away from milli-power output source requested by most applications of individual sensor. The mechanism understanding of piezo-electric conversional in ZnO material and device is crucial to further boost power output. In this paper, the Pd-dopied ZnO films grown by pulsed-laser deposited (PLD) in the Pd doping range of 0.01-0.05% are investigated. The grown films are structurally characterized by XRD,

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SEM and AFM. The piezoelectric properties of these films are characterized by Piezoelectric Force Microscopy (PFM). The free-carrier density is characterized by CV and Hall-effect station. It is found that the piezoelectric properties of the films are strongly dependent on free-carrier density. The observed corresponds of piezoelectric (PE) property to grain size is also theoretically explained by the combination mechanism of free-carrier and static-charge.. *Corresponding author, zhangw@njut.edu.cn

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16:00 **Biodegradable Silk Fibroin/Poly(3-Hydroxy-Butyric Acid-Co-3-Hydroxy-Valeric Acid) composite coatings obtained by MAPLE and dip-coating methods**

Authors : F.M. Miroiu1, N. Stefan1, A. Visan1, O.L. Rasoga2, I. Zgura2, C.Nita1, A. Stanculescu2, G. Dorcioman1, R. Cristescu1, I. N. Mihailescu1, G. Socol1
Affiliations : 1National Institute for Lasers, Plasma, and Radiation Physics, 409 Atomistilor 077125, Magurele - Bucharest, Romania; 2 National Institute for Materials Physics, 105 Atomistilor 077125, Magurele - Bucharest, Romania

Resume : Composite (silk fibroin – poly(3-hydroxybutyric-acid-co-3-hydroxyvaleric-acid)) SF-PHBV biodegradable coatings were deposited by Matrix Assisted Pulsed Laser Evaporation (MAPLE) and dip–coating (DC) methods, comparatively, studying their physico-chemical properties, as a first step of applicability in the local controlled release for tissue engineering or regeneration. Both SF and PHBV are natural biopolymers with excellent biocompatibility, but different degradability and tensile strength properties, herewith combined for attending targeted biomedical uses. The stoichiometric transfer of the composite thin films was demonstrated by FTIR spectra, which proved that all, MAPLE and dip-coating films preserved the chemical composition of constituent materials. The amides absorption maxima of fibroin indicated the amorphous (random coil) form. XRD revealed the partial crystalline PHBV polymer phase and in the mean time confirmed the predominantly SF amorphous presence. The SEM images showed that all films are relatively uniform, including droplets in case of the MAPLE ones. The wettability measurements showed composite films as highly hydrophilic surfaces, with the increase of PHBV component conferring a more resistant behaviour and a slight decrease of hydrophilicity. These results provide supportive information for release applications, where degradation rate may be tuned by controlling different composite material characteristics, mainly mixture ratio and crystalline status.

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16:00 **PINPIN a Si:H based structures for X-Ray image detection using the laser scanning technique**

Authors : M. Fernandes 1,2, Y. Vygranenko 1,2, M. Vieira 1,2
Affiliations : 1-Electronics, Telecommunications and Computer Engineering Department, ISEL, Lisbon, Portugal 2-CTS-UNINOVA, 2829-516 Caparica, Portugal

Resume : Conventional film based X-Ray imaging systems are being replaced by their digital equivalents. Different approaches are being followed by considering direct or indirect conversion, with the later technique dominating. The typical, indirect conversion, X-Ray panel detector uses a phosphor for X-Ray conversion coupled to a large area array of amorphous silicon based optical sensors and a couple of switching thin film transistors (TFT). The pixel information can then be readout by switching the correspondent line and column transistors, routing the signal to an external amplifier. In this work we present an alternative approach, where the electrical switching performed by the TFT is replaced by optical scanning using a low power laser beam and a sensing/switching PINPIN structure, thus resulting in a simpler device. The optically active device is a PINPIN array, sharing both front and back electrical contacts, deposited over a glass substrate. The spectral response of each pin structure was optimized for green or blue sensitivity depending on their function. During x-ray exposure, each glass side diode collects photons generated by the scintillator screen (560 nm), charging its internal capacitance. Subsequently a laser beam (445nm) scans the switching diodes (back side) retrieving the stored charge in a sequential way, reconstructing the image. The transient response of the device is presented and compared to an electrical simulation performed with the proposed device model.

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16:00 **Space- and time-resolved optical emission spectroscopy of transient plasma generated by ns and fs laser ablation of Pr- and Er-doped GaLaS**

Authors : G. Dascalu1, O. Pompilian2,3, S. Gurlui1, P. Nemec4, C. Focsa2
Affiliations : 1Faculty of Physics, University "Al. I. Cuza", 700506 Iasi, Romania; 2Laboratoire de Physique des Lasers, Atomes et Molécules (UMR CNRS 8523), Université

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Lille 1 Sciences & Technologies, 59655 Villeneuve d'Ascq, France ; 3National Institute for Lasers, Plasma and Radiation Physics, PO-Box MG-36, Ro-77125 Magurele-Bucharest, Romania; 4Faculty of Chemical Technology, University of Pardubice, Studentska 573, 53210 Pardubice, Czech Republic

Resume : An important step in optimizing the growth process of Pr and Er doped GaLaS (GLS) thin films by laser ablation is to study the properties of the plasma formed after the interaction of laser radiation-bulk material. The induced plasma expansion was investigated through time- and space-resolved optical emission spectroscopy and fast gate ICCD imaging. For target ablation we used two types of lasers with different pulse durations (ns and fs) and repetition rates (10Hz and 1kHz). The ICCD sequential snapshots of the spectrally unresolved plasma of Er and Pr doped GLS revealed the formation of a single plasma structure but with different dynamics as the temporal regime is changed. From the space–time evolution of spectral lines intensities we determined the velocities of various species and also the variation of the excitation temperature and electronic density. In some cases, the unusual higher velocities of atoms compared to ions suggest the presence of different recombination, excitation and ionization mechanisms or radiative processes during plasma expansion. Periodic oscillations of both excitation temperature and electronic density were observed with periods of 130ns and 100ns for the Er:GSL and Pr:GLS respectively.

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16:00 **Formation of femtosecond laser-induced periodic surface structures on crystal planes with different orientations**

Authors : Xxx Sedao, Claire Maurice, Florence Garrelie, Jean-Philippe Colombier, Stéphanie Reynaud, Romain Quey, Florent Pigeon
Affiliations : Université de Lyon, CNRS, UMR5516, Laboratoire Hubert Curien, Université Jean Monnet, F-42023 St-Etienne, France; Ecole Nationale Supérieure des Mines de Saint -Etienne, Laboratoire Georges Friedel, CNRS, UMR5307, 42023 St-Etienne, France

Resume : The formation of laser-induced periodic surface structures (LIPSS) has been widely observed following solid target irradiation with ultrashort laser pulses. The interference between incident laser and a surface scattered/diffracted wave leads to inhomogeneous energy deposition at the illuminated surface. The material response also contributes to LIPSS formation through relaxation and self-organization. Surface planes with different crystal orientations possess different densities of surface atoms, surface energies and potential bonding sites, therefore these planes respond differently to the energy absorption, which may consequently play a role during LIPSS formation. The present study shows the influence of crystal orientation on LIPSS formation. Electron Backscatter Diffraction (EBSD) characterization has been exploited to provide structural information within the laser spot on irradiated samples to determine the dependence of LIPSS formation upon the crystal orientation. The results provide experimental evidence that laser-induced lattice damage, the formation of LIPSS and crystal orientation are highly correlated. Significant differences on crystal planes with different orientations are observed at low-to-medium number of laser pulses at low fluence regime, outstandingly for (111)-oriented surface which favors dislocation storage rather than LIPSS formation.

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16:00 **Influence of the liquid level and duration of the ablation process on the characteristics of nanostructures created by nanosecond laser ablation of Ag and Au in water**

Authors : A.S. Nikolov1*, R.G. Nikov1, N.N. Nedyalkov1, P.A. Atanasov1, M.T. Alexandrov2, D.B. Karashanova3, N. E. Marinkov4 I. Z. Dimitrov4, and I. I. Boevski4
Affiliations : 1Institute of Electronics, Bulgarian Academy of Sciences, Tzarigradsko Chaussee 72, Sofia 1784, Bulgaria 2Institute of Experimental Pathology and Parasitology, Bulgarian Academy of Sciences, G. Bonchev Street, bl. 25, Sofia 1113, Bulgaria. 3Institute of Optical Materials and Technologies, Bulgarian Academy of Sciences, G. Bonchev Street, bl. 109, Sofia 1113, Bulgaria. 4Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev Str.,bl.11, 1113, Sofia, Bulgaria.

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Resume : Nanosecond pulsed laser ablation of Au and Ag targets in water was utilized to prepare noble metal nanostructures – nanoparticles and nanowire networks. The fundamental (λ = 1064 nm), the second (λ = 532 nm) and the third (λ = 355 nm) harmonics of a Nd-YAG laser system were used for their fabrication. The duration of the ablation process was varied to optimize the fabrication conditions for both materials. It was interrupted after 5, 10, 15, 20, 25 min respectively and the mass concentration of the nanostructures in the colloid were measured. This enabled us to establish the dependence of the

ablation rate on the concentration. The effect of the liquid pressure on the characteristics of the different nanostructures was investigated by changing the liquid level over the corresponding target. Five different values were utilized of the water level above the target surface (5, 10, 15, 20, 25 mm) at a constant liquid volume and duration of the ablation process (10 min) and different laser fluencies. Images obtained by transmission electron microscopy were used to visualize the morphology of the nanostructures produced. The profile of the optical extinction spectra of the colloids was helpful in assessing the state of the solid phase and the morphology of the material. To explain the differences in the spectra profiles, theoretical simulations were used of the extinction cross-sections for free nanoparticles and for aggregates of interacting nanoparticles.

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16:00 **Nanoindentation and polarised Raman spectroscopy of extruded polyamide films, modified by short pulse laser radiation**

Authors : L. Kidney1, E Keehan2, G. M. O'Connor1
Affiliations : 1NCLA/Inspire Laboratories, School of Physics, National University Galway, University Road, Galway, Ireland; 2Creganna Tactx Medical, Parkmore Industrial Estate, Galway, Ireland

Resume : A greater understanding of laser-polymer interactions at molecular level is desired in order to optimise properties of laser structured polymer materials. Nano hardness testing (NHT) has been used to analyse the changes in mechanical properties of extruded polyamide polymer films as a result of laser modification. Polyamide films were modified by applying pulses of 500fs duration in the ultraviolet (UV) and infrared (IR) range close to threshold fluence. NHT experiments were conducted on the modified surface and compared with unmodified material. An increase in both stiffness and hardness measurements as a result of laser modification was observed. The increase was found to be higher in the material modified at the UV wavelength compared to the IR wavelength. Polarised Raman spectroscopy has been used to correlate differences in mechanical properties with changes in molecular structure. The scattering spectra for four different combinations of incident and scattered polarisation were analysed indicating the result of laser modification. The ω (CH2) region was determined to be the most sensitive to changes in the polymer chain environment. The depolarisation ratio is examined in order to understand the configuration of the molecule and changes to this parameter are mapped across the surface of the modified polymers. These results are useful for advancing the use of short pulse lasers in the structuring of polymer materials and the realisation of polymer devices.

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16:00 **Study of the aging process of noble metal nanostructures created by pulsed laser ablation in water**

Authors : R.G. Nikov1, A.S. Nikolov1, N.N. Nedyalkov1, E.L. Pavlov, P.A. Atanasov1, M.T. Alexandrov2 and D.B. Karashanova3
Affiliations : 1Institute of Electronics, Bulgarian Academy of Sciences, Tzarigradsko Chaussee 72, Sofia 1784, Bulgaria; 2Institute of Experimental Pathology and Parasitology, Bulgarian Academy of Sciences, G. Bonchev Street, bl. 25, Sofia 1113, Bulgaria; 3Institute of Optical Materials and Technologies, Bulgarian Academy of Sciences, G. Bonchev Street, bl. 109, Sofia 1113, Bulgaria.

Resume : Colloids of noble metal nanostructures were produced by pulsed laser ablation of solid targets in water. The fundamental (λ = 1064 nm), the second (λ = 532 nm) and the third (λ = 355 nm) harmonics of a Nd:YAG laser system were utilized in the ablation process. Sedimentation and aggregation of the nanoparticles produced were studied by measuring the optical extinction spectrum of the colloids, which were stored in a cuvette at a constant temperature for this purpose. The optical extinction spectra were taken at different heights of the cuvette and their changes at different time periods after fabrication were traced. They were used to assess the aging process of the colloids expressed in sedimentation and aggregation of the nanostructures. To visualize these two processes, transmission electron microscopy was used. The influence of the aggregation on the optical properties of the colloids was evaluated by theoretical simulations of their optical extinction spectra. Ultrasonic treatment of the colloids was applied to achieve modification of the already created clusters and recover the optical properties of the colloids as closely as possible similar to these on the day of preparation. As a result, some of the aggregates were completely disintegrated while others fragmented into smaller ones. The aim was to establish the optimal storage conditions of the colloids in view of preserving their characteristics.

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16:00 **Production of silver nanoparticles by ultra-short pulsed laser ablation in nanoporous aqueous silica colloidal solutions**

Authors : A. Guarnaccio (1), Á. Szegedi (2), J. Valyon (2), S. Orlando (1), A. De Stefanis (3), A. De Bonis (4), R. Teghil (4), M. Sansone (4), A. Santagata (1)
Affiliations : 1) UOS Tito, Institute of Structure of Matter – CNR, C/da S. Loja, 85050 Tito Scalo (PZ), Italy; 2) Research Centre for Natural Sciences, Institute of Materials and Environmental Chemistry, Hungarian Academy of Sciences, 1025 Budapest,Pusztaszeriút 59-67, Hungary; 3) UOS Montelibretti, Institute of Structure of Matter – CNR, Rome Research Area-CNR, Via Salaria Km 29, 300, Monterotondo, Rome 00016, Italy; 4) Università degli Studi della Basilicata, Dipartimento di Scienze, Via dell'Ateneo Lucano 10 -85100, Potenza, Italy

Resume : Laser ablation of materials in Liquid has been demonstrated to be a versatile technique for nanoparticles production. The ablation of metal plates in solution has shown this peculiar ability whose scientific interest has been widely growing up during the last years. In this work the Laser Ablation in Liquid technique has been used for producing silver nanoparticles confined in hexagonally ordered mesoporous SBA-15 and MCM-41 silica materials. The goal of inserting Ag nanoparticles within the silica structure has been pursued recently for enhancing the catalytic suitability of such materials. With this aim silver nanoparticles have been generated by using a 100 fs, 800 nm Ti:Sa pulsed laser beam in confined nanoporous silica MCM-41 and SBA-15 water solutions. Polidispersion nanoparticle distributions were characterized by UV-Vis spectroscopy and the features were related to the preparation method of the colloidal solution as well as the laser beam parameters used. Furthermore, the obtained Ag nanoparticles dispersed within the nanoporous silica network was accomplished by XRD, SEM and TEM characterizations. A significant amount of 5 nm size silver nanoparticles, in the form of metallic silver (Ag0) can be obtained by a suitable selection of the laser ablation in liquid condition used. The work performed shows that the choice of the experimental parameters employed for laser ablation in aqueous silica suspension can affect dimension distributions of the obtained nanoparticle.

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16:00 **Laser Sintering of Magnesia with Nanoparticles of Iron Oxide and Aluminum Oxide**

Authors : L.V.García1, T. K. Das Roy1, G.A. Castillo1, S.Shaji1, 2
Affiliations : 1 Facultad de Ingenieria Mecanica y Electrica, Universidad Autonoma de Nuevo Leon, Av. Pedro de Alba, s/n Cd. Universitaria, San Nicolas de los Garza, Nuevo Leon, Mexico, 66451. 2 CIIDIT- Universidad Autonoma de Nuevo Leon, Apodaca, Nuevo Leon, Mexico.

Resume : Laser sintering is a rapid manufacturing technique used in ceramic and metal industries. Nanoparticles of Iron Oxide (Fe2O3, 20-40 nm), Aluminum Oxide (Al2O3, 50 nm), were mixed in different concentrations (3 and 5 wt %) in a Magnesium Oxide matrix. The powder mixture was compacted to pellets and irradiated with 532nm output of an Nd: YAG laser using different parameters (laser fluence, scanning speed, and irradiation time) for sintering. The refractory samples obtained were studied using X-Ray Diffraction, Scanning Electron Microscopy with Energy Dispersive X-ray Analyzer, Atomic Force Microscopy and X-Ray Photoelectron Spectroscopy. The results showed that the samples with concentrations of 3 and 5wt% of Fe2O3 presented the MgFe2O4 spinel-type phase after irradiation. With the addition of Al2O3-nanoparticles there were formations of MgAl2O4 spinel phase. The changes in morphologies and microstructures of MgO matrix with nanoparticles of Fe2O3 and Al2O3 due to laser sintering were analyzed.

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16:00 **Non-thermal and thermal phase transitions in tungsten – a theoretical study**

Authors : Y. Giret 1,2, S. L. Daraszewicz 2, D. M. Duffy 2, A. L. Shluger 2, and K. Tanimura 1
Affiliations : 1 The Institute of Scientific and Industrial Research (ISIR), Osaka University, 8-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan, 2 London Centre for Nanotechnology, Department of Physics and Astronomy, University College London (UCL), Gower Street, WC1E 6BT, London, UK

Resume : Tungsten is a candidate material for the divertor component in future fusion reactors. Nonetheless, its response to fierce reactor conditions, and in particular to the effect of strong electronic excitations on structural stability, are not yet fully understood. We present a combined ab-initio and two-temperature molecular dynamics study investigating different phase transitions of tungsten as a function of electronic temperature (Te) in an electron-ion non-equilibrium condition – a state that can be achieved with an ultra-short laser pulse

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irradiation. Our static ab-initio calculations of phase energetics and phonon spectra point to a non-thermal bcc-fcc phase transition at Te = 1.7 eV, which we report for the first time. Through two-temperature molecular dynamics, we investigate the dynamics of melting following electronic excitation induced by an ultra-short laser pulse. By calculating the electron-phonon coupling ab-initio combining the methods of Allen and Zhigilei we can estimate whether the electron-ion relaxation time allows for a meta-stable phase of fcc tungsten to be produced by laser irradiation. Finally, our two-temperature molecular dynamics study puts electronic temperature and hence laser fluence limits on the heterogeneous/homogeneous thermal and non-thermal melting transitions.

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16:00 **Photothermally induced bromination of carbon/polymer bipolarplate materials for fuel cell applications**

Authors : Martin Schade 1,2, Steffen Franzka 1,2, Nils Hartmann 1,2
Affiliations : 1 Fakultät fuer Chemie, Universität Duisburg-Essen, 45117 Essen, Germany; 2 CENIDE - Center for Nanointegration Duisburg-Essen, 47048 Duisburg, Germany

Resume : Water management remains a challenging problem in common hydrogen oxygen fuel cells [1]. In particular, during operation, condensation of water in the channel structure of the bipolar plates eventually blocks the gas flow and results in intermittent power losses. An approach in order to tackle this problem is the modification of the wettability of the bipolar plate material through laser chemical processing. Here we use a simple photothermal procedure for direct functionalization of carbon/polymer bipolarplate material. Through irradiation with a focused beam of an argon ion laser at λ = 514 nm in gaseous bromine local bromination of carbon/polymer material takes place. For characterization x-ray photoelectron microscopy and labeling techniques are employed. Subsequently, bromine groups can easily be substituted by other chemical functionalities, e.g. amine groups. This provides a facile approach in order to fabricate gradient structures and surface patterns with alternating hydrophilic/hydrophobic wetting characteristics. Mechanistic aspects and prospects of photothermal routines in micro- and nanofabrication of carbon/polymer materials are discussed. [1] M. Schade, S. Franzka, A. Schröter, F. Cappuccio, M. Gajda, V. Peinecke, A. Heinzel, N. Hartmann, Surface and Coatings Technology (2013), DOI:10.1016/j.surfcoat.2013.12.037

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16:00 **Characterization of hard coatings produced by laser cladding using laser-induced breakdown spectroscopy technique**

Authors : V. Piñon, J.M. Amado, A. Varela, M.J. Tobar, M. Mateo, A. Yañez, G. Nicolas
Affiliations : Universidad de A Coruña, Laboratorio de Aplicaciones Industriales del Láser, Campus de Ferrol, Spain Tel.: +34 981337400x3274; fax: +34 981337410; gines@udc.es

Resume : Protective coatings with a high abrasive wear resistance can be obtained from powders by laser cladding technique, in order to extend the service life of some industrial components. So this work was devoted on one hand, to produce laser clad layers of self-fluxing NiCrBSi alloy powder mixed with WC powder on stainless steel substrates of austenitic type (AISI 304) and on the other hand, to employ the laser-induced breakdown spectroscopy (LIBS) technique to chemically characterize these clad layers. With the suitable laser processing parameters (mainly output power, beam scan speed and flow rate) and powders mixture proportions between WC ceramics and NiCrBSi alloys, dense pore free layers have been obtained on single tracks, on large areas with overlapped tracks and on multiple layers. In this last case, a material with concentration gradient has been produced applying different proportions of WC particles through the coating. The results achieved by LIBS technique allowed us to determine the chemical composition of these coatings and was particularly interesting for multiple layers with different concentrations where the LIBS rasters performed on cross-sections allowed to discriminate the thicknesses of the different layers. Moreover the LIBS signals were correlated with the hardness measurements on these materials showing their dependence.

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16:00 **Hydrodynamic instabilities and ablation phenomena under the laser melting of powder layers**

Authors : Yuri Chivel
Affiliations : MerPhotonics 42100, Saint Etienne, France

Resume : Hydrodynamic instabilities and ablation phenomena under the laser melting of powder layers Yu.Chivel MerPhotonics , 42100 Saint Etienne,France Laser ablation under the action of laser is a well-known and well-studied

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phenomenon. Several different mechanisms are responsible for the material removal, among them is thermal evaporation that is studied in details. Nano- and micron-sized particles are observed at the early stage of the laser–target interaction. At present several mechanisms of particles release in pico – millisecond laser ablation are proposed assuming that most processes are related to initiation and decay of the metastable states. Alternative mechanism of laser ablation could be based on initial heterogeneity of the near surface layer of irradiated material. The destruction of near surface layers is influenced by structural inhomogeneties of solids. The process of melting of the of the thick metal powder layers has been conducted under full temperature control using a calibrated pyrometer and CCD camera. Layer 10x10 mm in square was scanned at a speed of 100 mm / s by spot 70 µm at scan shift 30 µm, which ensured the creation of a thin layer of the melt. Experimentally emission of dispersed particles from the surface of the overheated melt has been established. Measured particle temperature corresponds to the temperature o

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16:00 **Tailored Localized Surface Plasmon Resonance of noble metal thin films by single pulse Laser Annealing under a pressurized inert environment**

Authors : N. Kalfagiannis1, L. Bowen2, W.M. Cranton1, P. Patsalas3 and D.C. Koutsogeorgis1,*

Affiliations : 1School of Science and Technology, Nottingham Trent University, NG11 8NS, Nottingham, UK; 2G. J. Russell Microscopy Facility, University of Durham, South Road, Durham, DH1 3LE, UK; 3Department of Physics, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

Resume : In this work Ag and Au thin films (5-10 nm in thickness), grown by RF Magnetron Sputtering were subjected to Laser Annealing (LA), using pulsed UV laser sources; thus transforming the as grown layers to nanoparticles of various sizes and shapes. A systematic study over the applied laser wavelength, fluence and sample environment pressure is presented for a single pulse process. A key feature for a potential future large scale processing is simplicity and speed for high capacity and low fabrication costs; thus our motivation to study LA effects with only one single pulse. We used two laser sources, ArF (193 nm) and KrF (248 nm), and varying fluences (up to 1 J/cm2). A pressure cell was used to study the effect of LA whilst the sample is pressurized with an inert gas (up to 10 bar) and comparisons with experiments conducted under ambient atmosphere were made. The derived nanostructures were evaluated in terms of their topography employing Atomic Force Microscopy and their plasmonic behavior employing Optical Reflectance Spectroscopy (ORS). In summary we report the influence of the laser annealing parameters on tailoring the structural and optical properties of the NPs that are derived by nanostructuring thin metal films of Ag and Au. Acknowledgements: The research leading to these results has received funding from the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme (FP7/2007-2013) under REA grant agreement n° PIEF-GA-2012-330444.

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16:00 **Understanding photophysical effects : NPLIN on glycine, L - Histidine and D, L - glutamic acid**

Authors : Bertrand Clair, Aziza Ikni, Stephane Veesler, Philippe Scouflaire, Anne Spasojević-de Biré

Affiliations : Laboratoire Structures Propriétés et Modélisation des Solides, UMR 8580, Grande Voie des Vignes, 92295 Chatenay Malabry Cedex; Laboratoire Structures Propriétés et Modélisation des Solides, UMR 8580, Grande Voie des Vignes, 92295 Chatenay Malabry Cedex; Centre interdisciplinaire de nanoscience de Marseille, UPR 3118, campus de Luminy case 913, 13288 Marseille cedex 9; Laboratoire Energie MacroMoléculaire et Combustion, UPR 288, Grande Voie des Vignes, 92295 Chatenay Malabry Cedex; Laboratoire Structures Propriétés et Modélisation des Solides, UMR 8580, Grande Voie des Vignes, 92295 Chatenay Malabry Cedex

Resume : Since decades, dramatic efforts have been done in order to understand nucleation processes using model molecules like glycine, the simplest amino acid. Glycine can be crystallized using different methods. One of them NPLIN (Non Photochemical Light Induced Nucleation) allows a selective crystallization of polymorph in a particular range of Supersaturation. Non Photochemical Light Induced Nucleation is a growing field of studies since 1996 with more than 40 compounds including organic, inorganic and proteins probed in several conditions (solvents, LASER types, different beams …). The issues using this technique are huge, in particular polymorphic control and this selective crystallization is able to be used in pharmaceutics industry. Such objectives require carefully designed experimental setup to highly controlled

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parameters such as for example temperature and energy density and reducing uncertainty on the origin of nucleation combined with a strict experimental protocol based on the measurement of solubility and metastable zone of studied compounds. We report a new experimental setup designed to study Non Photochemical Light Induced Nucleation and we illustrate the different functionalities of our device through results on glycine. In the case of glycine crystals obtained through NPLIN nucleate at the meniscus and exhibit different morphologies. Nucleation efficiency as a function of the supersaturation and the energy density has also been established on a large number of samples in the same conditions. We show the crystallization behavior and the different crystal habit output according to energy densities and polarization. Furthermore, we will report new results about NPLIN on L - (+) - Histidine in light and heavy water together with L and D glutamic acid in light water. Since solubilities curve are an important factor in our field, we have measured the solubility of glycine in light and heavy water together with the solubility of L - (+) - Histidine in light and heavy water. It is the first time that solubility of L - (+) - Histidine is reported in heavy water.

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16:00 **Characterization of periodic nanostructures in 355nm and 1064nm ps and 1030nm fs laser-irradiated electroplated Cu films**

Authors : George Vakanas, Geert Van Steenberge, Antonios Florakis, Bjorn Vandecasteele, Ingrid De Wolf
Affiliations : Intel Corporation, 5000 W. Chandler Blvd, Chandler, Arizona 85226, USA; imec, Kapeldreef 75, B-3001 Leuven (Heverlee), Belgium, MTM, Faculty of Engineering, Kasteelpark Arenberg 44, B3001 Leuven (Heverlee), Belgium

Resume : Periodic, ultrafine-grained nanostructures on metallic films by laser irradiation have been reported in the literature before [1, 2], although with different motivations and process parameters. Our motivation is driven by 3D stacking technologies which require new ways to modulate Cu solid-state reaction kinetics and potentially faster diffusion creep bonding [3]. The current study involves the irradiation of ~2.5□m-thick electroplated Cu flat films, deposited on silicon wafer coupons, with 355nm, 1064nm ps and 1030nm fs sources and ~20□m spot size. Laser fluences at the Cu surface ranged from 18-2000 mJ/cm2, 210-1129 mJ/cm2 and 487-2268 mJ/cm2 for the 3 above wavelengths respectively. The samples processing took place in air (no closed chamber or special inert or chemical atmospheres) so oxidation is expected and characterized both (i) after irradiation and (ii) after microwave Ar/H2 plasma cleaning of the samples. Optical microscopy (OM), scanning electron microscopy (SEM), X-ray Photoelectron Spectroscopy (XPS) and micro-Raman spectroscopy results are presented. A literature comparison is discussed along with an outlook on future research recommendations.

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16:00 **Comparison of pulsed laser treated glassy carbon surfaces by spectroscopic ellipsometric and Raman spectroscopic investigations**

Authors : J. Csontos 1, Z. Pápa 1, M. Füle 2, J. Budai 1, Z. Toth 2
Affiliations : 1: University of Szeged, Department of Optics and Quantumelectronics, H-6701 Szeged Dóm tér 9., Hungary; 2: University of Szeged, Department of General and Environmental Physics, H-6720 Szeged, Boldogasszony sgt. 6., Hungary

Resume : Glassy carbon was ablated by high intensity laser pulses in air atmosphere. Two KrF lasers with different pulse lengths (18 ns and 480 fs, 248 nm), an ArF (20ns, 193 nm), and a frequency doubled Nd:YAG laser (8 ns, 532 nm) were applied to irradiate the surface of glassy carbon targets at ~1 J/cm2 fluences. The ablated areas were investigated by spectroscopic ellipsometry, which showed the appearance of a modified layer. In the case of the ns lasers the thickness of this layer was in the range of 40-120 nm, while in the case of fs laser it was 15 nm. In all cases the refractive indices of the treated areas slightly decreased compared to n of glassy carbon. Increase in extinction coefficient (k) was observed in the case of ArF treatment, while the values of k were decreased slightly in the cases of KrF lasers and significantly in the case of Nd:YAG laser treatments. The structural changes were monitored by Raman spectroscopy. The characteristic D and G peaks in Raman spectra were widened due to appearance of an amorphous phase. This widening has the smallest extent in the case of ArF and the highest in the case of Nd:YAG laser treated samples, respectively. Both Raman spectroscopy and spectroscopic ellipsometry indicate that the ArF treated samples have graphitic character and highest sp3 bond content is due to Nd:YAG laser ablation. These results are interpreted in the frame of numerical simulations concerning the temperature modifications due to laser irradiation.

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16:00 **Laser induced epitaxy of polycrystalline silicon films on glass substrates**

Authors : P. Prathap *, Z. Said-Bacara, A. Slaouia, C. Klimmb, C. Beckerb, F. Mermetc, A. Bahoukac
Affiliations : aInESS, CNRS-UdS, Strasbourg Cedex-2, France. bHelmholtz Zentrum Berlin für Materialien und Energie, Institute Silicon Photovoltaics, Kekuléstr. 5 12489 Berlin, Germany cIREPA LASER, Parc d'Innovation Pôle API, ILLKIRCH-GRAFFENSTADEN, FRANCE

Resume : In the present investigation, epitaxial growth of silicon films was carried out on poly-Si seed layers, which were grown by aluminium induced crystallization (AIC) on glass, using CW infrared laser annealing. The seed layers were RCA cleaned before the deposition of a-Si precursor using electron cyclotron resonance plasma enhanced chemical vapour deposition (ECR-PECVD) at 250oC. The films were characterized by elastic recoil detection analysis (ERDA) to evaluate the hydrogen content, and the analysis showed that the films contain a high concentration of hydrogen (~10 at. %). The laser crystallization process in solid phase regime resulted in crack free films while the surface is cracked in liquid phase regime. The microstructural quality and grain size distribution of laser annealed epitaxial layers showed a strong dependence on the gas mixtures (SiH4/Ar/H2) used to deposit a-Si precursor used for epitaxy. However, the layers showed a strong (100) orientation similar to the seed layer as observed from electron backscatter diffraction (EBSD) analysis. The average grain size of the epitaxial layers is found to be superior to 7 µm with a wide range of distribution from 1 µm to 30 µm. The texture of the epitaxial films was not affected by the film thickness but merely the average grain size. The laser scanning speed and its power are shown to have significant effects on the silicon crystallized fraction.

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16:00 **Investigation into removal pathways during nanosecond pulsed laser ablation of Li-ion battery electrodes**

Authors : Adrian Lutey*, Maurizio Fiorini^, Alessandro Fortunato*, Alessandro Ascari*
Affiliations : *Dipartimento di Ingegneria Industriale, Università di Bologna; ^Dipartimento di Ingegneria Civile, Chimica, Ambientale e dei Materiali, Università di Bologna

Resume : Multi-layer Li-ion battery electrodes for automotive applications have been exposed to nanosecond pulsed laser radiation of wavelength 1064 nm, following which Raman spectroscopy of ablated areas has been utilised to highlight changes in chemical composition and structure resulting from the ablation process. Anodes of thickness 110 micron and structure graphite-copper -graphite and cathodes of thickness 120 micron and structure LiFePO4-aluminium-LiFePO4 have been translated at velocities of 100 mm/s and 1 m/s under the laser beam with pulse fluence in the range 4-40 J/cm^2. Exposures executed at high velocity and low fluence lead to interaction with the upper coating layers only, whilst those at low velocity and high fluence lead to partial or complete ablation of the complete structures. Raman spectroscopy of virgin and redeposited material in each case has provided insight into the chemical reactions of the coating materials, suggesting possible thermodynamic pathways to ablation. Though the ablation behaviour of aluminium, copper and graphite are relatively well documented, little has been reported to date regarding that of LiFePO4. The proposed description of the process has allowed the extension of an existing single-pulse ablation model to materials typical of Li-ion battery electrodes; ultimately providing the necessary information for development of a complete process simulation.

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16:00 **Laser printing of copper nanoparticles ink and laser sintering of silver ink patterns**

Authors : M. Makrygianni1, I. Theodorakos1, D. Karnakis2, I. Zergioti1
Affiliations : 1National Technical University of Athens, Physics Department, Zografou Campus Greece, 15780 2 Oxford Lasers Ltd, Unit 8, Oxfordshire, OX11 7HP, United Kingdom

Resume : Laser Induced Forward Transfer (LIFT) of metallic nanoparticles (NPs) ink is receiving growing interest for the printing of uniform and well-defined conductive patterns. To date, Ag, and Cu inks have been studied as promising materials, since they exhibit high conductivity and low temperature processability. Laser sintering process of metallic inks has been widely studied, as it involves low temperature sintering process which enables a high-resolution patterning and minimizes the heat-affected zone and the thermal damage to the substrate, compatible with organic electronics. In this work, a nanosecond

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Nd:YAG laser was employed for the printing of copper nanoparticles (Cu NPs) ink by means of the LIFT process. The donor substrates were prepared by spin coating the Cu NPs ink on quartz and Ti coated quartz substrates in order to optimize the printing conditions for achieving printed droplets with a well-controlled diameter and shape. Additional, laser sintering process of silver NPs inks a comparison study between different laser sources (ps, ns and CW) was performed. The laser experimental work was combined with simulation of the sintering process, in terms of temperature distribution evolution. It was found that with the use of shorter pulses the temperature distribution was restricted in the ink layer without affecting the substrate underneath. The morphology and thickness of the printed Cu droplets and of the sintered Ag lines were investigated by optical, SEM and AFM microscopy. Electrical characterization measurements were also performed on both cases to demonstrate the fabrication of low resistivity electrodes for flexible electronics devices.

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Laser interaction with advanced materials: fundamentals and applications

26 May 2014 | 27 May 2014 | 28 May 2014 | 29 May 2014 | **30 May 2014**

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start at	Subject	Num.
	Laser surface nano & micro-structuring I : J.Bonse	
08:30	**Ab initio determination of transient electronic properties of an ultrafast laser irradiated metal surface. Consequences for LIPSS formation (Invited)** **Authors :** E. Bévillon, J.-P. Colombier, V. Recoules, R. Stoian **Affiliations :** Université de Lyon, F-42023, France, CNRS, UMR5516, Laboratoire Hubert Curien, Université Jean Monnet, 42000 St-Etienne, France ; Université de Lyon, F-42023, France, CNRS, UMR5516, Laboratoire Hubert Curien, Université Jean Monnet, 42000 St-Etienne, France ; CEA DIF, F-91297 Arpajon, France ; Université de Lyon, F-42023, France, CNRS, UMR5516, Laboratoire Hubert Curien, Université Jean Monnet, 42000 St-Etienne, France **Resume :** Nanostructuring features under ultrafast laser excitation of metallic surfaces are strongly influenced by light coupling and the associated material response under conditions of electron-phonon nonequilibrium. This is nowadays imperfectly described with uncertainties on the transient variation of optical and electronic properties during irradiation. In that context, dedicated ab initio calculations were carried out in the framework of the Density Functional Theory to elucidate some of the primary aspects of material response. Ground-state calculations and molecular dynamic simulations have been thus conducted to derive electronic structure and associated transport properties under nonequilibrium conditions. We observe that electronic temperature leads to strong modifications of the electronic screening. This displaces in turn the electronic structure, affecting transient electronic properties such as free electron number, specific heat and thermal pressure. Finally, we evaluate the optical index under different electronic temperatures based on the Kubo-Greenwood formalism. In addition to providing insights into the dynamics of optical response of a metallic surface, these transport properties also shines a new light on a recurring problem concerning periodicity variations of LIPSS (ripples) under ultrashort excitation. Accordingly, the consequences of thermal nonequilibrium on inhomogeneous electric field distribution on a rough metallic surface will be also addressed. **add to my program** **(close full abstract)**	J.XVI 1
09:00	**Comparison of LIPSS formation induced by accumulative pulse of nanosecond and picosecond laser beams in the UV regime** **Authors :** T.T.D.Huynh, A. Petit, N. Semmar **Affiliations :** GREMI-UMR 7344, CNRS/Université d'Orléans, 14, rue d'Issoudun, BP 6744, 45067 Orléans cedex2, France **Resume :** One of the ablated morphologies of interaction laser – matter, which have attracted particular attention, is the appearance of surface LIPSS (Laser Induced Periodic Surface Structure). LIPSS formation on copper thin films was investigated in this present work by applying accumulative pulses with 42 ps and 10 ns pulse duration at 266 nm wavelength and 1Hz repetition rate. Copper and Cobalt thin films were deposited on silicon and glass substrates by magnetron sputtering. Both laser beams have the same spatial energy distribution (Gaussian) but different pulse duration. This allows the study of this last parameter effect on LIPSS formation. Namely, a comparison of the ablation threshold and the incubation coefficient on copper and cobalt thin films varies with respect to the pulse duration and the shot number. Morphologies changes of ablated regions were studied as a function of pulse duration, fluence and shot number. Moreover, the change of reflectivity on copper thin film is also	J.XVI 2

identified during the LIPSS formation by Time Resolved Reflectivity (TRR) method. This method was widely used due to their non-destructive advantage namely in the nanosecond regime; it is also fast and sensitive with a high spectral/spatial resolution. In this study several beams were used (cw Cd-He (325 nm), Blue DPSS (473 nm) and He-Ne (633 nm)) as probing lasers directed onto the same UV heating laser spot. The reflected signals are measured using very fast photodiodes (less than 35 ps time rise) and correlated to the MEB images during the LIPSS formation.

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09:15 **On the large area LIPSS coverage by multiple pulses and the influence of pre-structuring**

Authors : Juergen Reif (a), Christian Martens (a), Sebastian Uhlig (a), Markus Ratzke (a), Olga Varlamova (a), Stephane Valette (b), Stephane Benayoun (b)
Affiliations : (a) Brandenburgische Technische Universitaet – BTU, Cottbus, Germany; (b) LTDS, Ecole Centrale de Lyon, Ecully France

Resume : The phenomenon of large areas coherent covering with LIPPS produced by multiple, adjacent spots is investigated by varying spot overlap and irradiation dose per spot. In contrast to the typical experimental arrangement, the linear traces of spots were produced by discontinuously advancing the sample between the individual spots. We show that even with almost no overlap the LIPSS patterns appear to be coherently connected. Further, we study the effect pre-structuring the sample surface by impressing lines, narrower than one spot diameter on stainless steel and silicon.

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09:30 **Dynamics of laser-induced structure formation on solid surfaces – moving ripples**

Authors : Christian Martens, Markus Ratzke, Olga Varlamova, Juergen Reif
Affiliations : Brandenburgische Technische Universitaet – BTU, Cottbus, Germany

Resume : To investigate the dynamical evolution of laser induced periodic surface structures (LIPSS) on solid surfaces (Si, stainless steel) we monitor the generated pattern in situ between successive laser pulses. By shifting an atomic force microscope on and off the irradiated spot at the target surface between the pulses, a movie is produced showing the pattern evolution. It is observed that the structures are not simply gaining increased contrast at a fixed position but, instead, they move from pulse to pulse, similar to propagating waves. This is in good agreement with our model of dynamic structure formation and contradicts the idea of a pulse-to-pulse enhancement of a given interference pattern.

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09:45 **Study on the coloration of alumina induced by laser**

Authors : J. Penide (1), F. Quintero (1), F. Arias-González (1), J. del Val (1), R. Comesaña (3), A. Riveiro (1, 2), F. Lusquiños (1), J. Pou (1)
Affiliations : (1) Applied Physics Department, University of Vigo ETSII, Lagoas-Marcosende, 9. Vigo, 36310, SPAIN; (2) Centro Universitario de la Defensa, Escuela Naval Militar, Plaza de España 2, 36920 Marín, SPAIN; (3) Materials Engineering, Applied Mechanics and Construction Dpt., University of Vigo, EEI, Lagoas-Marcosende, Vigo, E-36310, Spain.

Resume : Alumina has singular properties which make it a quite important material in many fields of the modern industry: electronics, medicine, car manufacturing, communications, etc. In most of its applications, elements made of alumina should be identified by some characters or symbols printed directly on them; however, there is still a lack of a reliable and efficient method to print on alumina. In this sense, laser marking is a promising process to solve this problem. In this paper, we present an extensive experimental study on the conditions to induce coloration on alumina by visible (532 nm) and near-infrared (1064 nm) laser radiation. Field Emission Scanning Electron Microscopy (FESEM) and Transmission Electron Microscopy (TEM) equipment were employed to analyze the results. The physical processes involved on laser induced coloration were determined in order to make the marks in alumina more legible. The most suitable laser operating conditions were also defined and are reported here. Finally, we propose an explanation for the differences of the coloration induced under different atmospheres and laser parameters. As a practical outcome, we have improved the current laser marking results so the identification of alumina elements becomes clearer since a higher coloration contrast was achieved.

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10:00 **Cofee Break**

Laser surface nano & micro-structuring II : J. Reif

10:30 **Femtosecond time-resolved diffraction and two-color dynamics of laser-induced periodic surface structures on fused silica**

Authors : S. Höhm (1), A. Rosenfeld (1), M. Herzlieb (1), J. Krüger (2), J. Bonse (2)
Affiliations : (1) Max-Born-Institut, Max-Born-Straße 2a, D-12489 Berlin, Germany ; (2) BAM Bundesanstalt für Materialforschung und -prüfung, Unter den Eichen 87, D-12205 Berlin, Germany

Resume : The dynamics of the formation of laser-induced periodic surface structures (LIPSS) on fused silica upon irradiation with linearly polarized fs-laser pulses (50 fs pulse duration) is studied using two complementary experimental setups. For analyzing the relevance of temporally distributed energy deposition in the early stage of LIPSS formation, a Mach-Zehnder interferometer generated multiple double-pulse sequences at two different wavelengths (400 & 800 nm) and with varying inter-pulse delays up to a few ps. These two-color experiments confirm the importance of the ultrafast energy deposition to the silica surface for LIPSS formation, particularly by the first laser pulse of each sequence. The second laser pulse subsequently reinforces the previously seeded spatial LIPSS frequencies. Additional fs-pump-probe diffraction measurements were performed in trans-illumination geometry to investigate the influence of transient excitation stages in the early LIPSS development. In this (second) setup, the temporal delay between the pump-pulse (800 nm wavelength; inducing the LIPSS) and the probe-pulse (a frequency-doubled fraction of the pump-beam) can be varied between 0 and 1 ns with a temporal resolution of ~0.1 ps. The results prove that the ultrafast energy deposition of the first few laser pulses to the materials surface is essential for the formation of LIPSS. In silica, it triggers specific subsequent physical mechanisms such as the formation of self-trapped excitons.

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10:45 **Experimental realization of adaptive femtosecond laser pulse shaping for optimized laser microstructuring of materials**

Authors : Stefan Kontermann, Wolfgang Schippers, Anna Lena Baumann, and Wolfgang Schade
Affiliations : Fraunhofer Heinrich Hertz Institute, EnergieCampus, Am Stollen 19B, 38640 Goslar, Germany; Fraunhofer Heinrich Hertz Institute, EnergieCampus, Am Stollen 19B, 38640 Goslar, Germany; Fraunhofer Heinrich Hertz Institute, EnergieCampus, Am Stollen 19B, 38640 Goslar, Germany; Fraunhofer Heinrich Hertz Institute, EnergieCampus, Am Stollen 19B, 38640 Goslar, Germany and Clausthal University of Technology, Institute of Energy Research and Physical Technologies and EFZN, EnergieCampus, Am Stollen 19A, 38640 Goslar, Germany

Resume : Adaptive femtosecond laser pulse shaping based on a self-learning adaptive algorithm loop is demonstrated for laser microstructuring of materials. It is shown that different temporal shapes of femtosecond laser pulses used for microstructuring lead to different material characteristics. We analyze optical and structural characteristics of silicon after irradiation with shaped high energetic femtosecond laser pulses. By scanning electron microscopy we reveal that silicon surface structures are of sub-wavelength dimensions and their morphologies after irradiation depend on the temporal laser pulse shape. Pulse shaping is realized by using a spatial light modulator in a 4f set-up that enables the Fourier synthesis of spectral components of the input laser pulses. With this, a wide range of temporal laser pulse shapes is produced. Laser pulse shapes are generated by an evolutionary algorithm that adaptively optimizes laser pulse shapes for a specific material characteristic. The feedback parameter of the evolutionary algorithm in this work is the reflection of the laser processed silicon surface. This reflection is measured by photodetection of a He-Ne laser beam, which is reflected from the spot processed with the femtosecond laser pulses. The evolutionary algorithm alters the pulse shape so that the reflection of the structured silicon surface is minimized. In this work we present the realization of adaptive femtosecond laser pulse shaping for laser material microstructuring.

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11:00 **Micro- and nano-structures micromachined by femtosecond laser irradiation on stainless steel, titanium, aluminum, and copper**

Authors : Edwin Jee Yang Ling, Tanvir Ahmmed, Phillip Servio, Anne Kietzig

J.XVII 3

Affiliations : Biomimetic Surface Engineering Laboratory, Department of Chemical Engineering, McGill University, 3610 University Street, Montreal, Quebec H3A 0C5, Canada

Resume : Ultrafast pulsed laser technologies have garnered increased interest due to their ability to precisely micromachine materials while maintaining a very small heat affected zone. Examples that invoke the use of such lasers include the fabrication of integrated circuits, coronary stents, thin film ablation for solar panels, processing techniques for microelectromechanical systems (MEMS), and surface structuring to produce superhydrophobic surfaces. Micro- and nano-scale surface structures were produced on four different metals (stainless steel, titanium, aluminum and copper) via femtosecond laser irradiation in air. The structures obtained include both anisotropic and isotropic, homogeneous and non-homogeneous patterns such as micro-bumps, holes, ripples, nano-forests and periodic micro-channels. The combination of various experimental parameters can be coupled together to generate both an accumulated pulse and line fluence distribution; we show how these distributions can be used to predict the surface microstructure for a given set of experimental conditions. In addition, the influence of material properties on the ensuing microstructure has been studied. The micro- and nano-structures formed by ultrafast laser irradiation modify the optical, chemical, and wetting characteristics of the machined metal, which can be used for engineering applications such as microfluidics and self-cleaning surfaces.

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11:15 **Periodic grating structures self-organized on titanium surface by double femtosecond laser pulses**

Authors : 1234 Laura Gemini, 12 Masaki Hashida, 12 Yasuhiro Miyasaka, 3 Jiri Limpouch, 4 Tomas Mocek and 12 Shuji Sakabe

Affiliations : 1 Advanced Research Center for beam Science, Institute for Chemical Research, Kyoto University, 611-0011 Kyoto, Japan 2 Department of Physics, Graduate School of Science, Kyoto University, 606-85802 Kyoto, Japan 3 FNSPE, Czech Technical University in Prague, 11519 Prague, Czech Republic 4 HiLASE Project, Institute of Physics, ASCR, 18221 Prague, Czech Republic

Resume : Laser induced periodic surface structures (LIPSS) were self-organized on Ti upon irradiation with 50 pairs of fs laser pulses (central wavelength 800 nm, pulse width 40 fs, repetition rate 10 Hz). The interspaces of LIPSS for different materials have been already successfully represented by a parametric decay model which describes the generation of gratings as a consequence of the parametric decay of the laser light into an electromagnetic wave and a surface plasma wave. In this work Ti surface was irradiated with 50 pairs of pulses in order to verify the model?s assumption, that is a variation of the surface plasma density might lead to a variation of the gratings interspaces. Being FTH the threshold fluence at which LIPSS self-organization starts for single pulse irradiation, the fluence of the first pulse (PP), responsible for the surface plasma formation, was varied and always kept below FTH, while the fluence of the delayed pulse (LP), responsible for LIPSS formation, was kept constant above FTH. Results show that LIPSS interspace data follow the parametric decay model prediction. SEM analyses show the formation of a new morphology composed by uniformly distributed circular nanoparticles, visible when the LP fluence is constant and just above FTH. The nanoparticles develop to periodic nano-ripples and finally to classic ripples when the PP fluence increases, highlighting the key role of the surface plasma density in LIPSS formation mechanism.

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11:30 **Formation of LIPSS on Niobium by femtosecond laser irradiation**

Authors : A. Rodriguez 2, A. Pan 1 2, A. Días1 2, M. Gómez-Aranzadi 1 2, S. M. Olaizola1 2

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Resume : The surface morphology of a Niobium sample, irradiated in air by a femtosecond laser with a wavelength of 800 nm and pulse duration of 100 fs, was examined. The period of the micro/nanostructures, parallel and perpendicularly oriented to the linearly polarized fs-laser beam, were studied by means of 2D Fast Fourier Transform analysis. The observed Laser-Induced Periodic Surface Structures (LIPSS) were classified as Low Spatial Frequency LIPSS (LSFL, periods about 600 nm), and High Spatial Frequency LIPSS, showing a periodicity around 300 nm, both of them perpendicularly oriented to the polarization of the incident laser wave. Moreover, parallel HSFL were observed with periods around 100 nm located at the peripheral areas of the

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laser fingerprint and overwritten on the perpendicular periodic gratings. The results indicate that this method of micro/nanostructuring allows controlling the Niobium grating period by the number of pulses applied, so the scan speed and not the fluence is the key parameter of control. A discussion on the mechanism of the surface topology evolution was also introduced.

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11:45 **SYMPOSIUM CLOSING REMARKS**

12:00 **Lunch**

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