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Tuesday, 22 May

Hotel Lido Caparena, Sala Convegni B

09:00-09:15 **OPENING BY THE CHAIRS**

Stephan Barcikowski, University of Duisburg-Essen (DE)
Giuseppe Compagnini, University of Catania (IT)

09:15-10:00 **KEYNOTE TALK** 1

Formation of nanoparticles and nano-composites by laser ablation in solution
F. Mafuné, Y. Takeda; Department of Basic Science, School of Arts and Sciences, The University of Tokyo (JP).
Nanometer sized particles and composites can show size dependent physical and chemical properties. Hence, preparation of size-selected and controlled metal nanoparticles in a solution is one crucial subject in chemistry and the physics of nano-scale materials. Much research has been directed for developing methods for their preparation, such as the chemical reduction of metal salt in a micelle or a reversed micelle. On the analogy of the laser ablation for preparing gas-phase clusters, a laser ablation method for the preparation of metal nanoparticles in a liquid has also been developed by many researchers. The first international meeting on "laser ablation in liquid" (ANGEL 2010) was held in 2010 in Switzerland, and there are more numbers of researchers who are involved in this active filed. We overview the recent developments of laser ablation in a solution for nanoparticle production and describe the mechanism of nanoparticles formation, size-reduction, and the relevant physical processes. [5292]

10:00-11:30
SESSION I: METALS
Chair: F. Mafuné, Department of Basic Science, School of Arts and Sciences, The University of Tokyo (JP)

10:00-10:20 2
Solvent effect on fabrication of gold nanoparticles by high-intensity laser irradiation of solution
T. Nakamura, Y. Herbani, S. Sato; Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University (JP).
We demonstrate a method for the preparation of noble metal and alloy nanoparticles by high intensity laser irradiation of metallic salt solution. The formation of nanoparticles in the absence of any reducing agents can be attributed to the reduction of metallic ions by the active species generated by high-intensity laser irradiation of solvent molecules. Liquid phase pulsed laser ablation (LP-PLA) of solids, on the other hands, has been studied for many years to obtain colloidal metal nanoparticles. Some studies reported that the control of particle size and stability of the colloid suspension by LP-PLA were possible by changing the type of solvents. In this study, the solvent effect on the fabrication of metal nanoparticles by high-intensity laser irradiation of solution was investigated. [5205]

10:20-10:50 **Invited talk** 3
Mechanisms of nanoparticle formation by ultra-short laser ablation of metals in liquid environment
T.E. Itina[1], M.E. Povarnitsyn[2,1]; Laboratoire Hubert Curien, UMR CNRS 5516 (FR);
[2]Joint Institute for High Temperatures RAS (RU).
Laser ablation in liquids is now commonly used to produce colloidal nanoparticles (NPs) that have found numerous applications in different areas. In the experiments, NPs of different materials can be rather easily produced by using laser systems with various pulse durations, shape, wavelengths, and fluence. Here, we focus our attention on metal (gold) nanoparticles produced by ultra-short laser pulses due to their unique plasmonic properties. To better understand the mechanisms of the NPs formation, we perform modeling of ultra-short laser interactions with gold target in the presence of a liquid (water). [5331]

10:50-11:10 **STUDENT PRESENTATION** 4
Exploring the formation of nanoparticles in laser induced plasma in liquid confinement
B. Kumar, R.K. Thareja; Department of Physics, Indian Institute of Technology Kanpur (IN).
Nanoparticles of different metals were synthesized using laser ablation in liquid confinement. We proposed to compare the size of nanoparticles synthesized in laser ablation and the size estimated using the plasma parameters. Formation of nanoparticles in plasma was established using laser light scattering during plasma plume expansion. Time resolved optical emission spectroscopy and shadowgraph imaging were used to estimate plasma parameters and these in turn were used to understand the growth of nanoparticles. The investigation revealed linear increase in the size of nanoparticles and their confinement within the shockwaves resulting due to explosive expansion of the plasma. [5152]

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11:10-11:30 STUDENT PRESENTATION

Size dependent alloying of Ag-Cu nanoparticles synthesized by pulse laser ablation technique 5

K.D. Malviya, S. Chithra, K. Chattopadhyay; Indian Institute of Science, Materials Engineering Department (IN).

We are investigating the enhancement of solid solubility in immiscible Ag-Cu alloy nanoparticles (NPs) prepared by pulse laser ablation(PLA) technique from the bulk target of eutectic composition (Ag-39.9 at.%Cu) in aqueous medium. The nanoparticles were prepared by using optimum concentration of surfactant, laser energy and rotation speed of the target. The peak fitted XRD pattern shows pure Ag and Ag(Cu) solid solution(ss) have average diffraction domain size 8nm and 6nm respectively. The TEM results shows that the particle synthesized without any surfactants have large particle size distribution(2-200nm) with oxide peaks whereas the sample with optimized conditions have only Ag and Ag(Cu) ss and distribution is narrow down to 25nm. [5183]

11:30-12:00 Coffee break

12:00-12:20

Blue-shift of plasmonic resonance of Au nanoparticles produced by picosecond laser ablation in pure water 6

F. Giammanco[1], E. Giorgetti[2], P. Marsili[2], A. Simonelli[1], M. Tiberi[1]; [1]Department of Physics "E.Fermi", University of Pisa (IT); [2]Istituto dei Sistemi Complessi, Consiglio Nazionale delle Ricerche (IT).

Blue-shift of plasmon resonance of Au nanoparticles (AuNPs) either capped or not, produced by chemical reduction or laser ablation, has been investigated by several authors since it is related to modifications of the size-dependent dielectric constant. In particular, it has been recently demonstrated that growing oxidation of AuNPs leads to an increasing blue-shift up to about 10 nm. In this work, we analyze in detail the phenomenon as a function of the laser fluence during the production of AuNPs in water by fundamental (1064 nm) and second harmonic (532 nm) of a Nd:YaG ps laser. Similarly, we measure the blue-shift during post-irradiation of previously prepared AuNPs colloids at a fluence that the plasmon peak occurs at 525 nm, i.e. the usual value in water. [5179]

12:20-12:40

Nanosecond laser ablation of Ag in aqueous adsorbate solutions: Advantages of SERS spectral probing of hybrid system evolution 7

K. Siskova[1,2], B. Vlckova[1], P.-Y. Turpin[2], A. Thorel[3], M. Prochazka[4]; [1]Charles University, Dept. of Physical and Macromolecular Chemistry (CZ); [2]Universite P.et M. Curie, Lab. Acid. Nucl. et Biophotonics (FR); [3]Ecole des Mines de Paris, Centre des Materiaux (FR); [4]Charles University, Institute of Physics (CZ).

The possibilities to control surface chemistry of plasmonic (Ag and Au) nanoparticles (NPs) during laser ablation (LA) have been demonstrated by in-situ functionalization of Ag NPs and Au NPs by chemical species and by bioconjugation of Au NPs. In this contribution, we assess the factors affecting Ag NPs-organic species hybrid system formation and stability during intermittent, nanosecond LA of a Ag target carried out in aqueous solutions of 2,2'-bipyridine and/or of a cationic free base porphyrin by using pulses of 1064 and 532 nm wavelengths. We demonstrate the advantages of SERS (surface enhanced Raman scattering) spectral probing of Ag NPs / organic adsorbate systems resulting from each of the five individual stages of the LA process (accompanied by SPE /surface plasmon extinction/ spectral measurements and TEM imaging of selected systems). [5221]

12:40-13:00

Preparation of functionalized plasmonic nanoparticles layer by laser ablation/electrophoretic deposition 8

J. Pfleger[1], Z. Kvíčalová[1], K. Šišková[2]; [1]Institute of Macromolecular Chemistry, Academy of Sciences of Czech Republic (CZ); [2]Regional Centre of Advanced Technologies and Materials, Department of Physical Chemistry, Faculty of Science, Palacky University (CZ).

Silver or gold nanoparticles incorporated in structures of organic semiconductors were found to enhance their optoelectronic functionality, as the photovoltaic conversion efficiency in organic solar cells. The observed photocurrent enhancement was discussed in terms of resonant light absorption in the metal clusters or improvement of electrode properties. Employment of laser ablation allows the preparation of nanoparticles with bare surface that allows the in-situ functionalization with proper optoelectronically active organic molecules, without shielding plasmonic effects by stabilizing surfactants. We describe here a method based on simultaneous laser ablation and electrophoretic deposition. [5245]

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13:00-13:20
Exploratory Study on Size-Selective Production of Gold Nanospheres in Aqueous Solution 9
D. Werner, T. Ueki, S. Hashimoto; The University of Tokushima, Department of Ecosystem Engineering (JP).
By applying high pressures well above the critical pressure of water (22.1 MPa), we prepared gold nanoparticles (Au NPs) using a nanosecond pulsed laser-induced size-reduction technique. The Au NPs thus obtained exhibited a remarkably narrow size distribution and size-selectivity dependent on the applied laser energy density. This is significant because previous attempts under ambient pressure failed to achieve such size-selective generation. Very spherical Au NPs of diameters, 46 nm and 33 nm with a standard deviation of only 2-3 nm, were obtained at the expense of original faceted 58-nm Au NPs. We ascribed our results to the formation of a super-critical water layer surrounding the liquid droplet NP transformed by laser heating. [5186]

13:20-14:30 Lunch break

14:30-16:20
SESSION II: SEMICONDUCTORS AND OXIDES
Chair: N. Koshizaki, National Institute of Advanced Industrial Science and Technology (AIST), Nanosystem Research Institute (NRI) (JP)

14:30-15:00 **Invited talk**
Semiconductor Nanoparticles By Laser Ablation in Liquid: Synthesis, Assembly and Properties 10
W. Cai, H. Zeng, S. Yang; Key Laboratory of Materials Physics, Anhui Key Lab of Nanomaterials and Nanotechnology, Institute of Solid State Physics, Chinese Academy of Sciences (CN).
Laser ablation in liquid (LAL) is a facile and productive method to fabricate various nanoparticles (NPs). Significantly, because of the extreme conditions and highly nonequilibrium growth, the LAL-formed NPs have a special microstructure, a surface state, and hence novel properties. The in-depth investigations would advance the understanding of some essential problems and some important applications of NPs. In this talk, we will give a brief review of our recent work on the growth, assembly, and properties of NPs by LAL. [5255]

15:00-15:20
Laser assisted fabrication of magnetic Gd-based nanoparticles in liquids 11
N.V. Tarasenko, A.V. Butsen, N.N. Tarasenka; B.I. Stepanov Institute of Physics (BY).
Nanoscale compounds and alloys of gadolinium are promising materials for applications as magnetic particles for the hyperthermia treatment. In this paper composition, morphology and magnetic properties of the ternary $Gd_5(Si_{1-x}Ge_x)_4$ nanosystems have been investigated. To obtain Gd (Si, Ge) nanoparticles we used laser irradiation processes in two different ways. First, the compound nanoparticles were synthesized by four step process which involved a sequential ablation of germanium, silicon and gadolinium targets followed by the additional laser irradiation of the mixture of the formed colloids. Second, laser ablation of the relevant target consisted of Gd (Si, Ge) alloy produced by thermal melting of stoichiometric mixture of the parent components (powders) in an argon atmosphere in a water-cooled graphite oven was used. [5209]

15:20-15:40
Violet-Blue Photoluminescence from Si Nanoparticles with Zinc-Blende Structure Synthesized by Laser Ablation in Liquids 12
P. Liu, Y. Liang, H.B. Li, J. Xiao, G.W. Yang; State Key Laboratory of Optoelectronic Materials and Technologies, Institute of Optoelectronic and Functional Composite Materials, Nanotechnology Research Center, School of Physics & Engineering, Sun Yat-sen University (CN).
Luminescence properties of Si nanostructures have been investigated widely because of their tremendous potential applications in fundamental physics and optoelectronics applications. However, up-to-date there is still few studies about the light luminescent Si nanostructure, especially the violet-blue light emission Si nanocrystals, be presented in securable literature. Here, we report that a kind of Si nanoparticles (NPs), which are prepared by a developed synthetic method of electrical-field assisted laser ablation in liquid (EFLAL), shows an obvious violet-blue light emission property in the photoluminescence testing. [5150]

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15:40-16:00 13

Optical Properties of Y2O3:Er,Yb nanoparticle prepared by Laser ablation in Liquid

Y. Onodera, T. Nunokawa, K. Nakamura, Y. Kitamoto, O. Odawara, H. Wada; Tokyo Institute of Technology (JP).

In the past several years, there has been increasing interest in fluorescent nanoparticles due to various potential applications. These fluorescent nanoparticles are promising materials for bio-medical field such as a marker for bioimaging. One of important optical properties is upconversion (UC) which emits visible light with infrared excitation. The advantages of the upconversion nanoparticles are high transparency, low damage and low autofluorescence of tissue. For bio-medical application, the size of nanoparticle in the range from a few 10 to 200nm is needed. In this study, we prepared Y2O3:Er,Yb nanoparticles by laser ablation in liquid and controlled the size of nanoparticles. The effect of decreasing particle size on upconversion spectra was also investigated. [5219]

16:00-16:20 STUDENT PRESENTATION 14

Formation of inorganic fullerene-like MoS_2 nanostructures by laser ablation in water

M. Sinatra[1], G. Messina[1], G. Compagnini[1], S. Scalese[2]; [1]University of Catania, Dipartimento di Scienze Chimiche (IT); [2]Istituto per la Microelettronica e Microsistemi CNR (IT).

There has been increasing interest in the synthesis of nanostructures based on transition metal chalcogenides with layered structure such as molybdenum disulphide (MoS_2) because of their potential applications in areas such as electrochemistry and lubrication, as well as host materials for intercalation chemistry. Recently, it has been predicted and experimentally demonstrated the existence of transition metal chalcogenides nanostructures in the form of fullerene-like (Inorganic Fullerene, IF) nanoparticles, as well as in monodimensional and two dimensional structures. [5204]

16:20-16:50 Coffee break

16:50-18:10

SESSION II: SEMICONDUCTORS AND OXIDES (continued)

Chair: W. Cai, Key Laboratory of Materials Physics, Anhui Key Lab of Nanomaterials and Nanotechnology, Institute of Solid State Physics, Chinese Academy of Sciences (CN)

16:50-17:10 15

Titanium dioxide nano-sphere preparation by pulsed laser irradiation in liquid

Y. Ishikawa[1], M. Ohira[1], N. Koshizaki[2], Q. Feng[1]; [1]Kagawa University, Department of Advanced Materials Science, Faculty of Engineering (JP); [2]National Institute of Advanced Industrial Science and Technology (AIST), Nanosystem Research Institute (NRI) (JP).

We have been studying spherical particle fabrication by laser irradiation of nanoparticles dispersed in liquid. In this technique, dispersed nanoparticles are melted by nanosecond pulsed laser irradiation with adequate fluence, which is lower than that used in general laser ablation in liquid for nanoparticle fabrication. The formed droplets become spherical particles after cooling. Our group has already reported various *submicrometer*-sized spheres such as B_4C, ZnO, TiO_2, and CuO. In this study, we further confirmed the formation of *nanometer*-sized TiO_2 spheres together with submicrometer spheres depending on laser irradiation condition. [5253]

17:10-17:30 16

Doping Impurities in Semiconductor Nanocrystals assisted by Laser Ablation in Liquids

J. Liu, C. Liang; Key Laboratory of Materials Physics, Institute of Solid State Physics, Chinese Academy of Sciences (CN).

The doping of foreign atoms is critical in tailoring the properties and potential applications of semiconductor nanocrystals. As shown in Fig. 1, a general strategy for successfully incorporating various impurities inside the regular crystal lattice of hematite (α-Fe_2O_3), a promising candidate for water splitting and environmental protection, is developed. Liquid-phase laser ablation-derived colloidal clusters are used as doping precursors for the metastable growth of doped hematite nanocrystals, thereby avoiding surfactants and hazardous liquid byproducts. The doping percentage, morphology, and structure of the hematite nanocrystals are greatly affected by the type and amount of the colloidal precursors used. High-resolution transmission electron microscopy and the corresponding component analysis reveal that the dopant atoms either form superlattice structures or distribute as disordered solid solutions inside the crystal lattice of hematite. The optical absorption spectra and the resulting band gaps of the doped-hematite nanocrystals are investigated. Typical electronic transitions consisting of ligand to metal charge transitions, Fe^{3+} d-d transitions, and pair excitations distinctly occur in the optical spectra. The simultaneous incorporation of impurities and preferential growth mechanism of hematite nanocrystals are also further elaborated. [5262]

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17:30-17:50 17

Laser-based generation of functional silicon dots for biomedical application

R. Intartaglia[1], A. Barchanski[2], K. Bagga[1], A. Diaspro[1], F. Brandi[1],C. L. Sajti[2]; [1]Department of Nanophysics, Istituto Italiano di Tecnologia (IT); [2]Nanotechnology Department, Laser Zentrum Hannover e.V. (DE).

Heavy-metal-free semiconductor material like Silicon Nanoparticle (Si-NPs) is attracting scientists because of its particular size-dependent optical properties, biocompatibility, stability against photo-bleaching, useful for the diverse applications in biomedical field such as *in vivo* fluorescence imaging label, bio imaging contrast agent and cellular therapy. Compared to conventional chemical methods, pulsed laser ablation in liquid (PLAL) has emerged as an alternative approach for the generation of pure nanoparticles, including semiconductors free of any contaminant. In particular, sized-controlled generation of silicon nanoparticle via PLAL method have been recently reported by our group giving an insight to the optical properties of laser-generated Si-NPs in liquid. More recently, we established that laser ablation-based in situ bio-conjugation is a suitable method for the production of bioconjugated semiconductor nanoparticles. Our approach shows a remarkable size control and surface coverage of NPs as well demonstrates the potential use of these biodegradable tools as probing and imaging agent of biological systems. [5232]

17:50-18:10 18

Interaction of Pulse Laser Beam with Colloidal Nanoparticles

A. Pyatenko, N. Koshizaki; National Institute of Advanced Industrial Science and Technology (AIST), Nanosystem Research Institute (JP).

The process of laser ablation in liquid phase became very populam method for production of nanoparticles of different size, shape, and chemical composition. Recently we developed a new method in which pulse laser technique permits to produce spherical monodisperse submicron particles for wide class of materials from metals to semiconductors and even insulators. To understand the mechanism of particle formation, particle heating-meltingevaporation model can be applied. This model assumes that all the energy absorbed by particle from a laser beam is spent for particle heating, melting, and evaporation. [5168]

19:30-22:00 **CONFERENCE DINNER**
Location: Restaurant, Hotel Lido Caparena

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09:00-11:10
SESSION III: CARBON BASED AND NANOCOMPOSITES
Chair: D.B. Chrisey, Department of Materials Science and Engineering, Rensselaer Polytechnic Institute (US)

09:00-09:30 **Invited talk**

Laser-based synthesis of functional polymer nanocomposites 19

P. Wagener[1], A. Schwenke[2], A. Hahn[2], S. Barcikowski[1]; [1]University of Duisburg-Essen, Technical Chemistry I and Center for Nanointegration Duisburg-Essen (CeNIDE) (DE); [2]Laser Zentrum Hannover e.V., Department of Nanotechnology (DE).

Polymer nanocomposites are versatile materials for a manifold of applications in medicine, photonics and energy applications. In this talk, we give an overview of our recent research on laser-based synthesis of bioactive polymer nanocomposites, in particular for medical application. Those nanocomposites take advance of specific features of laser-generated nanoparticles like-wise their high purity or ligand-free, chemically active surfaces. Thus, agglomeration-free dispersion of nanoparticles into polymer matrices can be achieved using *in situ* functionalization with matrixstructural analogous coupling agents, or monomer-grafting followed by fluid-based compounding of colloidal metal, semiconductor, and metal alloy or even mixed nanoparticles. [5226]

09:30-09:50 **STUDENT PRESENTATION**

Pulsed laser ablation of Pd target in the aqueous solution of multi-walled carbon nanotubes to decorate MWCNTs with Pd nanoparticles for hydrogen storage 20

A. Reyhani[1], S.Z. Mortazavi[2], P. Parvin[2], R. Malekfar[3]; [1]Phys. Dept., Faculty of Science, I.K.I. University (IR); [2]Phys. Dept., Amirkabir University of Technology (IR); [3]Phys. Dept., Tarbiat Modares University (IR).

Since their discovery in 1991, carbon nanotubes have been of great interest because of their unique structural, electrical, and mechanical properties. Their potential applications include nanodevices, quantum wires, ultrahigh-strength engineering, sensors, hydrogen storage media and catalyst supports. To optimize the use of nanotubes in many of these applications, there is a need to attach functional groups to their surface and then assemble the nanotubes into the structures or attach other nanostructures to the nanotubes. Regarding our previous work, the laser ablation of Pd target in deionized (DI) water due to Q-switched Nd:YAG laser (1064 nm) and ArF excimer laser (193 nm) irradiations was systematically studied. Here, the pulsed laser ablation in liquid is investigated to decorate the multiwalled carbon nanotubes with Pd nanoparticles particularly for hydrogen storage applications. [5195]

09:50-10:10 **STUDENT PRESENTATION**

Vertically oriented graphene flakes deposited during electric field assisted laser ablation of carbon targets in water 21

P. Russo[1], M. Sinatra[1], O. Puglisi[1], G. Compagnini[1], S. Scalese[2]; [1]University of Catania, Dipartimento di Scienze Chimiche (IT); [2]Istituto per la Microelettronica e Microsistemi CNR (IT).

The discovery of graphene has stimulated enormous interest on 2D carbon nanostructure in view of their extraordinary properties and potential applications. A challenge has always been to identify a high yield production pathway, suitable to give graphene or graphene-like structures without collateral structural damage and with the possibility to manipulate the layers (individually or collectively) in order to have a particular arrangement for given applications.
In this work a green and controllable strategy is presented to grow few layer graphene flakes at the electrodes during the ablation of a carbon targets in water with the assistance of an electric field (5-10 V/cm). [5173]

10:10-10:30

Stability of water-soluble C60 nanoparticle by laser ablation in water 22

T. Asahi, M. Arinishi; Ehime University (JP).

Organic nanoparticles prepared by of its microcrystalline powder in water dispersed stably in pure water without any surfactants and disperse agents. This is an advantage in the applications to advance nanomaterials, new pharmacological agents and drugs. However, the mechanism of the colloidal stability has not been clear yet. In this work, we prepared C_{60} water suspension (nC_{60}) with a mean size of 50 nm by ns-laser ablation of its micrometer-sized powder in distilled water, and examined the coagulation by inorganic electrolytes. [5242]

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10:30-10:50 — 23

Laser induced formation of polyacetylene derivatives from liquid alkyl benzenes

W. Marine, E. Chelnokov, M. Rivoal, L. Bekere, N. Larina, A. Baronnet, D. Ferry, F. Thibaudau, V. Khodorkovsky; CNRS, UMR 7325 et Université Aix-Marseille, ClNaM (FR).

The interaction of the high-power femtosecond pulses with molecules results in a variety of nonlinear phenomena including strong field induced polarization and alignment of molecules, and excitation of molecules to the higher excited states than those available by the conventional sources of light. Such processes are inevitably accompanied by laser ablation along with heating and expansion of the ablated product. In this presentation, for the first time, we demonstrate a constructive ablation of liquid alkyl benzenes leading to the unprecedented chemical reaction sequences giving rise to the formation of the polymeric nanomaterials. [5191]

10:50-11:10 — 24

Graphene generation in cryogenic liquid using Q-switched Nd:YAG laser

S.Z. Mortazavi[1], P. Parvin[1], A. Reyhani[2]; [1]Phys. Dept., Amirkabir University of Technology (IR); [2]Phys. Dept., Faculty of Science, I.K.I. University (IR).

Graphene, a two-dimensional honeycomb lattice of carbon atoms as the thinnest material in our universe, is now at the center of the significant research efforts. A novel technique is introduced for the graphene fabrication in the cryogenic liquid based on the pulsed laser ablation of graphite target. Graphene is fabricated using nanosecond pulsed Nd:YAG laser at 1064 nm in liquid nitrogen. The main advantage consists of the single-stage process without need to high vacuum devices and additional chemical components, potential to select the desired sizes as well as the manipulation of their crystallite structures using laser properties. [5192]

11:10-11:40 Coffee break

11:40-12:40

SESSION III: CARBON BASED AND NANOCOMPOSITES (continued)

Chair: N. Tarasenko, Institute of Physics, National Academy of Sciences of Belarus (BY)

11:40-12:00 — 25

Upconverting nanoparticles in sol-gel coatings by pulsed laser ablation

M.-C. Hernandez[1], A. Zoubir[1], M. Louarn[2], A. Garcia[3], B. Maxit[4], R. Kling[1], A. Zoubir[1]; [1]ALPhANOV (FR); [2]Polyrise (FR); [3]ICMCB (FR); [4]Cordouan Technologies (FR).

Sol-gel coatings offer a large variety of applications such as anti-reflection, hydrophobic and self-cleaning coatings. When additional functions such as luminescence are needed nanoparticles are frequently added to the coating. The use of lasers for the direct generation and dispersion of nanoparticles in the liquid has various advantages. This technique provides nanoparticles with a defined size distribution, from any kind of materials, without additives and surfactants which can be an undesired source of chemical contamination.

In this paper, results about generation of photoluminescent nanoparticles directly created in a sol-gel solution are presented. [5229]

12:00-12:20 — 26

Significant metal-enhanced fluorescence due to a single Medusa-nanoparticle prepared by pulsed laser ablation in supercritical fluid

K. Saitow[1,2], H. Suemori[2], H. Tamamitsu[2]; [1]Hiroshima University, Natural Science Center for Basic R&D (JP); [2]Hiroshima University, Department of Chemistry, Graduate school of science (JP).

We developed a unique method for generating nanomaterials, by taking advantage of pulsed laser ablation (PLA) in both the gas and liquid phases. That is, PLA was performed in a supercritical fluid. This method enabled us to obtain the RGB light-emitting Si-nanocrystal and a white-light-continuum of Si nanocrystal ranging from near-UV to red wavelength regions.

Here we show a noble metal nanoparticle with characteristic morphology, generated by the method, that gives significant metal-enhanced fluorescence. [5225]

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12:20-12:40
Gold nanoparticle size dynamics during irradiation with high-repetition rate UV nanosecond pulses 27
A. Marcinkevicius, Y. Ichikawa, B. Liu, Y. Che; IMRA America, Inc. (US).
Active control of nanoparticle size and shape using various light sources has attracted considerable interest in scientific community over the last ten years. Depending on wavelength, fluence, and pulse duration of the laser sources used in these studies two basic mechanisms have been identified leading to fragmentation of nanoparticles: thermal evaporation and electron ejection. In this contribution, we will present detailed study of the gold nanoparticle size change during irradiation of the colloid with nanosecond 355 nm pulses at 20 kHz repetition rate. Laser fragmentation was carried out for two types of the aqueous gold colloids: commercially available nanoparticles with narrow size distributions and nanoparticles made by laser ablation in water. [5237]

12:40-14:00 Lunch break

14:00-15:50
SESSION IV: METHODS
Chair: T. Tsuji, Kyushu University (JP)

14:00-14:30 **Invited talk**
Pulsed laser melting in liquid for fabrication of submicrometer spherical particles 28
N. Koshizaki[1] A. Pyatenko[1], H.Q. Wang[1], Y. Ishikawa[2], T. Tsuji[3]; [1]National Institute of Advanced Industrial Science and Technology (AIST), Nanosystem Research Institute (NRI) (JP); [2]Kagawa University, Faculty of Engineering, Department of Advanced Materials Science (JP); [3]Institute of Advanced Materials Chemistry, Kyushu University (JP).
A few submicrometer spherical particles were occasionally observed in the electron microscopic images of products obtained by pulsed laser ablation in liquid at high fluence. These particles are usually treated as an unwanted byproduct. However, if we irradiate a laser onto smaller particles with low fluence (several 100 mJ cm^{-2}), we can produce mostly spherical particles with several 100 nm in size. This was initially found for B_4C spherical particles by irradiating laser onto the B particles dispersed in organic solvent through the high-temperature carbonization reaction. This method is, however, quite versatile and applicable to various kinds of materials, such as metals (Au, Ag, etc.), oxides (ZnO, TiO_2, etc.) and semiconductors (Si, GaP, etc.). [5270]

14:30-14:50
Generation of nanoparticles for temperature sensing by laser ablation in liquids 29
S.M. Avanesyan, R.F. Haglund, Jr.; Vanderbilt University,
Department of Physics and Astronomy (US).
Luminescent thermographic phosphor materials can be used for all-optical non-contact measurements of temperature up to hundreds of °C. For example, the green luminescence of the phosphor $Y_{2.97}Ce_{0.03}(Al_{1-x}Ga_x)_5O_{12}$ has a distinct temperature-dependent lifetime in the range of 40-20 ns; the emission peaks between 500-540nm and is easy to detect. We have recently shown that it is possible to monitor temperature of laser-irradiated materials in real time with nanosecond time resolution. These materials could in principle be used as realtime diagnostics for target and ablation-plume temperatures; one can also envision applications in microfluidics and biological studies. [5273]

14:50-15:10
Versatile laser based approach to generate bimetallic nanoparticle with controlled composition for biosensing application. 30
R. Intartaglia, K. Bagga, A. Gopalakrishnan, G. Das, A. Genovese, E. Di Fabrizio, A. Diaspro, F. Brandi; Nanobiotech Facilities, Istituto Italiano di Tecnologia (IT).
Metallic Nanoparticle (MNp) has become important for a variety of bio-applications including, biosensing, Np-enhanced Raman scattering etc...In this context, AuAg bimetallic NP (biMNp) synthesized by laser based method, offering unique surface chemistry, has been investigated in the past. The approach has mainly consisted in the post-irradiation of mixed colloidal solution (CS), and biMNp compositions has been controlled by adjusting both initial concentration of Ag and Au colloids mixture and/or the irradiation time. [5234]

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15:10-15:30 31

Catalysis of condensation of metal nanoparticles ablated in the superfluid helium by quantized vortices

E.B. Gordon, Institute of Problems of Chemical Physics RAS (RU).

Coagulation of the products of metal ablation by pulsed laser inside superfluid helium is significantly different from that for all other liquids. This is mainly a consequence of two specific features of He II. The first is that quasi 1-D quantized vortices appeared in He II serve as the centers of condensation for any particles suspended in the fluid. The second is a highly nonlinear character of heat transfer in superfluid helium - up to heat flux of 10 W/cm2 it is the best existing heat-conducting material, but at larger fluxes it transforms into a good heat-insulating substance. The combination of these peculiarities leads to existence of two different regimes of metal condensation. [5213]

15:30-15:50 STUDENT PRESENTATION 32

Pulsed laser ablation of a continuously-fed wire in liquid flow for high-yield production of silver nanoparticles

G.C. Messina[1], P. Wagener[2], R. Streubel[2], G. Compagnini[1], S. Barcikowski[2]; [1]University of Catania, Dipartimento di Scienze Chimiche (IT); [2]University of Duisburg-Essen, Technical Chemistry I and Center for Nanointegration Duisburg-Essen (CeNIDE) (DE).

Increasing nanoparticle productivity is a prominent topic in the field of laser ablation in liquid. Although it has been demonstrated that it is possible to reach the gram-scale range, still a large portion of the laser pulse energy is not harvested for nanoparticle production. Hence, for industrial application the ablation efficiency may be further increased and ideally, the process should be transformed into a continuous process to benefit from steady-state conditions. Changing the target geometry is a promising, non-cost-effective approach,and it has been shown that ablation of a metal wire in air can heavily increase the productivity of nanoparticles compared to conventional techniques using bulk targets. The quantitative ablation of a thin, heat-confining, continuously-fed wire enables efficient and continuous nanoparticle fabrication. This work presents the first example of pulsed laser ablation of a silver wire in liquid flow. [5222]

15:50-16:10 Coffee break

16:00-18:45 **SOCIAL PROGRAMME**
Meeting point: Lobby, Hotel Lido Caparena

19:00-20:30 **POSTER SESSION**
Location: Roof Terrace La Pergola, Hotel Lido Caparena

Hotel Lido Caparena, Sala Convegni B

09:00-10:30
SESSION V: METALS II
Chair: P. Wagener, University of Duisburg-Essen, Technical Chemistry I & Center for Nanointegration Duisburg-Essen (CeNIDE) (DE)

09:00-09:30 **Invited talk** 33
Pulsed Laser Ablation In Liquid For Hollow Structure Generation
Z. Yan[1], N.F. Scherer[1], D.B. Chrisey[2]; [1]James Franck Institute, The University of Chicago (US); [2]Department of Materials Science and Engineering, Rensselaer Polytechnic Institute (US).
The process of pulsed laser ablation of metals in liquid (PLAL) is a library of constituents, interactions and time-scales, and an understanding of its disparate regions of parameter space will facilitate the reproducible fabrication of micro-/nanostructures almost by design. Herein, we describe a comprehensive mechanistic scenario of pulsed laser ablation in liquid with an emphasis on the role of laser-produced bubbles. The laser-generated particles tend to aggregate on the bubble surface to decrease the free energy of the colloidal solution, resulting in hollow particles. [5247]

09:30-09:50 34
Laser assisted synthesis of multifunctional magnetic nanostructures
V. Amendola, M. Meneghetti; Department of Chemical Sciences, University of Padova (IT).
Laser ablation and laser irradiation in liquids can be used respectively for the synthesis and the dimensional control of functional nanostructures. However, the crystalline phase of the final product is strongly related to the chemical properties of the starting material and of the liquid environment. For instance, laser ablation of a bulk target of iron can yield oxide, carbide or metal nanoparticles (in some cases, even with a core@shell metal@graphite structure), just by varying the solvent. The case study of laser-assisted synthesis of magnetic nanomaterials with nanosecond-pulses will be presented. Moreover, we will show how laser assisted techniques can be used as a common platform for combining magnetic and plasmonic properties in a single multifunctional nanotool for biomedical applications. [5210]

09:50-10:10 35
Preparation of submicron-sized spherical particles of gold using laser irradiation in liquids
T. Tsuji[1], T. Yahata[1], M. Tsuji[1], N. Koshizaki[2], Y. Ishikawa[3]; [1]Kyushu University (JP); [2]AIST (JP); [3]Kagawa University (JP).
Laser irradiation is a powerful technique for the size-modification of colloidal particles. In general, focused laser light at high fluence enough to cause the fragmentation of colloidal particles is used to reduce particle size.
Recently, Ishikawa and Koshizaki have revealed that irradiation of non-focused laser light at moderate fluence for nanoparticles (NPs) of various materials induces the fusion of the NPs, and remarkably, submicron-sized spherical particles (SMPs) with narrow size distribution were formed. In our research, we apply this technique to obtain gold SMPs with minimum additional substances. For example, such pure gold SMPs will be useful to fabricate SALDI substrates. [5217]

10:10-10:30 36
One pot synthesis of Cu-based bifunctional nanoparticles by ps laser ablation
E. Giorgetti[1], P. Marsili[1], D. Scarpellini[1], S. Trigari[1], F. Giammanco[2], M. Muniz Miranda[3]; [1]Istituto dei Sistemi Complessi, Consiglio Nazionale delle Ricerche (IT); [2]Department of Physics "E. Fermi", University of Pisa (IT); [3]Department of Chemistry, University of Firenze (IT).
Bifunctional metal nanoparticles (NPs) are attractive structures, which combine the nanoscale properties of two different materials, i.e. two metals or a metal and an oxide. For example, Cu/Ag bifunctional nanoparticles are expected to exhibit the Raman enhancing properties of both copper and silver in a wider spectral range and, at the same time, the catalytic and bactericide properties of both metals. In principle, by using such structures, it would be possible to catalyze and monitor by Raman spectroscopy a chemical reaction directly to the single NP level.
This contribution is aimed at describing a one-pot synthesis procedure, which allows preparing stable, uncapped, Cu-based bifunctional nanoparticles in water. [5185]

10:30-11:00 Coffee break

Hotel Lido Caparena, Sala Convegni B

11:00-12:20
SESSION VI: PLASMA AND SAXS SPECTROSCOPY
Chair: M. Meneghetti, University of Padua (IT)

11:00-11:20 37
Study on the role of laser cavitation bubble for the production of NPs by laser ablation of metals in water
A. De Giacomo[1,2], A. Santagata[2], M. Dell'Aglio[2], R. Gaudiuso[1], A. De Bonis[3], G.C. Messina[4], G. Compagnini[4], P. Wagener[5], S. Barcikowski[5]; [1]University of Bari, Department of Chemistry (IT); [2]Institute of Inorganic Methodologies and Plasmas-CNR (IT); [3]University of Basilicata, Department of Chemistry (IT); [4]University of Catania, Dipartimento di Scienze Chimiche (IT); [5]University of Duisburg-Essen, Technical Chemistry I & Center for Nanointegration Duisburg-Essen (CeNIDE) (DE).
In this work the laser ablation of a metal target submerged in water has been performed. With the aim of relating the properties of the laser induced cavitation bubble dynamics with the formed nanoparticles (NPs) different experimental conditions have been used. Laser induced cavitation bubble is a dynamic process whose features are mainly dependent on the laser pulse parameters, external liquid pressure and target geometry. For highlighting this, the plasma formation and bubble evolution have been studied, in different experimental conditions (laser energy, target shape and liquid pressure) by time resolved optical emission spectroscopy and shadowgraphy, respectively. [5236]

11:20-11:40 38
Observation of optical emission intensity from laser ablation plasma produced in supercritical water
K. Sasaki[1], H. Goto[2], N. Takada[2]; [1]Division of Quantum Science and Engineering, Hokkaido University (JP); [2]Department of Electrical Engineering and Computer Science, Nagoya University (JP).
As is known from the name of this conference, the trend of nanoparticle generation by laser ablation is shifting towards the process in liquid phase from conventional gas-phase laser ablation. In this work, we focused our interest on supercritical water as the third medium for laser ablation. Supercritical fluids are attractive as the medium for laser ablation because of high chemical reactivity and distinctive thermodynamic parameters. We observed optical emission intensity from laser ablation plasma produced in supercritical water. [5198]

11:40-12:00 39
A structural view on particle formation inside the cavitation bubble
A. Plech[1], S. Ibrahimkutty[1], P. Wagener[2], A. Menzel[3], S. Barcikowski[2]; [1]Institute for Synchrotron Radiation, Karlsruhe Institute of Technology (DE); [2]University of Duisburg-Essen, Technical Chemistry I and Center of Nanointegration Duisburg-Essen (CeNiDE) (DE); [3]Paul Scherrer Institut (CH).
Pulsed laser ablation in liquids is a highly dynamic mechanism involving cluster ejection, particle aggregation and cavitation. The clarification of these phenomena requires the application of fast analytical methods of structure determination. By using X-ray scattering as an ultrafast probe for the structure formation, the nanoscale evolution is accessible.
We have performed both pump-probe experiments on nanoparticles in suspension, as well as particle formation within ablation plumes on a target surface, which show rich phenomena including particle size evolution. [5165]

12:00-12:20 40
Optical spectroscopy of the plasma: a tool for the growth process analysis
D. Amans[1], M. Diouf[1], G. Ledoux[1], C. Dujardin[1], K. Masenelli-Varlot[2]; [1]Université de Lyon, Université Lyon 1, UMR 5620, Laboratoire de Physico-Chimie des Matériaux Luminescents (FR); [2]Université de Lyon, INSA-Lyon, UMR 5510 (FR).
Pulsed laser ablation in liquids has demonstrated its versatility to obtain a wide variety of nanoparticles. Nevertheless the involved growth processes of nanoparticles (seeds growth, interaction liquid-plasma) are still largely misunderstood. The case of carbon compounds synthesis is particularly interesting: nano-diamon, nano-graphite, onion…. The growth of these various phases is mainly driven, for the bulk, by the pressure. In the case of PLAL, the key parameters are more subtle and some questions remain to be addressed: Are the high pressures (shockwave) necessary or not (like in CVD growth) ? Does the Laplace-Young pressure explain the nanoparticles sizes? Does the ratio between C and C_2 drive the competition between sp^3 and sp^2 structures? Checking the plasma thermodynamic behavior as well as the species appearing during the synthesis is a key point to understand the growth process. We present a plasma analysis inspired from the light induced breakdown spectroscopy. [5199]

12:20-13:45 Lunch break

Hotel Lido Caparena, Sala Convegni B

13:45-15:45
SESSION VII: BIO APPLICATIONS
Chair: T.E. Itina, Laboratoire Hubert Curien, UMR CNRS 5516 (FR)

13:45-14:15 **Invited talk**

Bioconjugation of gold nanoparticles obtained by laser ablation for targeting tumour cells and imaging with Surface Enhanced Raman Scattering reporters 41

M. Meneghetti[1], V. Amendola[1], A. Scarsi[1], L. Litti[1], M. Gobbo[1], A. Boscaini[2], M. Di Chio[3], G. Fracasso[2], M. Colombatti[2]; [1]Department of Chemical Sciences, University of Padova (IT); [2]Department Public Health and Community Medicine, University of Verona (IT); [3]Department of Pathology and Diagnostic, Section of Immunology, University of Verona (IT).

Plasmonic is an emerging field for nanomedicine applications which need new and efficient materials for diagnostic and therapeutic purposes. Localized surface plasmon resonances are interesting excitations of nanostructured metal nanoparticles which can be exploited for different applications both in diagnosis and therapy. The dimensions of nanoparticles, usually below 100 nm, are ideal for an interaction at the level of single cells which have dimension of the order of tens of microns and recognize submicron structures, in particular those of the order of some tens of nanometers. Among metal nanoparticles, gold nanoparticles are interesting because of their proved biocompatibility which, sometimes, is questioned only because of the stabilizing molecules which are needed in the case they are obtained by a reduction process. [5180]

14:15-14:35 **STUDENT PRESENTATION**

Preservation of biomolecule functionality and integrity during laserbased fabrication and laser-induced ligand release of functional nanobiohybrids 42

A. Barchanski, M. Meißner, C.L. Sajti; Laser Zentrum Hannover e.V., Nanotechnology Department (DE).

Functional nanobiohybrids from gold nanoparticles (AuNP) conjugated with effective biomolecules feature a broad application range in biomedical and regenerative sciences, covering advanced cell imaging and controlled cargo delivery with local release. On the other hand, nanoparticles applied for in vivo applications require an ultrapure particle surface which can be realized by pulsed laser ablation in liquids (PLAL) in particular. Bioconjugation of PLAL-fabricated AuNP with thiolated molecules can be easily performed in one-step during the ablation process (in situ), resulting in stable conjugates with strong ligand binding and controlled molecule loading on the AuNP surface. From the productivity point of view, longer laser pulses scale up the efficiency of AuNP production compared to fs-pulsed ablation, functionality and integrity of conjugated biomolecules becomes crucial and strongly correlates with laser and ablation parameters applied during the in situ conjugation process. For biomolecule release purposes for instance in cellular drug delivery by laser light exposure, these parameters have to be considered carefully. [5241]

14:35-14:55 **STUDENT PRESENTATION**

Super-SERS-Active Substrates and highly Effective Antimicrobial Activities of Silver Nanoparticles Synthesized by Laser Ablation in Liquids 43

H.B. Li, P. Liu, Y. Liang, G.W. Yang; State Key Laboratory of Optoelectronic Materials and Technologies, Institute of Optoelectronic and Functional Composite Materials, Nanotechnology Research Center, School of Physics & Engineering, Sun Yat-sen University (CN).

In recent decades, laser ablation of a solid target in a liquid environment has been widely used in preparation of nanomaterials and fabrication of nanostructures. Remarkably, there are many groups that pay attention to this issue in the world, and a large variety of nanomaterials such as metals, metallic alloys, semiconductors, polymers, and etc, have been synthesized using laser ablation of solid in liquid. Therefore, laser ablation in liquids (LAL) has been recognized to be an effective and general route to synthesize nanocrystals and fabricate nanostructures. In this study, using LAL, we synthesized silver nanoparticles (NPs) in different solvents show different in formation rate, particle size, particle size distribution, the stability of the colloid solution. [5149]

14:55-15:25 **Invited talk**

Nanoparticles and ultrashort lasers in biophotonics 44

A. Heisterkamp[1,3], J. Krawinkel[1], M. Schomaker[2,3], D. Heinemann[2,3], H. Meyer[2,3]; [1]Friedrich-Schiller -University Jena, Institute of Applied Optics (DE); [2]Laser Zentrum Hannover, Biomedical Optics (DE); [3]REBIRTH Excellence Cluster (DE).

Nanoparticles have a widespread use in biophotonics especially as biomarkers a nd sensors. In this talk another aspect of nanoparticles, in particular gold nanoparticles (AuNP), will be addressed. Using ultrashort laser pulses, the near-field scattering of the electric field at the particles allows the confinement of optically delivered energy into the vicinity of the AuNP. Usually these laser pulses are focused by high NA objectives to enable subcellular manipulation with high cell viabilities. If AuNP are used and are attached to a cell membrane, this membrane can be opened transiently by this interaction, being an efficient delivery method for impermeable molecules into the cell. Different effects may occur when irradiating an AuNP with ultrashort laser pulses and finally enable the molecule to transfer. [5294]

Hotel Lido Caparena, Sala Convegni B

15:25-15:45 STUDENT PRESENTATION

Development of Plasmonic nanosensors for imaging cancerous cells

S. Das, J. Turunen; Department of Physics and Mathematics, University of Eastern Finland (FI).

In 2010, a survey conducted all over the world says that more than 7 million humans around the world died of cancer. One in three women and one in two men developed cancer during their lifetime. About 15 percent of all deaths worldwide, was attributed to cancer. In some nations, cancer will surpass heart disease to become the most common cause of death. This paper attempts to demystify the behaviour of cancer-the defining plague of our generation. Here, we present a novel method based on silver nanoparticle-generated transient photothermal vapour nanobubbles. These intracellular plasmonic nanobubbles are effective in the diagnosis (by optical scattering) and treatment (by mechanical, nonthermal and selective destruction of target cells) of cancerous cells. [5146]

15:45-16:15 Coffee break

16:15-17:15

SESSION VII: BIO APPLICATIONS (continued)

Chair: A. HeisterkampFriedrich-Schiller-University Jena, Institute of Applied Optics (DE) & REBIRTH Excellence Cluster , (DE)

16:15-16:35 45

Influence of laser process parameters on NPs generation during ablation of metals in liquid for antimicrobial application with ultrashort CPA laser system

T. Sibillano[1], D. Longano[2], N. Ditaranto[2], A. Conte[3], A. Ancona[1], N. Cioffi[2], F.P. Mezzapesa[1], M.A. Del Nobile[3], A. Valentini[4], L. Sabbatini[2], L. Torsi[2]; [1]CNR-IFN Istituto di Fotonica e Nanotecnologie UOS BARI, Dipartimento Interateneo di Fisica "M. Merlin" (IT); [2]Dipartimento di Chimica, Università degli Studi di Bari "Aldo Moro" (IT);[3]BIOAGROMED (IT); [4]Dipartimento Interateneo di Fisica "M. Merlin" (IT).

Pulsed laser ablation of a metal target in liquid ambient has been used to fabricate colloidal metallic nanoparticles in recent years, offering several advantages in contrast to the chemical procedures. In this work, an experimental study on the influence of several laser parameters in the generation and properties of metal nanoparticle colloids is reported. A novel Yb-doped fiber based CPA laser system delivering a 100 µJ maximum pulse energy with a repetition rate up to 10 MHz and pulse duration variable from ps to fs has been used for nanoparticle generation. We compared the influence of the main process parameters on the ablation efficiency and nanoparticle properties of various metals in a stationary liquid. [5227]

16:35-16:55 46

Size control and protein conjugation of ligand-free, laser-fabricated gold nanoparticles by delayed conjugation in liquid flow

C. Rehbock, P. Wagener, L. Gamrad, S. Barcikowski; University of Duisburg-Essen, Technical Chemistry I and Center of Nanointegration Duisburg-Essen (CeNiDE) (DE).

Due to their high quantum yield, low photobleaching and excellent biocompatibility, bioconjugated gold nanoparticles are widely used in medical diagnostics and therapy. The conjugation of these nanoparticles with proteins is particularly interesting as they form a corona around the particle, which significantly affects their impact on biological systems. Fabrication of bioconjugates by pulsed laser ablation in liquid is a promising alternative to chemical synthesis as ligand-free particles can be obtained and thus the interactions of proteins with bare nanoparticle surfaces can be studied In this work, an advanced method based on delayed conjugation in liquid flow is presented, where continuous nanoparticle generation and bioconjugation are spatially separated. [5162]

16:55-17:15 47

Highly Efficient and Controllable Surface Functionalization of Gold Nanoparticles Prepared by Femtosecond Laser Ablation in Water

W. Qian, M. Murakami, Y. Ichikawa, Y. Che, A. Marcinkevicius; IMRA America, Inc. (US).

For every biomedical application of gold nanoparticles, stability, biocompatibility, and targeting efficacy are the key requirements and surface modifications are essential for meeting these requirements. Although various surface modification strategies have been established, the fabrication of gold nanoparticles conjugated with a defined number of one or multiple types of ligands still presents a major challenge. In this presentation, we address this challenge by demonstrating highly efficient and controllable PEGylation of gold nanoparticles produced by femtosecond laser ablation. [5215]

17:15 **EOS STUDENT & POSTER AWARD CEREMONY**

17:30 **END OF EOS TOPICAL MEETING**

Wednesday, 23 May, 19:00 - 20:30 CEST - Roof Terrace La Pergola, Hotel Lido Caparena

ANGEL2012_5151_001 STUDENT PRESENTATION

Fabrication and Cathodoluminescence Performance of Zinc Molybdates Micro- and Nanoplates and Rods upon Electrochemistry Assisted Laser Ablation in Liquids 49

Y. Liang, P. Liu, H.B. Li, G.W. Yang; State Key Laboratory of Optoelectronic Materials and Technologies, Institute of Optoelectronic and Functional Composite Materials, Nanotechnology Research Center, School of Physics & Engineering, Sun Yat-sen University (CN).

Polyoxometalates (binary-metal oxides containing Mo, W, V, Ta and a second transition metal such as Cu, Fe, Co, Ni species) have been studied extensively due to industrial interest in the area of catalysts in crude oil refining technologies, photochromisms, magnetism, sorption, and energy storage. In order to promoting performance of polyoxometalates, researchers have developed a variety of techniques for the synthesis of polyoxometalate nanostructures. However, these methods have some visible flaws such as synthesis route requiring high temperature or high pressure condition, introducing of various templates or additives, and demanding of complicated synthetic procedures and causing impurities in final products, etc, which actually restrict their applications in industrial. Therefore, developing new synthesis of polyoxometalate nanostructures are becoming urgent in technical demand. In this study, we propose a general strategy for fabricating polyoxometalate nanostructures: electrochemistry assisted laser ablation in liquid (ECLAL).

ANGEL2012_5156_002

Applications of metal nanocolloids prepared by high efficient laser ablation 50

T. Nishi, N. Suzuki, H. Sugiyama, K. Yano; TOYOTA CENTRAL R&D LABS., INC. (JP).

Low nanoparticle yield has been serious problem in laser ablation for nanoparticle generation. Improvement of nanoparticle yield in laser ablation in liquid has been studied. As the result, high nanoparticle yield could be achieved by low fluence laser irradiation. The experimental setup is shown in Fig. 1. In this method, the interaction between incident laser light and nanoparticles produced by previous pulse can be practically prevented. Therefore, continuous nanoparticle generation is also possible.

In the case of silver, nanoparticle yield of more than 20 mg/h could be achieved using second harmonic Nd:YAG laser light with the fluence of 0.5 mJ/cm^2. In addition, nanoparticles have been dispersed in liquid without any chemical reagent. Antibacterial activities of silver nanocolloids are shown in Fig. 2. Silver nanocolloid show bactericidal activity against bacterium coli.

In the presentation, we will introduce another method to produce, which also achieve high yield.

ANGEL2012_5158_004 STUDENT PRESENTATION

Turbostratic shell encapsulated ZrO_2 nanoparticles and high-pressure $ZrSiO_4$ phase by PLA on Zr in TEOS 51

C.H. Wu[1], S.Y. Chen[2], P. Shen[1]; [1]National Sun Yat-sen University, Department of Materials and Optoelectronic Science (TW); [2]I-Shou University, Department of Mechanical and Automation Engineering (TW).

Pulsed laser ablation (PLA) on Zr plate in TEOS was employed to fabricate C-Si-H signified ZrO_2 nanocondensates and a high-pressure $ZrSiO_4$ phase. The ZrO_2 particles with relatively large size were relaxed to have ambient cell parameters and vulnerable to t→m transformation whereas the ones less than 10 nm in size were ca. 10% densified to retain the cubic (c) and t-symmetry. The lattice densification can be rationalized by miniature size to exert a significant capillarity effect besides the rapid heating and cooling effect of the PLA process.

ANGEL2012_5159_005 STUDENT PRESENTATION

Effect of Solution Temperature on Gadolinium Oxide Nanoparticles Growth by Pulsed-Laser Ablation in Liquid 52

N. Luo, G. Yang, D. Chen; Sun Yat-sen University, State Key Laboratory of Optoelectronic Materials and Technologies (CN).

Since the pioneer work of pulsed-laser ablation in liquid (PLAL) had been reported by Patil et al, PLAL has been used in generating nanoparticle colloids of various materials due to its simple procedure. Though gadolinium oxide (Gd_2O_3) nanoparticles have been considered as potential positive magnetic resonance imaging (MRI) contrast agents, there is little work about its preparation by PLAL. In this paper, a microsecond Nd:YAG laser (λ = 1064nm) with 6 μs pulse duration at a repetition rate of 10 Hz -1 kHz was employed to ablate a gadolinium target immersed in the liquid.

Wednesday, 23 May, 19:00 - 20:30 CEST - Roof Terrace La Pergola, Hotel Lido Caparena

ANGEL2012_5163_006 STUDENT PRESENTATION

Tungsten Oxide Nanoflakes Synthesized by Laser Ablation in Liquids and Highly Gas Sensitive Performance

J. Xiao, P. Liu, Y. Liang, H.B. Li, G.W. Yang; State Key Laboratory of Optoelectronic Materials and Technologies, Institute of Optoelectronic and Functional Composite Materials, Nanotechnology Research Center, School of Physics & Engineering, Sun Yat-sen University (CN).

Tungsten oxide (WO_3) have attracted extensive attention in recent years due to their excellent physical and chemical properties, such as electrochromism, photochromism, gaschromism, high sensitivity gas sensing and etc, and thus have been widely used for Infrared switching devices, catalyst, and practical gas sensors. Moreover, the nanostructures of tungsten oxide have been provided to have better performance in gas sensing and a faster rate of photochromism than that of bulk materials, owing to their large surface-to-volume ratio and quantum size effect. Thus, various methods for fabricating tungsten oxide nanostructures have been reported recently, such as sol-gel, sputtering and thermal evaporation technologies.

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ANGEL2012_5166_007 STUDENT PRESENTATION

Mechanically-induced lattice defects in ZnO microparticles boost laser fragmentation efficiency

M. Lau[1], P. Wagener[1], S. Breitung-Faes[2], A. Kwade[2], S. Barcikowski[1]; [1]Technical Chemistry I and Center for Nanointegration Duisburg-Essen (CeNIDE), University of Duisburg-Essen (DE); [2]Institute for Particle Technology, Technische Universität Braunschweig (DE).

Laser fragmentation of microparticles in liquid is a promising and versatile approach to generate colloidal nanoparticles (NP). A current challenge in laser-based synthesis of NPs is to enhance NP-productivity and efficiency of the fragmentation process. In this work, we show how productivity could be increased by a simple mechanical pre-treatment of the microparticle educt in a stirred-media mill. As can be seen in fig. 1, pre-milling of microparticles strongly enhances laser fragmentation efficiency probably caused by lattice defects which were generated during the milling process.

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ANGEL2012_5171_008 STUDENT PRESENTATION

PEDOT:PSS/AuNPs-nanocompounts by preparation of Gold Nanoparticles in an aqueous solution of PSS using laser ablation

A. Essaidi, M. Chakif, B. Schöps, A. Aumann, Q. Guo, S. Abreu Fernandes, S. Xiao, K. Kowalick, C. Esen, A. Ostendorf; Ruhr-University Bochum, Department of Laser Applications Technology (DE).

In this paper, we describe a new method to obtaining stabilized *poly(3,4-ethylene-dioxythiophene):Poly(sodium 4-styrenesulfonate)/gold nanoparticles* composite (PEDOT:PSS/AuNPs). In a first step, gold nanoparticles (AuNPs) were produced by picoseconds laser ablation of a gold metal plate in an aqueous solution of *Poly(sodium 4-styrenesulfonate)* (PSS). The aqueous dispersions of AuNPs/PSS were doped in a second step with conducting polymer of *poly(3,4-ethylene dioxythiophene)* (PEDOT) by mixing the prepared AuNPs/PSS-composite with PEDOT:PSS aqueous solution to formulate a conducting polymer-nanocomposite (PEDOT:PSS/AuNPs). This nanocomposite is expected to be used as improved conducting layers in different optoelectronic devices such as electrochromic devices, organic light-emitting diode (OLED), organic solar cells (OSC), etc.

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ANGEL2012_5174_009 STUDENT PRESENTATION

Gold nanoparticles obtained by pulsed laser ablation in liquids: formation of monolayers on chemically functionalized patterns/substrates

R. García-Calzada[1], P. Rodríguez-Cantó[1], V. Chirvony[1], R. Abargues[2], J. Martínez-Pastor[1]; [1]Instituto de Ciencia de los Materiales, Universidad de Valencia (ES); [2]Intenanomat S.L. (ES).

The advantages of nanoparticles (NPs) synthesized by pulsed laser ablation in liquids (PLAL) include chemical purity, high colloidal stability without capping agent due to a charged surface,a possibility of efficient *in situ* (bio)conjugation, and others. In the present work we show that not only colloidal solutions, but also layers formed by Au NPs synthesized by PLAL method demonstrate advantages as compared to those formed by chemically synthesized Au NPs bearing charged ligands. It is worth noting that high-quality immobilization of NPs on solid substrates is crucially important for development of solid-state nanotechnology.

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Wednesday, 23 May, 19:00 - 20:30 CEST - Roof Terrace La Pergola, Hotel Lido Caparena

ANGEL2012_5176_011 STUDENT PRESENTATION

Structure and optical property modifications of iron oxide nanoparticles via pulsed laser ablation in water 57

Y. Zheng[1], P. Shen[1], S.Y. Chen[2]; [1]National Sun Yat-sen University, Department of Materials and Optoelectronic Science (TW); [2]I-Shou University, Department of Mechanical and Automation Engineering (TW).

Hematite (α-Fe_2O_3) powders microns in size were subjected to pulsed laser ablation (PLA, using Nd-YAG laser under 532 nm excitation and 400 mJ fluence) in water to fabricate sesquioxide nanoparticles with tailored structure and optical properties. The Fe_2O_3 nanoparticles thus formed are less than 5 nm in size with a predominant γ-type (maghemite) and minor α-type structure as indicated by X-ray diffraction (Cu Kα) and representative lattice images taken by transmission electron microscopy (TEM, FEI Tecnai G2 F20 at 200 kV). The ultrafine α-Fe_2O_3 and γ-Fe_2O_3 nanoparticles were densified and hydrogenated to affect the surface energy and hence the phase stability. In this connection, a hydrated surface of α-Fe_2O_3 and γ-Fe_2O_3 was known to have smaller surface energies.

ANGEL2012_5181_012 STUDENT PRESENTATION

Laser generation of stoichiometric PtIr alloy nanoparticles for electrophoretic coating of neural electrodes 58

J. Jakobi[1], K. Schwabe[2], J.K. Krauss[2], S. Barcikowski[1]; [1]University of Duisburg-Essen, Technical Chemistry I and Center of Nanointegration Duisburg-Essen (CeNiDE) (DE); Hannover Medical School, Department of Neurosurgery (DE).

Laser generation of nanoparticles in liquids provides not only pure colloids, but also enables a versatile liquid-target combination. Not at least, the generation of alloy nanoparticles in volatile solvents with specific properties is also possible and is one of the benefits of this method.
We will show recent results on laser generation of PtIr alloy nanoparticles in organic liquid including analysis of nanoparticle ultrastructure. Furthermore, the possibility of electrophoretic coating with electrostatically stabilized nanoparticles will be discussed at the example of PtIr neural electrodes.

ANGEL2012_5182_013

Rutile micro and nanostructures obtained by ultrashort laser ablation of titanium in liquid 59

A. De Bonis[1], A. Galasso[1], N. Ibris[2], A. Laurita[2] , A. Santagata[3], R. Teghil[1]; [1]Università della Basilicata, Dipartimento di Chimica "A.M. Tamburro" (IT); [2]Università della Basilicata, C.I.G.A.S. (IT); [3]CNR-IMIP, Unità di Potenza (IT).

Titanium oxide nanostructures have been produced by ultrashort laser ablation of a titanium target in water. Laser pulse duration of 100fs (800nm, 1KHz) and 250fs (527nm, 10Hz) were applied. The obtained nanostructures have been observed and characterized by AFM, SEM, HR-TEM, Micro-Raman and XRD. Varying the focusing conditions, nanoparticles of different dimensions have been obtained. In any case, the nanoparticles have a mean diameter in the range of 20nm with a typical rutile crystal structure. Moreover, AFM images show the presence of nanowires with a diameter and length of tens and hundreds of nm, respectively.

ANGEL2012_5184_014 STUDENT PRESENTATION

The effects of post-irradiation and ambient ions on the stability of gold nanoparticles produced by laser ablation in water 60

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We investigated the effects of post-irradiation at 266, 355, 532, and 1064 nm on gold nanoparticles (NPs) produced by laser ablation in deionized water. The size distribution of gold NPs was broadened to generate large NPs and the long-term stability (up to 55 days) deteriorated significantly upon irradiation at 266 and 532 nm while there were no apparent changes at 355 and 1064 nm as shown in Fig.1. Also, we examined the stability of gold NPs formed in different salt solutions such as LiCl, NaCl, KCl, NaBr, and NaI. The stability as well as the size distribution of NPs turned out to be highly dependent on the ions.

Poster presentations

Wednesday, 23 May, 19:00 - 20:30 CEST - Roof Terrace La Pergola, Hotel Lido Caparena

ANGEL2012_5194_018 STUDENT PRESENTATION

Fabrication of various carbon nanostructures by Q-switched Nd:YAG laser ablation of graphite in water 61

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In the past decades, research on carbon nanomaterials has developed tremendously because of unique physical and chemical properties. Carbon exists as three well known allotropes, distinguished by their orbital hybridisations: diamond, graphite and carbyne, with sp^3, sp^2 and sp^1 structures, respectively. In 1978, Strelnitskii et al. observed a new crystalline phase of carbon that was named C_8, because there are eight carbon atoms in the primitive cell with the body-centered cubic (bcc) phase.

ANGEL2012_5196_019

The physical effects on the formation of polyynes by liquid laser ablation 62

Y.E. Park, S.K. Shin, S.M. Park; Department of Chemistry, Kyung HeeUniversity (KR).

Polyynes were preparedby laserablation of a graphite target in deionized water changing physical parameters such as ablation wavelength (266, 355, 532, and 1064 nm), power, and timein order to elucidate their effects on the carbon chain length and formation efficiency of polyynes. We analyzed the UV-Vis spectra of polyyne solutions and examined the branching ratios of C_6H_2, C_8H_2, and $C_{10}H_2$ as well as their concentrations at different ablation conditions. It turned out that the amount of polyynes increased with the ablation laser wavelength while the branching ratios were highly wavelength-dependent.

ANGEL2012_5200_020

Investigation of physical properties of magnetic Nd-Fe-B-C nanoparticles generated in Distilled water using Nd:YAG laser 63

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In this work, Nd -Fe- B-C magnetic nanoparticles were generated by pulse of Nd:YAG Laser irradiation on the Nd -Fe- B-C magnetic target in Distilled water. Percentages of Element in bulk and nano-particles were investigated by energy- dispersive X-ray (EDAX) .mean particle sizes of the samples were analyzed by transmission electron microscope (TEM). The average size of the nanoparticles was 6.23 nm. A typical SAED ring pattern from the nanocrystals showed a tetragonal structure in Nd -Fe- B-C nanoparticles similar the bulk sample. Magnetic force microscope (MFM) represents the magnetic properties in nanoparticle were preserved.

ANGEL2012_5201_021 STUDENT PRESENTATION

Pulsed laser ablation in liquids containing a complexing molecule: impact on the phase of oxide nanoparticles 64

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In this contribution, we present the impact of complexing molecules on the growth of doped oxides nanoparticles during laser ablation in liquids. Two particular effects of complexing agents will be discussed: (i) Their ability to avoid the formation of coarse particles with broad size distributions and the formation of very unstable precipitates and (ii) the growth, out of the thermodynamic equilibrium, that can lead to a blend of different phases (for a given stoichiomety) and compositions (for complex stoichiometries: ternary, quaternary…). These molecules can be tentatively used to select a crystallographic phase, but the effect on the stoichiometry is not demonstrated.

ANGEL2012_5206_022

Optical Characterization of Laser ablated Copper/Copper Oxide Nanocomposites 65

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Copper/copper oxide nanocomposites were prepared by laser ablation from a copper target in tetrahydrofuran with 0.0 wt% and 0.8 wt% concentrations of polystyrene. Ablation was performed with second harmonic of pulsed nanosecond Nd:YAG laser (532 nm). We used 80 and 150 mJ pulse energies. The ultraviolet-visible absorption spectra indicated two shoulders at 300 nm and 340 nm. The photoluminescence emission spectra (excited by 350 nm) displayed two broad range of peaks centered at 760 nm and 800 nm for the first measurement which confirmed the production of Cu/Cu_2O nanocomposites. After 6 months, the photoluminescence emission spectra showed three peaks at 380, 400 nm and 420 nm.

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ANGEL2012_5207_023 STUDENT PRESENTATION

Synthesis of biocompatible fluorescent HAp quantum dots

66

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Fluorescent quantum dots such as CdSe, CdS, ZnS, InP, and InAs, etc. have been developed and applied as novel cell labeling agents. However, poor solubility, poor biocompatibility, and disposal issues make these quantum dots impractical in some applications. Hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$, HAp) nanoparticles have gained increasing interest in medicine because of their high biocompatibility and good biodegradability which is due to the fact that calcium phosphate is the inorganic mineral of human bone and teeth. Due to their biodegradable nature, HA nanoparticles may serve as an ideal candidate for both cancer diagnosis and cellular labeling. Rare earth doped Hap nanoparticles with visible excitation can be used as florescent probes in biomedical applications. Liquid phase pulsed laser ablation (LP-PLA) is a unique and promising technique for synthesis of chemically pure nanoparticles (NPs) in liquid.

In this paper, we report the growth of chemically pure europium doped HAp nanoparticles synthesized by LP-PLA technique using third harmonics (355nm) of Nd-YAG laser.

ANGEL2012_5211_025

Size selection in centrifugal field of chemical-free noble metal nanoparticles obtained by laser ablation

67

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Noble metal nanoparticles (MNPs) obtained by laser ablation in liquids are free of chemical by-products, can be easily functionalized and are stable for long time (especially in water). However, their full exploitation is often limited by the poor size distribution, when compared to state of the art MNPs obtained by wet chemistry approaches. Density gradient ultracentrifugation (DGU) is an established technique to sort nanomaterials such as carbon nanotubes, graphite flakes and recently it was demonstrated to be effective also for the size selection of MNPs. However, the proposed separation techniques exploit salts and/or other chemicals, for the formation of density gradients. This inevitably depresses the stability and the purity of MNPs.

Here, we show two sorting approaches, based on preparative ultracentrifugation, which reduced the standard deviation of MNPs from 65% to 30-10% without affecting the peculiarities of MNPs produced by laser ablation.

ANGEL2012_5212_026

Single-Molecule Surface-Enhanced Raman Scattering from Gold and Silver Nanoparticles Obtained by Laser Ablation

68

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Single-Molecule Surface-Enhanced Raman Spectroscopy (SM-SERS) provides information about the inner structure of species, as well as about the local environment. The pattern of vibrations appearing in Raman spectra may be used to probe a local plasmon resonance distribution. This distribution allows to characterize new-synthesized substrates and the molecular interaction/orientation with respect to nanoparticles surfaces. Up to date most SM-SERS substrates have been prepared by chemical synthesis of nanoparticles.

ANGEL2012_5214_027 STUDENT PRESENTATION

Core-shell silicon-graphite nanoparticles and carbon nano-onions produced by laser ablation of a Si target in chloroform: formation mechanism

69

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It has been recently shown that pulsed laser ablation in some organic liquids, first of all in toluene, can result in formation of carbon byproducts: graphite shells around gold and Si nanoparticles, free-standing fullerene-like carbon spheres. However, the formation mechanism of carbon by-products remains to be unclear.

In the present study we show that pulsed laser ablation of a Si target in chloroform ($CHCl_3$) results in formation of the core-shell structures consisting of multicrystalline nanoparticles (NP, the core), which include Si and SiC nanocrystalls of ≈10 nm diameter, and multilayer graphite shell wrapping the NPs. Besides, a large number of carbon nano-onions is formed. It turned out that carbon products formation in chloroform is much more effective than in toluene and other organic solvents.

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ANGEL2012_5216_028 70

Effect of inert atmosphere on nanosecond laser ablation of Ag in water and on subsequent Ag nanoparticle fragmentation

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Laser ablation (LA) of Ag and/or Au in water is usually carried out under aerobic conditions, i.e. in air, e.g. Interestingly, the first experiments on LA in liquids were carried out under argon. In this contribution, we evaluate the effect of inert atmosphere on nanosecond laser ablation of Ag in water and on the subsequent Ag nanoparticle fragmentation (NF). In particular, a four step Ag foil laser ablation-Ag nanoparticle fragmentation procedure in ultrapure water was carried out both under argon and in air. Nd/YAG laser pulses were used for laser ablation (1064 nm) and for the three step Ag hydrosol treatment in the absence of Ag foil in the sequence 1064/532/1064 nm. TEM and surface plasmon extinction (SPE) spectra provide evidence of larger Ag nanoparticle (NP) formation and of their efficient fragmentation in the second and third step of the procedure carried out under argon.

ANGEL2012_5218_029 STUDENT PRESENTATION 71

Plasmonic nanoparticles as SERS ultrasensitive sensors

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The realization of sensors with superior chemical specificity and sensitivity is the main aim in the research area of molecular sensing. It is of great importance to be able to detect small amounts of chemical species, ranging from toxic gas molecules for environment sustainability to biomolecules for analytical medicine.

Plasmonics can give excellent contributions for ultrasensitive detection sensors. The enhancement of the local electromagnetic field nearby a metal nanostructure surface can be exploited for *Surface Enhanced Raman Spectroscopy* (SERS). This technique gives the possibility for a highly specific detection and its sensitivity can be increased by choosing the appropriate excitation wavelength resonant with the plasmonic structure. In fact the plasmonic extinction band can be tuned in a wide spectral range, from the UV-Vis to the near IR, by simply varying the morphology and the dimensions of metal nanostructures.

The aim of this work is to compare the enhancement performance of different gold nanoparticles (NPs) in the visible and near-IR range.

ANGEL2012_5224_031 STUDENT PRESENTATION 72

Advanced liquid flow reactor designs for laser ablation in liquid

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Today's state-of-the-art in laser-fabrication of nanoparticles is usually carried out in stationary batch chambers. These systems are almost universal and can be used for a broad range of materials, but they also involve several limitations such as low reproducibility and productivity because of residence time dispersion and post-irradiation side-effects. Application of liquid flow bears quantitative and qualitative advantages over stationary liquid, but chamber design is still challenging in order to avoid dilution of the colloid aiming at narrow residence time distributions (high Bodenstein numbers). In this work, we present the principal design criteria for engineered solutions of these challenges and realize two specific types of reactors, including experimental verification: (i) a flow reactor aiming at high-throughput fabrication of nanoparticles, realized by a continuous wire-feeding system with wire-concurrent liquid flow, allowing constant concentration and high productivity for hours. (ii) a reactor design for mild laser-based synthesis of photosensitive bioconjugates, realized by spatial separation of the nanoparticle fabrication and their bioconjugation in order to control nanoparticle size by their residence time.

ANGEL2012_5228_032 STUDENT PRESENTATION 73

Generation of Nanoparticles by Laser Ablation in Liquids: Stoichiometry/ Composition and Characterization of NiTi-Nanoparticles

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Material properties of NiTi-nanoparticles generated by laser ablation in different liquids have been analyzed and are presented here. Depending on the processes environment, the composition of the generated nanoparticles differs from the bulk material. Also, an oxide layer (core/ shell) is formed on the NiTi-nanoparticles surface. The thickness of the layer differs depending on the organic liquids. Along with the change of the surface layer, various crystalline structures are obtained. The lattice structure and lattice space of the nanoparticles are investigated by the transmission electron microscopy (TEM) and x-ray diffraction analysis (XRD).

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ANGEL2012_5230_033 STUDENT PRESENTATION

Production of Co, Ni and Ti nanoparticles in liquid environment using femtosecond laser

74

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Due to various probable application areas, synthesis of metallic nanoparticles has become an important research area in recent years. Depending on the application area, various metallic nanoparticles such as silver, gold, titanium, cobalt etc. are produced. Cobalt and titanium nanoparticles have important application in the conductive electrolytic membranes of various fuel cells, data storage devices and water pollutants, paints industry, as electrically conductive fillers, biomedicine respectively. In this study, the plasmonic behaviour and size variation of cobalt, nickel, titanium nanoparticles (see figure) produced in a distilled water has been investigated using an ultrafast Ti:Sapphire laser.

ANGEL2012_5231_034

Silver and gold nanoparticles for toxicological research

75

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The critical issue to introduce the products of nanotechnology is to be safe for the environment and humans. Investigation of the nanoparticle interaction with biological cells is a major task of nanotoxicology.

The dependence of the toxicity on the composition of nanomaterial has been studied using the stable aqueous suspension of gold and silver nanoparticles of the same size with narrow distribution function produced by laser ablation of metal target in deionized water using 1062 nm Yb fiber laser with 100 ns pulse duration. The beam was focused on the target surface (fluence 80 J/cm^2, spot diameter 40 μm). Investigations have shown that proper preparation of the target surface by given number of scanning cycles allows to produce spherical Ag and Au nanoparticles with required average diameter measured by dynamic light scattering and semi-contact atomic force microscopy (sc-AFM).

ANGEL2012_5233_035

Size control of Si dots induced by *in-situ* pulsed laser *ablation-photofragmentation* in liquid

76

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Silicon nanoparticles (Si-NPs) have triggered large research activity with an outlook for various applications ranging from light-emitting devices, energy technology, to fluorescent biological label. The control of the size of the produces Si-NPs is of fundamental importance for these applications due to the size-dependent optical properties of semiconductor nanoparticles. Recently, our group reported the Si-NPs generation by near-infrared femtosecond PLAL demonstrating a size control mechanism dependent on the laser pulse energy.

Here, we report on the Si-NPs production and the size control mechanism by systematic studies over process time at different pulse energy, using the fundamental, second and third harmonic wavelength of a Picosecond Nd:YAG laser.

ANGEL2012_5235_036 STUDENT PRESENTATION

Real-Time Spectroscopy of Nanoparticle Evolution During Laser Ablation of Gold Thin Films in Dye Solution

77

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The diversity of nanoparticle applications has resulted in concentrated efforts into improving the control of nanoparticles (nps) generated during laser ablation of different materials in order to compete with current synthesis methods. To achieve control of this process, it is imperative to develop the understanding of the fundamental science behind the formation and evolution of nps. Difficulties have been encountered in many studies when attempting to detect nano-scale changes in particle size and for this reason this study applies an indirect method to characterize the nps. Rhodamine 6G dye solution (R6G) has a strong fluorescence signal and a characteristic Raman spectrum that is inherently difficult to detect. However, in the presence of gold (Au) nps, the fluorescence is quenched to varying degrees and the Raman signal is enhanced via a process called Surface Enhanced Raman Spectroscopy (SERS). Both processes are highly sensitive to the size and the concentration of the Au nps in the solution and are therefore ideal indicators for understanding the laser generation of nps in a liquid.

This study applies these real-time spectroscopic techniques to nps generated during laser ablation of thin (10 - 75 nm) Au films submerged in a 10 mm column of R6G in a cuvette.

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ANGEL2012_5238_037 STUDENT PRESENTATION

Fabrication and characterization of zinc oxide nanoparticles by pulsed laser ablation in liquid 78

G. García G.[1], G.A. Castillo[1], D. Avellaneda[1], J.A. Aguilar Martínez[1], B. Krishnan[1,2], S. Shaji[1,2]; [1]Universidad Autónoma de Nuevo León, Facultad de Ingeniería Mecánica y Eléctrica (MX); [2]Universidad Autónoma de Nuevo León-CIIDIT (MX).

Pulsed laser ablation in liquid is a simple and effective technique for obtaining nanomaterials. Zinc oxide is a wide band gap material (3.3 eV) with unique optical properties and electrical conductivity for applications as window material in solar cells and optoelectronic devices. Laser ablation in liquid medium (PLALM) has been used to synthesize zinc oxide nanoparticles in different aqueous solution such as hydroxide/dodecyl sulfate and deionized water mixed with oxidizing agent H_2O_2. However, as the experimental parameters are varied as well the final nanostructure, size distribution and the optical properties of zinc oxide change.
In the present work, zinc oxide nanoparticles were fabricated by pulsed laser ablation of a Zn metal in distilled water.

ANGEL2012_5239_038 STUDENT PRESENTATION

Structure and properties of nanocrystalline titanium dioxide obtained by pulsed laser ablation in water 79

G. García G.[1], G.A. Castillo[1], T.K. Das Roy[1], B. Krishnan[1,2], D.I. García Gutiérrez[1,2], S. Shaji[1,2]; [1]Universidad Autónoma de Nuevo León, Facultad de Ingeniería Mecánica y Eléctrica (MX); [2]Universidad Autónoma de Nuevo León-CIIDIT (MX).

Pulsed laser ablation in liquid is a simple technique for nanomaterial fabrication. Titanium dioxide nanocrystals have been extensively studied for their high photocatalytic activities, chemical stability, and a variety of applications. Titanium dioxide nanoparticles have been created by laser ablation of a titanium target in various liquid environments such as water, ethanol, 2-propanol and n -hexane. The physical and chemical properties of TiO_2 nanoparticles are highly correlated with its phase structure and morphology as well as its particle size.
In this work, TiO_2 nanostructures were synthesized by pulsed laser ablation of titanium rod immersed in distilled water at different focusing conditions of the source laser.

ANGEL2012_5240_039

Characterization of hercynite nanoparticles obtained by pulsed laser ablation in liquid medium for refractory applications 80

G.A. Castillo[1], G. García G.[1], T.K. Das Roy[1], A.M. Guzmán[1], S. Shaji[1,2]; [1]Universidad Autónoma de Nuevo León, Facultad de Ingeniería Mecánica y Eléctrica (MX); [2]Universidad Autónoma de Nuevo León-CIIDIT (MX).

Hercynite added refractory materials have shown improvement in their chemical, thermal and mechanical properties. Pulsed laser ablation in liquid media is a remarkable process for the fabrication of nanomaterials and is widely used in production of various kinds of nanoparticles such as noble metals, alloys, oxides and semiconductors. Laser ablation in liquid phase with nanosecond pulses has been studied for efficient generation of pure ceramic nanoparticles in an aqueous environment and corundum nanoparticles was obtained.
In the present work, nanoparticles of hercynite were obtained by pulsed laser ablation of a hercynite target in distilled water.

ANGEL2012_5243_040

Pure aqueous colloid of flavonoids prepared by laser ablation in water 81

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Intense pulse-laser Irradiation to suspended microcrystalline powder in poor solvents, e.g. water, leads to its fragmentation into nanoparticles. This technique allows fabrication of pure organic nanoparticle colloids without any chemical additives, which will give great contribution to advance nanomaterials, new phamatical agents and drugs. Here, we applied this technique to water-insoluble flavonoids which is a class of plant secondary metabolites, and succeeded in preparing stable nanoparticle colloids four kinds of compounds, i.e. flavones and isoflavones, in Figure 1.

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ANGEL2012_5244_041 82
Mn Ferrite nanoparticle generation in distilled water using Nd:YAG laser
H.R. Dehghanpour[1], L. Delshad[1], P. Parvin[2]; [1]Physics Department of Tafresh University (IR), [2]Amirkabir University of Technology (IR).
In this work, we have generated Mn Ferrite nanoparticles by Nd:YAG(1064 nm)laser irradiation in distilled water. Then, we have investigated shape and size of nanoparticles by TEM (Transmission electron microscopy). Chemical composition of nanoparticle was characterized using EDX (Dispersive x-ray energy)and the magnetic properties of them have studied by MFM (Magnetic force microscopy).The results show that the chemical composition and magnetic properties of nanoparticles are nearly similar to bulk sample.

ANGEL2012_5249_043 83
Picosecond Laser Pulse Generation of Gold Nanoparticles with on-Line Surface Plasmon Resonance Detection
M. Maciulevičius, A.Vinčiūnas, M. Brikas, G. Račiukaitis; Center for Physical Sciences and Technology, Laboratory for Applied Research (LT).
Size of nanoparticles and its distribution are very important for applications in bio-medicine. Promising drug delivery applications need mono-dispersed nanoparticles. Therefore, by producing nanoparticles by laser ablation in the liquid, it is very important to control the size distribution of generated nanoparticles. It is well known that surface plasmon resonance (SPR) spectra depend on the size of nanoparticles. Thus if there is a predominant shape of nanoparticles, the optical transmittance and absorption properties of colloidal solution can provide a sufficiently reliable information on the colloid nanoparticle size distribution. The goal of our work was to develop a system for the on-line nanoparticle characterization.

ANGEL2012_5250_044 STUDENT PRESENTATION 84
Synthesis of gold and silver nanoparticles by nanosecond laser ablation
A.E. Tyurnina, V.Y. Shur, D.K. Kuznetsov, E.A. Mingaliev, R.V. Kozin, D.S. Chezganov; Institute of Natural Sciences, Ural Federal University (RU).
The size dependence of the properties of gold and silver nanoparticles opens their wide application in microelectronics, optics, catalysis, and medicine.
The dependence of the nanoparticle size on the target surface condition has been studied during surface treatment by focused laser beam scanning. The suspensions with silver and gold nanoparticles were produced by ablation of the target drown in deionized water. The Yb fiber laser with 1062 nm wavelength and 100 ns pulse duration has been used. The laser beam has been focused on the target surface (fluence 80 J/cm^2, spot diameter 40 μm).

ANGEL2012_5251_045 STUDENT PRESENTATION 85
Production of the stable suspension of the gold nanoparticles with required sizes using laser fragmentation
V.Y. Shur, A.E. Tyurnina, R.V. Kozin, D.K. Kuznetsov, E.A. Mingaliev; Institute of Natural Sciences, Ural Federal University (RU).
Silver and gold nanoparticles of different sizes and shapes have been attracting much attention due to their unusual size and shape-depending properties.
It is known that the morphology and sizes of nanoparticles produced by laser ablation can be changed by fragmentation under the action of subsequent laser pulses.
The separated additional fragmentation process has been applied to water suspension of gold nanoparticles with average sizes about 4 nm produced by 1062 nm Yb fiber laser ablation of metal target drown in deionized water. The proper surface treatment of the target has been used for production of the suspension with controlled stability. The fragmentation process consisted of two stages has been developed.

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ANGEL2012_5261_046 STUDENT PRESENTATION

Optimization of SERRS signals based on Gold Nanoparticles synthesized by laser ablation and a new functionalized Nile Blue dye

L. Litti, M. Gobbo, V. Amendola, A. Scarsi, F. Bertorelle, M. Meneghetti; Department of Chemical Sciences, University of Padova (IT).

Surface Enhanced Resonant Raman Scattering is a spectroscopic tool alternative to fluorescence in bio-sensing devices because of its high response in particular in multiplexing experiments. We use Gold Nanoparticles (AuNPs), synthetized with Laser Ablation Synthesis in Solution (LaSiS), to obtain aqueous colloidal solutions without any surfactant and therefore characterized by high reactivity.

To optimize the SERS signals we aggregate the AuNPs to obtain a large number of hot spot, where the local electric field is strongly enhanced.

In this work we present the experimental conditions to optimize the aggregation of nanoparticles and a synthesis of a new lipoic acid functionalized Nile Blue (LipNB) that guarantees a better binding to the AuNPs surface.

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ANGEL2012_5268_047 STUDENT PRESENTATION

Combined gold and SiOx nanostructures by pulsed laser ablation in liquids with simultaneous chemical synthesis of silica

T. Salminen, T. Niemi; Optoelectronics Research Centre, Tampere University of Technology (FI).

Pulsed laser ablation in liquids (PLAL) and simultaneous chemical nanostructure synthesis offers possibilities to produce nanostructures that combine multiple materials in a straightforward manner. For example, PLAL can be applied to create colloidal nanostructures from one or several materials in a single solution. Silicon dioxide nanoparticles can be chemically formed by the well-known Stöber method.

We have studied the combination of PLAL of gold and simultaneous Stöber method to create combinations of nanostructures.

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ANGEL2012_5271_048 STUDENT PRESENTATION

Detergent-free synthesis of Au nano-square plates in dynamic nano-phases during laser-induced phase separation; Effect of repetitive laser-irradiation

D. Shirasawa, S. Kajimoto, U. Qazi, H. Fukumura; Tohoku University, Department of Chemistry (JP).

Metal nanoparticles have recently been applied to biochemistry and spectrochemistry because of their unique optical properties depending on the size and structure. A lot of synthesis techniques have been investigated for controlling the size and shape of nanoparticles. Liquid-liquid interface and micelle have also been employed as reaction fields. Recently, our group has introduced a dynamic phase separating media as a dynamic reaction field. Laser-induced phase separation via spinodal process can be initiated by a temperature jump method. In this study, Au nanoplates (AuNPs) were synthesized via photochemical reaction in nano-phases during laser-induced phase separation. In addition, we have investigated size control of AuNPs by controlling size of nano-phases and laser-irradiation time.

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