



**Strasbourg (France)**

**E-MRS Spring Meeting 2002**  
June 18 - 21, 2002

## **SYMPOSIUM Q**

**Current Trends in Nanotechnologies:  
from Materials to Systems**

Symposium Organizers:

Hermann Grimmeiss, University Lund, Sweden

Wolfgang Jantsch, Johannes Kepler University, Linz, Austria

Giovanni Marletta, University of Catania, Italy

Yasunori Taga, Toyota Central Research, Aichi, Japan

Papers will be published in Materials Science Engineering C

## SYMPOSIUM Q

# E-MRS 2002 SPRING MEETING

## SYMPOSIUM Q

Tuesday, June 18, 2002  
Mardi 18 juin 2002

Morning  
Matin

Session I: Nanofabrication 1  
Session Chair: H.G. Grimmer

- 09:00           **Q-I.1**           **MOLECULAR SELF-ASSEMBLY ON SURFACES**  
**W.M. Heckl**, Ludwig-Maximilians-Universität München, Institut für Kristallographie and Center for NanoScience (CeNS), Germany  
The formation of highly ordered monolayers of organic molecules through physisorption mediated molecular self-assembly at the solid-liquid interface is an example for the spontaneous creation of order. The resulting two-dimensional molecular crystal structures can be determined using the combination of scanning tunneling real space analysis and diffraction methods together with molecular modeling. Here we present examples ranging from liquid crystals to heterocyclic organic molecules like trimesic acid, representative for a molecular host-guest system. In the case of DNA-molecules we have proposed a functional role of this process of spontaneous self-organization for the emergence of terrestrial life, which may also lead towards the construction of genetically based supramolecular architectures for modern technical applications, such as heterogeneous catalysis.  
Lit.  
Molecular Self-Assembly, W.M. Heckl, in: Highlights in Laserphysics, eds. Figger et al., Springer Verlag, Berlin, New York 2002
- 09:40           **Q-I.2**           **FIELD CONFIGURED SELF-ASSEMBLY: MANUFACTURING AT THE MESOSCALE**  
**Alan O'Riordan**, Gareth Redmond, Nanotechnology Group, NMRC, Ireland  
Mesoscale components are an important class of functional objects whose dimensions span a range of length scales intermediate between that of individual molecules and microscopic objects. A critical challenge in the development of integrated systems that exploit mesoscale components as active device elements is the availability of novel substrates and integration tools that enable manipulation and assembly of components into dense multifunctional arrays in which components may interface with each other and with the macroscopic world. Herein, we present a novel self-assembly approach to parallel heterogeneous integration of functional mesoscale components at interface substrates. A programmable force field method is employed whereby electric fields, configured by selective addressing of receptor and counter electrode sites patterned on a chip substrate, drive the electrophoretic transport, positioning and localisation, i.e., self-assembly, of components at target receptor locations. To demonstrate the applicability of this new method, a variety of mesoscale components ranging from latex spheres to 50 micron GaAs-based light emitting diodes are successfully manipulated on-chip using programmed electrophoretic force fields. Following field configured assembly, active devices may be bonded to each respective receptor site facilitating direct electrical addressing of components either individually or collectively in an array format.
- 10:00           **Q-I.3**           **HIGH VOLTAGE SCANNING PROBE MICROSCOPY FOR NANOFABRICATION**  
**Y. Rosenwaks**, Dept. Physical Electronics, Faculty of Engineering, Tel-Aviv University, Ramat-Aviv 69978, Israel  
Scanning probe microscopy has opened new opportunities to image semiconductors, and insulators electronic properties with unprecedented spatial resolution. In the first part of the talk several novel applications concerning electrical measurements using scanning probe techniques recently developed and demonstrated by our group will be presented. The first is the measurement of two-dimensional potential distribution of operating semiconductor devices like diodes and light emitting diodes (LEDs). The second application, called near-field photovoltage spectroscopy (NFPVS), combines the measurement of contact potential difference (CPD) with near-field optical excitation. The second part of the talk will describe a novel high voltage atomic force microscope recently developed in our group. Current scanning probe instrumentation does not permit applying high voltages (in the kV range) between AFM tip and sample. We will describe a high voltage AFM (Patent pending) that allows us to apply voltages as high as 15 kV across an AFM measured sample. The use of the method for nanoscale domain inversion in bulk ferroelectrics will be described, and possible other applications will be discussed.
- 10:20           **BREAK**

## SYMPOSIUM Q

Session II: Nanofabrication 2  
Session Chair: C. Sotomayor Torres

- 10:50      **Q-II.1**      **GOLD NANOPARTICLES ON SELF-ASSEMBLED MONOLAYERS BY CHEMICAL VAPOR DEPOSITION**  
A.K. Aliganga(a), S. Krämer(a), U. Weckenmann(b), J. Käshammer (a), R.A. Fischer(b), S. Mittler(a), (a)Max Planck-Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany, (b)Lehrstuhl für Anorganische Chemie II, Ruhr-Universität Bochum, 44780 Bochum, Germany  
Gold nanoparticles are of great current scientific interest due to their functions as elements of novel nanometer-scale optical and electronic devices [1]. Their huge variety of properties starting from single electron tunneling to linear and nonlinear optical effects can be controlled by the size of the particles [2]. For nanoelectronics and nanosensors it is necessary to bind the particles to a surface. Therefore, separation of the particles and growth on prepatterned structures is desired. The preparation of nanoparticles is usually done in solution, where the particles are stabilized by organic ligands. In this study, a method based on chemical vapor deposition to produce gold nanoparticles directly on functionalized surfaces is presented. Chemical Vapor Deposition of metals is a well known technique to form ultrathin films [3]. In previous works it was shown, that gold can be deposited with an organometallic precursor on self-assembled monolayers with thiol headgroups [4]. The amount of gold can be controlled by the reaction time and the pressure during the deposition [5]. The formation of the gold film is done under a moderate temperature of 60°C. Hereby the organic layer is not destroyed. The gold is selectively growing on thiol groups and is not deposited on methyl groups [6]. Arising from this fact results on the investigation of the chemical vapor deposition on mixed monolayers containing two different  $\text{-S-}$ ,  $\text{-S-S-}$ ,  $\text{-S-S-S-}$  thiols, a dithiol and a thiol will be presented. In the first step we investigated the relationship between the molar ratio of the molecules in solution and the ratio in the self-assembled monolayer. By combining the selectivity of the deposition and the control of the number of functional groups on the surface it should be possible to control the amount of gold and the size of the clusters. First results obtained from mass spectrometry and AFM are shown. The results presented are significant steps toward the goal of producing a defined alignment of gold nanoparticles on patterned SAMs and also the surface functionalization of single clusters within the matrix.  
[1] Jana, N.R. et al., (2001) Chemistry of Materials 13, 2313-2322  
[2] Zhang, X.Y. et al., (2001) Journal of Materials Chem.11, 1732-1734  
[3] Kodas, T.T. and Hampden-Smith, M.J. (1994) The Chemistry of Metal CVD, VCH Weinheim  
[4] Käshammer, J. et al., (1998) Optical Materials 9, 406-410  
[5] Wohlfart, P. et al., (1999) Thin Solid Films 340, 274-279  
[6] Winter, C. et al., (2000) Chem. Vap. Deposition 6, 199-205
- 11:10      **Q-II.2**      **SPM AND TOF-SIMS INVESTIGATION OF THE PHYSICAL AND CHEMICAL MODIFICATION INDUCED BY TIP WRITING OF SELF-ASSEMBLED MONOLAYERS**  
B. Pignataro, A. Licciardello and G. Marletta, Laboratory for Molecular Surfaces and Nanotechnologies, Dipartimento di Scienze Chimiche, Università degli Studi di Catania, V.le A. Doria, 95125 Catania, Italy  
The combination of self-assembled monolayer technology and near field tools appear particularly suitable for the direct chemical synthesis of nanostructures at surfaces. Spatially-defined nanometric features have been successfully already obtained on self-assembled monolayers of trichlorosilane on silicon oxide by locally inducing electrochemical modification via a biased conductive Atomic Force Microscopy (AFM) tip. Although the nanoelectrochemical effects on adhesion and friction properties have been observed, the nature of the probe-induced chemical modification of the organic layer is still an open problem, due to the inherent difficulty in achieving a nanometric scale chemical characterization. In this paper the nanoelectrochemical modification of alkyl self-assembled monolayers obtained on hydrogenated silicon surfaces via radical-initiated reactions of 1-alkenes is investigated. Scanning Probe Microscopies (SPM) showed that while the height of the organic layer is only slightly changed, the frictional properties of the modified regions are a factor 2-3 increased with respect to the unmodified areas. Time Of Flight Secondary Ion Mass Spectrometry (TOF-SIMS) experiments, including chemical imaging and analysis of the retrospective spectra, allowed to investigate the nature of the chemical modification, suggesting complex oxidation processes. The last experiments were performed by writing patterns of some microns in size on the self-assembled monolayer.
- 11:30      **Q-II.3**      **SIZE- AND SHAPE-DEPENDENT OPTICAL RESPONSE OF VANADIUM DIOXIDE NANOCRYSTAL FILMS**  
R. Lopez(a), L.A. Boatner(b), L.C. Feldman(a), R.F. Haglund, Jr.(a), T.E. Haynes(b), (a)Vanderbilt University, Nashville TN 37235, USA, (b)Oak Ridge National Laboratory, Oak Ridge TN 37831, USA  
Vanadium dioxide exhibits a semiconductor-to-metal transition (SMT) near  $T_c \sim 67\text{C}$  in which the monoclinic low-temperature form changes to a tetragonal rutile structure. We have for the first time (to our knowledge) been able to characterize the size dependence SMT in the nanoscale regime by synthesizing thin films of isolated  $\text{VO}_2$  nanocrystals. The films were fabricated by stoichiometric ion implantation to an average depth of 200 nm in fused silica substrates and fibers; subsequent annealing at 1000 C in argon induced the precipitation of the  $\text{VO}_2$  nanocrystals. The initially faceted nanocrystals grew with increasing annealing time into elongated cylinders with typical diameters of 50 nm and aspect ratios as large as 1::4. The optical transmission vs temperature of the  $\text{VO}_2$  nanocomposite shows a size-dependent hysteresis almost an order of magnitude wider than that seen in  $\text{VO}_2$  thin films. This size dependence has been used to test a model of the nucleation mechanism that initiates the SMT. In the metallic state, the surface plasmon resonance occurs around 1.5  $\mu\text{m}$ , and shows a size- and aspect-ratio dependent redshift and broadening; in contrast, the plasmon band in  $\text{VO}_2$  thin films occurs around 3  $\mu\text{m}$ . Doping with Ti or W ions changes both the hysteresis width and the transition temperature for the SMT. These nanocomposite properties open up such "smart materials" applications as optical switching, holographic memory and optical limiting.

## SYMPOSIUM Q

- 11:50      **Q-II.4**      **FABRICATION OF MINIATURISED SI-BASED ELECTROCATALYTIC MEMBRANES**  
Giuseppe D'Arrigo and Corrado Spinella CNR-IMM, Stradale Primosole 50, 95121 Catania, Italy  
The fabrication of porous electrocatalytic membranes with a wide surface plays an important role in the electrochemical technology for energy storage and bio-catalytic processes. The electrocatalytic reactions are generated in proximity of the membrane surface where the catalyst elements are localised. For this reason it is necessary to use a porous material with a wide surface. Porous Si is characterised by a surface as wide as 200 m<sup>2</sup> for cm<sup>3</sup>. In this work we fabricated a suspended and auto-supporting electrocatalytic sector, by using only surface micromachining processes compatible with the standard Si-based ULSI technology. This sector can be used for the realisation of miniaturised and Si-based proton exchange membrane fuel cell. The structures consist in two symmetric semi-cells fabricated on a Si wafer. A patterned Au structure is used to define the permeable porous sector areas and to collect the energy produced during the cell operation. Miniaturised micro channels localised below the porous sectors are formed by using only surface micromachining processes. The microchannel allows the comburent and fuel injection from the tank towards the reactor sector. The catalyst element (Pt or Rb) is deposited inside the porous Si skeleton by plating or sputtering. The proton exchange membrane is deposited on the patterned porous membrane by a spinning process. The compatibility with the ULSI processes allows the integration of the power consumption circuit on the fuel cell.
- 12:10      **Q-II.5**      **PULSED LASER ANNEALING OF Si/Ge SUPERLATTICES**  
N.A. Sobolev, Universidade de Aveiro, Portugal, and Institute of Solid State and Semiconductor Physics, Minsk, Belarus; G.D. Ivlev, E.I. Gatskevich, Institute of Electronics, Minsk, Belarus; A.B. Lopes, A. Fonseca, J.P. Leitao, M.C. Carmo, Universidade de Aveiro, Portugal; H. Presting, U. König, Daimler Chrysler Research Center, Ulm, Germany  
Thin layer Si<sub>n</sub>Ge<sub>n</sub> superlattices (SL) were treated by 80 ns pulses of a ruby laser in a wide range of energy densities  $E_s$ . The induced structural and electronic changes were monitored *in situ* by time resolved reflectivity (TRR) at wavelengths of 1.064 and 0.532  $\mu$ m and *ex situ* by scanning electron microscopy (SEM), Raman scattering and low-temperature photoluminescence (PL). Three regimes were observed. At the lowest energy densities, no effects were observed *ex situ*, though the TRR revealed changes of the reflectivity that had different character at 0.532 and 1.064  $\mu$ m, obviously due to interference effects. At  $E_s > 0.37$  J/cm<sup>2</sup>, the TRR exhibited an even more intricate behaviour. A network of microcracks emerged in the SEM. The folded acoustical phonon that is a fingerprint of the superlattice structure disappeared in the Raman spectra. Thus, a complete melting of the SL that is followed by a total intermixing in the liquid phase and a solidification as a Si/Ge alloy may be concluded. When the energy density exceeded ca. 0.7 J/cm<sup>2</sup>, the TRR showed at both 0.532 and 1.064  $\mu$ m a rise of the reflectivity lasting for about 200 ns. A quasiregular cell structure with a characteristic cell dimension of ca. 100 nm appears on the sample surface. The physical processes occurring during the SL melting and solidification as well as possible applications of the fabricated cell structures are discussed.
- 12:30      **LUNCH**

## SYMPOSIUM Q

Tuesday, June 18, 2002  
Mardi 18 juin 2002

Afternoon  
Après-midi

Session III: Nanofabrication 2  
Session Chair: W. Heckl

- 14:00           **Q-III.1**           **NANOIMPRINT LITHOGRAPHY: AN ALTERNATIVE NANOFABRICATION APPROACH\***  
**C.M. Sotomayor Torres**, Institute of Materials Science and Department of Electrical & Information Engineering, University of Wuppertal, 42097 Wuppertal, Germany  
The need for accessible, flexible and low-cost nanofabrication techniques is becoming increasingly acute as fast developments in the general field of nanotechnology demand smaller and smaller structures in a variety of materials.  
Nanoimprint lithography (NIL), with its apparent simplicity and resolution down to 6 nm, has become a preferred technique for one-level nanopatterning of thin films, which themselves act as a mask for further nanofabrication steps, or which can be used as-printed thanks to the functionality of the thin film itself.  
In this talk, we review the progress of NIL and compare it to other alternative nanofabrication techniques. Throughput, resolution and issues affecting critical dimensions will be discussed. The use of NIL to realise passive optical devices over several cm<sup>2</sup> and organic electronic devices down to 30 nm will be demonstrated. Moreover, progress in the synthesis of novel polymers for photolithography, NIL and electron beam writing, opens the door to mix-and-match lithography giving hope to use NIL in multilevel nanofabrication processes.  
\*In collaboration with: C Clavijo Cedeño, J Seekamp, A P Kam, T Hoffmann, S. Zankovych, P Ferrand, F Bulut., C Menozzi, M. Cavallini, M Murgia, G Ruani, F Biscarini, M Behl, R Zentel, J Ahopelto, F Reuther, K Pfeiffer, L Montelius, B Heidari.  
Acknowledgements: This work is supported by the EU Growth project MONALISA, the EU IST FET project CHANIL and the German Research Council (DFG)
- 14:40           **Q-III.2**           **NANOCRYSTALS IN GATE OXIDES BY ION BEAM SYNTHESIS - FUNDAMENTALS AND APPLICATIONS IN NON-VOLATILE MEMORIES**  
**K.-H. Heinig**(a), B. Schmidt(a), J. von Borany(a), K.-H. Stegemann(b), and T. Müller(a), (a)Forschungszentrum Rossendorf, Institut für Ionstrahlphysik und Materialforschung, PO Box 51 01 19, 01234 Dresden, Germany, (b)Zentrum Mikroelektronik Dresden, Grenzstr. 28, 01109 Dresden, Germany  
Semiconducting or metallic nanocrystals (NCs) embedded in the gate oxide of a MOS field effect transistor can be charged/decharged by tunnelling of electrons from/to the (001)Si substrate, caused by an appropriate voltage pulse applied to the gate. There is a difference in the source/drain current for charged and neutral NCs which can be used for the storage of information. The basis of this memory concept is quite simple, however the fabrication of tiny NCs (~2 nm) placed in the right position within the very thin (< 20 nm) gate oxide is a strong challenge to materials research. Different processes are being developed to fulfill this challenge of microelectronics. Among them, ion implantation of impurity atoms in the gate oxide followed by their precipitation during subsequent annealing is the only process which is completely compatible with CMOS technology. Here it will be shown by atomistic process simulations how at ion beam synthesis a thin NC-free SiO<sub>2</sub> layer (only a few nm thick) can be achieved between the Si/SiO<sub>2</sub> interface and the NC containing oxide. The predictions will be compared with Ge+ implanted SiO<sub>2</sub> layers.
- 15:00           **Q-III.3**           **MEMORY EFFECTS IN MOS DEVICES BASED ON Si QUANTUM DOTS**  
**I. Crupi**(a,b), S. Lombardo(b), C. Gerardi(c), G. Ammendola(c), E. Rimini(a,b), M. Melanotte(c), (a)Department of Physics and INFN, University of Catania, Catania, Italy, (b)CNR-IMETEM, Catania, Italy, (c)C. R&D, STMicroelectronics, Catania, Italy  
Nanocrystal CMOS memories are a promising scaling approach of FLASH memories in which the conventional poly silicon floating gate is replaced with an array of quantum dots. It is well known that, in order to achieve nonvolatility in a traditional memory cell, the tunneling oxide thickness is maintained above 7 nm and, as a consequence, high voltages and long times are required for both write and erase operation. Therefore, the development of a new memory device, using silicon dots to store the charge in the place of the standard floating gate, has recently attracted much attention. Silicon quantum dots have been deposited on top of a 3 nm tunnel oxide by Low Pressure Chemical Vapour Deposition (LPCVD) and coated with a 7 nm Chemical Vapour Deposited (CVD) oxide. The stack was incorporated in Metal-Oxide-Semiconductor cell structure in order to study by electrical measurements memory effects. In this work we put in evidence the potential advantages of this approach through our experimental results on program, erase and retention characteristics. The data are shown and discussed in comparison with tunnel models.

## SYMPOSIUM Q

- 15:20      **Q-III.4**      **FIELD-INDUCED TUNNELING IN SiGe WIRES**  
E. Giovine, A. Notargiacomo, L. Di Gaspare, E. Palange and F. Evangelisti, Unita INFM and Dipartimento di Fisica 'E. Amaldi', Universita di Roma TRE, V. Vasca Navale 84, 00156 Roma, Italy, R. Leoni, G. Castellano, G. Torrioli and V. Foglietti, Istituto di Elettronica dello Stato Solido, IESS-CNR, V. Cineto Romano 42, 00156 Roma, Italy  
Recently, several works have investigated different kinds of Si-based nanowires, which are promising structures for nanoelectronics. A common feature of the I-V characteristics in narrow wires is the presence of a poorly conducting region at low applied voltages up to a certain threshold value. Usually, this behavior is the signature of single electron and Coulomb blockade effects, resulting from the charging of small islands naturally induced by disorder. In the present work we find that source-drain characteristics, exhibiting poorly conducting region and a threshold for the conduction, can also be obtained in absence of Coulomb blockade and single electron effects in wires fabricated from SiGe 2D-electron gas. We show that this behavior can be the signature of field induced tunneling in depleted wires. In this case the source-drain current as a function of gate bias does not exhibit the characteristic oscillations related to single electron phenomena. Therefore the presence of current oscillations is a necessary check in order to establish unambiguously the Coulomb blockade and single electron effect occurrence. Sets of wires, with different length (500÷4000 nm) and width (100÷1000 nm), were fabricated. The carrier mobility was in the range  $(0.7\div 1.0)\times 10^5$  cm<sup>2</sup>/Vs at T = 4.2 K. A four-probe configuration was adopted for the measurements. On a set of 500 nm-long wires, after the deposition of a 500-nm-thick oxide layer, a metallic gate covering the whole wire was fabricated.
- 15:40      **Q-III.5**      **ORDERING AND ANCHORING OF LARGE ORGANIC MOLECULES ON METAL SURFACES**  
F. Rosei, Y. Naitoh, M. Schunack, E. Lægsgaard, I. Stensgaard F. Besenbacher, Institute of Physics and Astronomy and CAMP, University of Aarhus, 8000 C Aarhus, Denmark and P. Jiang, A. Gourdon, C. Joachim, CEMES - CNRS, 29 Rue Marvig, 31055 Toulouse Cedex, France  
Large organic molecules have recently attracted interest from a fundamental point of view and for prospective applications in nanoelectronics. We investigated the adsorption of Lander molecules on Cu(110) by Scanning Tunneling Microscopy (STM). The Lander has a central polyaromatic molecular wire, and four spacer legs for isolation from the substrate. We created a template for molecular adsorption on the Cu substrate by O<sub>2</sub> dosing at high temperatures: the surface is thus patterned with alternating bare Cu regions and (2x1) reconstructed Cu-O areas, aligned parallel to the [001] direction. The Lander molecules avoid the top of Cu-O rows, adsorbing exclusively on bare Cu regions, and attaching to the edge of Cu-O rows. By tuning oxygen dosing and molecular coverage we obtain long rows of molecular wires. This type of assembly opens new possibilities for ordering organic molecules on surfaces in a controlled manner. Manipulation experiments with the STM at low temperatures on isolated Lander molecules adsorbed on step edges reveal a restructuring of the Cu steps: when removed from a step, a tooth-like structure appears. The structure's width is two atomic rows, corresponding to the distance between the spacer legs within the molecule. Repeating the same manipulation experiments on molecules adsorbed at low temperatures (150 K), no restructuring of the Cu step edges is found. The process is thus thermally activated.
- 16:00      **BREAK**
- Session IV: Biotech 1  
Session Chair: W. Heiss
- 16:30      **Q-IV.1**      **NANO- AND MICRO-PATTERNING OF BIOFUNCTIONAL SURFACES**  
**B. Kasemo**, Chalmers University of Technology, 41296 Goteborg, Sweden  
Biofunctional surfaces is the R&D area, where properties and processes at interfaces between synthetic materials and biological environments are investigated and tailored biofunctional surfaces are fabricated. Examples are medical implants in the human body [2], biosensors and biochips for clinical diagnostics and drug screening, tissue engineering scaffolds, bioelectronics, and biomimetic materials.  
Model systems range from the unique water structures at solid surfaces and water shells around proteins and biomembranes, via amino and nucleic acids, proteins, DNA, phospholipid membranes, to cells and living tissue at surfaces.  
The sophisticated (bio)recognition ability of biological systems call for advanced design and preparation of surfaces, e.g. topographic, chemical and viscoelastic patterns on surfaces to match proteins at the nm scale and cells at the micrometer scale.  
I will first introduce the field and then give selected examples from micro- and nanofabrication approach to make biofunctional surfaces e.g. for cell growth and differentiation [1, 2 and references therein]. Other examples are the (bio)chemical functionalization of surfaces by using supported biomembranes and biosensor development, taking the QCM-D technique developed in our group as a specific example [4].  
[1] B. Kasemo, Surface Science Vol 500, in press  
[2] B. Kasemo and J. Gold, Advances in Dental Research. 13 (1999) 8, and references therein  
[3] Keller, C. A., Glasmästar, K., Zhdanov, V. P., and Kasemo, B., Phys. Rev. Lett. 84, 5443 (2000).  
[4] Höök, F., Ray, A., Nordén, B., and Kasemo, B., Langmuir, 17, 8305-8312 (2001).

## SYMPOSIUM Q

- 17:10      **Q-IV.2**      **MODIFIED SILICA PARTICLES FOR GENE DELIVERY**  
M. Nacken(a), H. Schmidt(a), H. Schirra(a), M. Sameti(b), C.-M. Lehr(b), Zs. Csögör(a),  
(a)Institut für Neue Materialien, Im Stadtwald Geb. 43, 66123 Saarbrücken, Germany;  
(b)Department of Biopharmaceutics and Pharmaceutical Technology, Saarland University, P.O.  
Box 15 11 50, 66123 Saarbrücken, Germany  
In somatic gene therapy, the transfer of DNA into specific cell nuclei is an important strategy. Inorganic nanoparticles have an interesting potential due to the possibility of the tailoring of the surface reactivity and the electrical surface potential (zeta potential) obtainable by the surface modification. SiO<sub>2</sub> nanoparticles have been chosen for reasons of low toxicity. In order to obtain positively charged nanoparticles, basic surface groupings have been proposed. Different types of aminosilanes have been tested for surface modification of SiO<sub>2</sub> nanoparticles. The zeta potential at pH = 7.4 could be varied from -38.8 mV (unmodified 10 nm particles) to +20 mV (gamma-aminopropyltriethoxysilane) to + 49.8 mV (3-glycidoxypropyltrimethoxysilane and ethylenediamine). In the paper, the different types of surface modification and their effect on the condensation of DNA are discussed.
- 17:30      **Q-IV.3**      **LIVING CELLS AND CRYSTALLIC CORES AS PERMANENT OR REMOVEABLE CORE FOR LAYER-BY-LAYER POLYELECTROLYTE ENCAPSULATION**  
S. Krol, D. Silvano, A. Diaspro, O. Cavalleri, A. Gliozzi INFM, University of Genoa, Via Dodecaneso 33,16146 Genova, Italy  
Nanocapsules prepared by alternate assembly of polyelectrolytes onto charged cores are a promising tool to solve future biomedical and biophysical problems. Through the choice of proper cores one can tailor the properties of the shells as well as address specific application requirements.  
We investigated the use of differently shaped CaCO<sub>3</sub> crystals, easily removable by acid addition, to prepare hollow capsules. Empty shells endowed with specific permeability and surface properties can be advantageously used to encapsulate a wide range of molecules like enzymes, proteins or DNA. The shell functionalization with specific proteins will allow the targeting of the capsule to damaged cells and the subsequent release of the encapsulated substances to repair or destroy them. Using living cells as core and keeping them alive in a protected environment can lead to the production of microsized bioreactors. Encapsulated cells, when properly targeted, could also be regarded as the origin of new tissue.  
By means of fluorescence microscopy techniques as well as atomic force microscopy we could show the surviving of encapsulated cells for at least one week and their ability to duplicate after encapsulation by breaking the shell.
- 17:50      **Q-IV.4**      **NANOTECHNOLOGIES IN THE EUROPEAN COMMISSION RTD PROGRAMMES**  
**Bernardus Tubbing**, European Commission, Research DG, Growth programme  
The European Commission aims at creating a favourable climate for nanotechnology research and development. This is pursued through supporting a wide range of actions, first of all long term research projects of significant size that normally comprise both academic and industrial partners, and focus on multi-disciplinary aspects.  
Already in the 4th Framework Programme (1994 - 1998), some 80 projects involving nanotechnology were funded. In the 5th Framework Programme, (1998- 2002) the estimated funding level is about 45 MEUR/year. The overall project portfolio is very wide in scope, encompassing for example nano-electronic devices, giant magneto-resistance, carbon nano-tubes, bio-sensors, molecular diagnostics, nano-composite materials, atomic force microscopes, etc.  
The budget of the current 5th Framework Programme is 14.96 EUR billion. This represents approximately 4% of the total European research funding, but with a broad-ranging impact. The 5th Framework Programme comprises four Thematic Programmes, covering the life sciences, information technologies, materials sciences and industrial technologies, and environmental and energy related research, as well as three Horizontal Programmes covering educational, mobility and other aspects. Nanotechnology falls under virtually all the mentioned Programmes, being majority of the funding in the form of grants to research projects.  
Nanoscience and nanotechnology present great scientific challenges and show a high potential for innovation and novel applications in many areas. For these reasons, the European Commission proposal for the 6th Framework Programme (2002 - 2006) contains a strong focus on nanotechnology. Out of a total proposed funding of 17.5 EUR billion, 1.3 EUR billion would be devoted to a priority thematic area of research on nanotechnology, knowledge-based materials and new industrial processes. Within an integrated approach, long term projects (research and networks) will be funded with the ultimate aim of stimulating the introduction of nanotechnologies in existing industrial sectors and/or of originating novel breakthroughs, which can lead to entirely new materials, new devices, new products and new industries.

## SYMPOSIUM Q

Wednesday, June 19, 2002  
Mercredi 19 juin 2002

Afternoon  
Après-midi

Session V: Tubes & Wires  
Session Chair: C. Joachim

- 14:00      **Q-V.1**      **NANOTUBES AND NANOWIRES**  
**M. Dresselhaus**, Department of Electrical Engineering and Department of Physics, MIT, Cambridge MA, USA  
Single wall carbon nanotubes (SWNTs) are important both for the new nanoscience concepts that they introduce and for their promise for practical applications. SWNTs provide a system that is simple enough so that detailed calculations of their properties can be carried out, and predictions about their physical behavior can be made. The large density of electronic states for one-dimensional (1D) systems and the strong electron-phonon coupling under resonance conditions allow observation of the Raman spectra from one individual single wall carbon nanotube. Observation of the Raman spectra from an individual nanotube is used to provide a definitive identification of the nanotube structure, including the nanotube diameter and chirality. This information is further used to determine, to high resolution, the profile of the joint density of states near one of its characteristic 1D singularities. Nanowires likewise show unique properties, allowing observation of phenomena not observed in their 3D analogs. One illustration of such behavior is observed in bismuth, which is a semimetal in bulk form, but can become a semiconductor, as the wire diameter is reduced below a critical diameter. This system again is simple enough to make predictions about the critical diameter for the semimetal-semiconductor transition as a function of crystallographic orientation and isoelectronic antimony alloying. The occurrence and control of unusual properties of nanostructures are the drivers for the exploitation of nanoscience in nanotechnology applications.
- 14:40      **Q-V.2**      **PROCESSING PARAMETERS OF CVD GROWN CARBON NANOTUBES**  
**F.H. Kaatz**, Mesalands Community College, Tucumcari NM 88401, USA, **M.P. Siegal**, D.L. Overmyer, and P.P. Provencio, Sandia National Laboratories, Albuquerque NM 87145, USA  
Carbon nanotubes are investigated for possible use in sensing devices and as cold-cathode field-emitters in flat panel displays. We describe the sample preparation and growth via thermal chemical vapor deposition. Processing parameters such as metal catalyst layer thickness, surface preparation, processing gas, temperatures, and times are studied. We show by SEM and TEM that several structural forms are possible using different parameters. Nanotube outer (inner core) diameters, ranging from 5-350 nm (2-15 nm), are controlled primarily by growth temperature, which varies from 630-790°C, respectively. These films all grow on Si(100) using sputtered Ni as the catalyst. A tungsten diffusion barrier prevents unwanted silicidation. These experiments define nanotube growth conditions which can be applied to the use of anodized Al templates with pre-determined pinhole sizes for optimal growth of aligned multiwalled carbon nanotube arrays. The electron emitting properties of these samples are studied by high-voltage stimulated emission in vacuum. Under proper conditions, we achieve good emission at 2-5 V/μm from large areas of the sample.  
\* Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. DOE under Contract DE-AC04-94AL85000.
- 15:00      **Q-V.3**      **Fe-CONTAINING MESOPOROUS HOST FOR CARBON NANOTUBES**  
**N. Petkov**, S. Mintova, K. Karaghiosoff, T. Bein, Department of Chemistry, University of Munich, Butenandtstr. 5-13 (E), 81377 Munich, Germany  
Microporous and mesoporous silica films have attracted considerable attention during the last few years with a view on novel applications such as selective membranes, functionalized optical coatings, sensors, and as templates for growing conductive materials. Mesoporous films on silicon wafers were prepared by evaporation-induced self-assembly of Fe-containing precursor acidic silica/surfactant solutions. The state of the precursor solutions used for the preparation of Fe-containing mesoporous thin films was investigated with liquid <sup>13</sup>C NMR, <sup>29</sup>Si NMR and light scattering techniques prior to film deposition. A transformation of the resulting mesophase film structure from one-dimensional hexagonal to three-dimensional cubic was observed by varying the Fe- and surfactant-content and solvent in the precursor solutions, and changing the thermal treatment during the calcination process. Cubic Fe-containing mesoporous films possessing an accessible channel system suitable for growing conductive materials were obtained. The structural features of carbon nanotubes grown by catalytic decomposition of hydrocarbons will be discussed. The preferred orientation of the carbon nanotubes in the film host is currently investigated by grazing incidence X-ray diffraction (GID) using synchrotron radiation.

## SYMPOSIUM Q

- 15:20      **Q-V.4**      **PREPARATION OF ORDERED MAGNETIC NANOWIRES IN THE MESOPOROUS SILICA MATRIX**  
A.A. Eliseev, K.S. Napolskii, A.V. Knotko, A.V. Lukashin, A.A. Vertegel and Yu.D. Tretyakov, Dept. of Materials Science, Moscow State University, 119899 Moscow, Russia  
One of the most important challenges in material science is the preparation of nanostructures with the controlled properties and creation of the functional nanomaterials. However, the use of the nanostructures as materials is strongly restricted because of their low stability. The approach to solve this problem is the preparation of the so-called nanocomposite materials, i.e. nanoparticles incorporated into an inert matrix. This enables one to avoid aggregation of nanoparticles and protect them from external influences (e.g., from oxidation in air), which simplifies application of such materials.  
Here we report the synthesis of magnetic nanocomposites using mesoporous silica as a host material. Iron nanoparticles were incorporated into the pores of mesoporous silica. During the synthesis, a hydrophobic metal complex (e.g., Fe(acac)<sub>3</sub> or Fe(CO)<sub>5</sub>) was introduced into the hydrophobic part of the as-prepared meso-SiO<sub>2</sub>/surfactant composite. The suggested method results in the formation of iron nanowires inside the silica framework. Particles shape and size are in good agreement with the shape and size of the pores. Particles are uniform and well ordered in the silica matrix. Thus, mesoporous silica serves as nanoreactor for the formation of Fe-nanoparticles. This approach leads to functional materials with nanosized active elements in amorphous silica matrix, which could find application as high-density data storage devices.  
This work is supported by RFBR (grant 00-03-32579)
- 15:40      **BREAK**
- Session VI: Biotech 2  
Session Chair: B. Kasemo
- 16:10      **Q-VI.1**      **MULTIPLE INTERNAL REFLECTION SPECTROSCOPY FOR QUANTITATIVE INFRARED ANALYSIS OF THIN FILM SURFACE COATING FOR BIOLOGICAL ENVIRONMENT**  
N. Rochat, A.Troussier, F.Vinet, CEA/LETI, CEA-Grenoble, 17 rue des Martyrs, 38054 Grenoble Cedex 9, France  
A study of silica surface preparation for covalent grafting of biological molecules has been made by Multiple Internal Reflection (MIR) infrared spectroscopy. The samples investigated are composed of silicon substrate covered with a thick silica layer submitted to various chemical steps. The two prism coupling geometry is used. Compared to bevelled angle MIR, this configuration allows the analysis with variable distance propagation and the sample to be its own reference. As a consequence, quantitative results will be presented.  
The samples have been modified by silane chemistry to introduce a specific function such as an aldehyde for covalent attachment of an NH<sub>2</sub> modified oligonucleotide or protein. The successive chemical steps have been followed and quantified in term of reaction efficiency. In these conditions we could characterise the silica surface hydroxylation (OH site creation), the silanisation (graft of a carbonated chain with an epoxy group), the hydrolyse of this epoxy group in alcohol and the oxidation of this alcohol in an aldehyde.  
An additional study has been made about type and quantity of OH bond present on the silica surface for various hydroxylation steps. Spectra have been studied using the decomposition of the OH large band in several absorption peaks.  
This study demonstrate that the MIR method using variable propagation distance is a powerful tool for process characterisation. Moreover it allows the optimisation of a reliable process for biochips.
- 16:30      **Q-VI.2**      **NANO STRUCTURED IMAGING OF BIOLOGICAL SPECIMENS IN VIVO WITH LASER PLASMA SOFT X-RAY CONTACT MICROSCOPY**  
A.C. Cefalas(a), P. Argitis(b), P. Di Lazaro(c), F. Flora(c), T.W. Ford(d), A.D. Stead(d), C.N. Danson(e), D. Neely(e), E. Sarantopoulou(a), Z. Kollia(a), S. Kobe(f), (a)National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, 48 Vas. Constantinou Av., Athens 11635, Greece, (b) Institute of Microelectronics, NCSR "Demokritos" 15310 Ag. Paraskevi, Greece, (c)ENEA, Via Enrico Fermi 27, 00044 Frascati, Italy, (d)School of Biological Sciences, Royal Holloway, University of London, Egham, Surrey TW20 0EX, UK, (e)Central Laser Facility, Rutherford Appleton Laboratory, Chilton, Didcot, Oxon OX11 0QX, UK, (f)Jozef Stefan Institute, 1000 Ljubljana, Jamova 39 Slovenija  
Images of biological specimens in vivo were obtained using soft X-rays in the water window (2.3-4.4 nm), from laser plasma generated from short laser pulses focused on solid targets. The images were obtained on sensitive, high resolution photoresists with grey scale capabilities developed for this type of application. Successful biological imaging is based on the different absorption caused by water and the carbon-rich proteins of the living biological specimens [1]. Atomic force and scanning electron microscopy of the biological images clearly suggesting a lateral resolution better than 50nm.  
[1] A. C. Cefalas, P. Argitis, Z. Kollia, E. Sarantopoulou, T. W. Ford, A. D. Stead, A. Maranka, C. N. Danson, J. Knott, D. Neely, Appl. Phys. Letters V72, (25), (1998)

## SYMPOSIUM Q

- 16:50 **Q-VI.3** **FORMATION OF NANOMETRIC-SCALE PROTEIN AGGREGATES ON ION IRRADIATED POLYMER SURFACES**  
C. Satriano and G. Marletta, Department of Chemistry, University of Catania, V.le A. Doria 6, 95125 Catania, Italy  
This work deals with the nanometric-scale structure of the protein films adsorbed on low-energy ion irradiated poly(hydroxymethylsiloxane) (PHMS) surfaces. Measurements of serum proteins adsorption onto both untreated and ion-beam irradiated PHMS surfaces were performed both in-situ, by means of the Quartz Crystal Microbalance with Dissipation Monitoring (QCM-D), and ex-situ, by X-ray Photoelectron Spectroscopy (XPS) and Atomic Force Microscopy (AFM). Important differences for both kinetics and conformational effects were found by QCM-D technique, suggesting different organizations of the protein adlayers at different ion doses. In particular, in correspondence of the fluence of  $5 \times 10^{14}$  ion/cm<sup>2</sup> the catastrophic protein aggregation was observed by AFM with the formation of aggregates with about 60 nm of height and 250 nm of diameter, at the very same fluence threshold where an unexplained enhancement of cell adhesion and cell spreading processes was previously observed. The possible models to account for the observed protein-surface interaction effects and the prompting effects toward the cell adhesion process are discussed in view of the physico-chemical modification undergone by the irradiated surfaces.
- 17:10-18:30 **POSTER SESSION I**  
Nanofabrication
- Q/PL.01** **POROUS A3B5 COMPOUNDS**  
I. Simkiene, J. Sabataityte, R.A. Bendorius, V. Pacebutas  
The direct bandgap A3B5 nanocrystals are very interesting from the viewpoint of the physics of low dimensional structures as well as for the application purposes. For instance, the effects of dimensional quantization are expected particularly are pronounced in GaSb nanostructures due to small effective mass of carriers and large exciton Bohr radius. We have modified the technology of electrochemical etching for Si and applied it for A3B5 compounds. As a result, porous GaAs and GaSb nanocrystalline films were obtained. In order to assess the luminescence properties of the porous material and their dependence on etching conditions, the photoluminescence (PL) spectra of porous GaAs and GaSb were measured at room temperature. At room temperature the forbidden energy gap of monocrystalline GaAs and GaSb is near 0.87 eV and 1.85 eV, respectively. While the intense PL peaks for both porous materials were observed in the range of 560 to 740 nm. The XPS results indicated that the porous layer consisted predominantly of GaAs and GaSb for the corresponding porous A3B5 compounds. Therefore, the most reasonable assumption is that the green/red light of porous GaAs and GaSb is emitted by GaAs and GaSb crystallites. In addition, calculations have shown that the diameter of nanocrystals should be larger than 8 nm in porous GaAs films and should be in the range of 5.6 to 6.1 nm in porous GaSb structures for observation of PL peaks at wavelengths mentioned above.
- Q/PL.02** **NANOCRYSTALLISATION OF AMORPHOUS ALLOYS BASED ON IRON**  
Z. Stoksosa, J. Rasek, P. Kwapulinski, G. Haneczok, G. Badura, J. Lelstko, Institute of Physics and Chemistry of Metals, Silesian University, Bankowa 12, 40-007 Katowice, Poland  
In the last ten years an increasing progress in the field of new soft magnetic materials is observed which is related to a development of new technologies of material production [1].  
In the present paper the Fe-X-Si-B and Fe-Cu1-X-Si-B alloys (X - alloy addition or their combination) obtained by melt spinning technique were investigated. As quenched samples were in amorphous state. In order to obtain a nanocrystalline phase the examined samples were annealed at temperatures from the range 300 - 900 K for 1 h. For annealed samples magnetic properties (permeability, coercive field, magnetisation) as well as electric properties were measured at room temperature. The structural changes were examined by applying X-ray diffraction method and electron microscopy observations (HREM-JEM 3010). These examinations were supplemented by measurements of electrical resistivity and magnetic permeability in situ with linear heating rates (0.5-10 K/min). These measurements allow to study the crystallisation processes (first and second stages, activation energy), and to determine the Curie temperature. The observed magnetic permeability enhancement can be explained by Herzer model which take into account formation of nanocrystalline phase supplemented by two terms i.e. magnetoelastic energy and stabilisation energy connected with presence of microvoids [2].  
[1] L. K. Varga, F. Mazaleyrat, J. Kovac, A. Kakay, JMMM 215-216 (2000) 121  
[2] G. Herzer, L. L. Varga, JMMM 215-216 (2000) 506
- Q/PL.03** **POROUS SILICON-DIAMOND LIKE CARBON FILMS SYSTEMS FOR FIELD EMISSION APPLICATION**  
N.I. Klyui, V.G. Litovchenko, A.A. Evtukh, O.B. Korneta, A.G. Rozhin, Yu.M. Litvin, Institute of Semiconductor Physics, National Academy of Science of Ukraine, 45 prospect Nauki, 03028, Kiev, Ukraine and V.M. Puzikov, A.V. Semenov, Institute of Monocrystals, National Academy of Science of Ukraine, 60 prospect Lenina, 61001, Kharkov, Ukraine  
Optical (refractive index, extension coefficient, optical band-gap, photoluminescence spectra) properties, field emission properties, and surface structure (studied by AFM) of diamond-like carbon (DLC) films, deposited onto porous silicon (PS) were investigated. Two kinds of DLC films, deposited onto PS by PE CVD technique and from separated ion beams, were used.  
The emission properties of porous silicon-DLC film doped with nitrogen and rare-earth elements were studied. In order to modify the films and systems properties, conventional and rapid thermal annealing was carried out.  
The strong influence of the film doping with nitrogen, silicon and rare earth elements on electron field emission parameters is observed.  
Effect of the field emission parameters (emission threshold, work function) improvement after the film deposition has been found.  
The mechanism of the effect observed have been proposed and discussed. We suppose that the porous silicon acts as source of electrons while carbon-based nanoclusters situated on silicon wires are the emission sites.

## SYMPOSIUM Q

- Q/PL.04** DEVELOPMENT OF NANOCRYSTALS IN AMORPHOUS AL-ALLOYS  
N. Boucharat, H. Rösner, G. Wilde, Forschungszentrum Karlsruhe, Institut für Nanotechnologie, P.O. Box 3640, 76021 Karlsruhe, Germany  
Amorphous Al-based metallic alloys such as Al92Sm8 and Al88Y7Fe5 are partially devitrified by thermal treatments that lead to a nanometre-scaled dispersion of Al crystallites embedded in an amorphous matrix. The unequal component diffusivities limit crystal growth and allow the development of a high number density of Al-nanocrystals that yields a high tensile strength of the nanocomposite material. Yet, the origin of the nanocrystallization process is still discussed controversially. Calorimetric and structural investigations on alloys produced by both mechanical intermixing and rapid solidification processes indicate that the nanocrystals originate from quenched-in nuclei. Detailed investigations concerning the kinetics of nanocrystallization have been performed by determination of the nanocrystal size distribution after continuous heating and isothermal annealing. The formation of additional phases has also been observed after such treatments related to the modifications of the matrix composition as a result of component diffusivities. Additionally, isothermal microcalorimetry investigations have been conducted to monitor the early stages of nanocrystal development directly on long time scales. The results are compared to crystallization kinetics models and discussed with respect to the nature of the underlying nucleation and growth mechanisms.
- Q/PL.05** GROWTH AND OPTICAL STUDIES OF OPALS AS THREE-DIMENSIONAL (3D) PHOTONIC CRYSTALS  
D. Comoretto, INFN, Dipartimento di Chimica e Chimica Industriale, Università di Genova, Genova, Italy, R. Grassi, F. Marabelli and L.C. Andreani, INFN, Dipartimento di Fisica "A. Volta", Università di Pavia, Pavia, Italy  
Photonic crystals are materials with periodical modulation of the dielectric constant at nanometric scale. They are widely studied for their optical properties that allow manipulation of the light flux thus making them good candidates for optical signal processing. If the photonic crystal exhibits the suitable structure, all the optical characteristics including the presence of a band gap depend on the dielectric contrast between the component media, one of them being typically the void.  
We report on the growth of three-dimensional photonic crystals like artificial opals by self-assembly of silica or polystyrene nanospheres. AFM and SEM microscopy images of opals show a triangular packing of the spheres at the surface while in the bulk the spheres are assembled into a FCC lattice grown along a [111] direction. The energy position of an optical pseudo gap in transmittance and reflectance spectra at varying angles of incidence is observed and accounted for by theoretical calculations of the photonic band structure based on the plane-wave expansion. These calculations indicate that the pseudo gap is due to the splitting of the bands in the L point of the Brillouin zone. The spectroscopic data show additional structures due to both other features of the Brillouin zone and to the diffraction of the light from the regular surface of the sample acting as a regular grating. Preliminary work on the opals infiltration with conjugated polymers for nonlinear optics is also reported
- Q/PL.06** HYDROGEN ENHANCED CLUSTERISATION OF CARBON IN CRYSTALLINE SILICON  
Yu.V. Gorelkinskii, Kh.A. Abdullin, B.N. Mukashev and G.O. Tojibaev, Institute of Physics and Technology Kazakstan Ministry of Education and Science, Kazakstan  
We have revealed for the first time strongly hydrogen-enhanced clusterization of carbon atoms along with self-interstitial in H-implanted silicon. As object of researches was used EPR a signal of the earlier not identified EPR defect ( $S=1/2$ ) [1]. We note that in FZ - silicon with low content of carbon irradiated with fast neutrons or protons even traces of P is not observed. However, after H- implantation and annealing of the same samples at 850K secondary H- implantation leads to creation of the PK4. H-implantation in Fz samples enriched with carbon generate most prominent signal of the defect. We have reliably identified hyperfine interaction (hfi) with an isotope  $^{29}\text{Si}$ . Three groups of hf satellites were revealed: 1) - one equivalent Si atom with localization of ~42% and A and tensor of tetragonal symmetry; 2) - four equivalent Si atoms (~16%); 3) - weak hfi which can be caused by an isotope of  $^{13}\text{C}$ ; if in structure of the defect are involved four equivalent carbon atoms. We have found that electronic structure of this defect corresponds to the double donor in a positive charge state. Uniaxial stress experiments reveal that activation energy for atomic reorientation is very large (2.8 eV) and as well as data of piezoelectric tensor are in good agreement with cluster's nature of the defect. Details of experiments and discussion will be presented in report.  
[1] E. Mu, J.C. Wao, M.X. Yan, G.G. Qin, Phys. Lett A 118 (1986) 347
- Q/PL.07** OPTIMISATION OF SOFT MAGNETIC PROPERTIES IN NANOPERM TYPE ALLOYS  
P. Kwapulis(a), A. Chrobak(b), G. Hanecczek(a), Z. Stoksoś(a), J. Rasek(a), J. Lelstko(a), (a)Institute of Physics and Chemistry of Metals, Silesian University, 12 Bankowa, 40-007 Katowice, Poland, (b)Institute of Physics, Silesian University, 4 Uniwersytecka, 40-007 Katowice, Poland  
As it is known nanocrystalline alloys can be obtained by application of a suitable thermal annealing of amorphous alloys at temperatures closed to the crystallisation temperature. In the present paper the Fe-X<sub>2</sub>-B<sub>22</sub> alloys (X=Cr, Zr and Nb) obtained by melt spinning method were investigated using the several experimental techniques: X-ray diffraction, HREM (JEM 3010), magnetic measurements (magnetic permeability, coercive force, saturation magnetisation) and electric measurements. In order to find thermal and time conditions of formation of nanocrystalline phase the examined samples were annealed at temperatures from the range 300 ? 900 K for 1 h. For annealed samples magnetic and electric properties was measured at room temperature. It has been shown that for all examined alloys magnetic properties can be improved (e.g. increase of permeability of about 5-6 times) by annealing at following temperatures: 600, 600, 650 and 700 K for Fe<sub>78</sub>B<sub>22</sub>, Fe<sub>76</sub>Cr<sub>2</sub>B<sub>22</sub>, Fe<sub>76</sub>Zr<sub>2</sub>B<sub>22</sub>, and Fe<sub>76</sub>Nb<sub>2</sub>B<sub>22</sub>, respectively. This effect, according to Herzer model, can be attributed to formation of nanocrystalline phase with grain size of the order of 10 nm (Fe<sub>76</sub>Zr<sub>2</sub>B<sub>22</sub>).
- Q/PL.08** SENSOR HETEROSTRUCTURES WITH AMORPHOUS AND NANO-CRYSTALLINE SEMICONDUCTORS  
E.P. Domashevskaya and E.A. Tutov, Physics Department, Voronezh State University, 494693 Voronezh, Russia  
Some general and specific properties of heterostructures formed by single-crystalline silicon with amorphous films of tungsten trioxide (a-WO<sub>3</sub>/c-Si and por-Si/c-Si) were illustrated in the work basing on the study of the functional properties of these structures as well as the methods of investigations of their electrophysical characteristics.  
A high sensitivity of electrophysical parameters of heterojunction in such structures to the external exposures and a free access of optic radiation to heterojunction as well as adsorbate molecules towards disordered semiconductor allow to use these structures as optical and gas sensors including those ones with large area (the main trends of functional applications) [1]. They can be also applied for the study of structural and energy characteristics of disordered materials and electronic processes proceeding inside them under different external exposure factors.  
[1] E.A. Tutov, A.A. Baev, S.V. Ryabtsev, A.V. Tadeev Thin Solid Films, 296 (1997) 184.  
[2] E.A. Tutov, A.A. Baev Appl. Surf. Sci., 90 (1995) 303.  
[3] E.A. Tutov, A. Yu. Andryukov, S.V. Ryabtsev Tech. Phys. Letters, 26(2000) 778.  
[4] E.A. Tutov, A. Yu. Andryukov, E.N. Bormontov Semiconductors 35 (2001) 816.

## SYMPOSIUM Q

- Q/PL.09** ENHANCED LOW-FIELD MAGNETORESISTANCE IN NANO-SCALE PHASE-SEPARATED MANGANITES  $Y_xLa_{1-x}MnO_3$   
L. Zhou, Y.P. Wang, G.L. Yuan, J.-M. Liu and Z.G. Liu, Laboratory of Solid State Microstructures, Nanjing University, Nanjing 210093, China  
Enhanced low-field magnetoresistance (LFMR) effect has been observed in nano-scale phase separated polycrystalline  $Y_xLa_{1-x}MnO_3$  (0 < x < 0.75) bulk ceramic samples which are prepared using conventional solid-state reaction sintering. We have obtained a magnetoresistance ratio as large as 20% under low magnetic fields of 2kOe, while the magnetoresistance of the self-doped  $La_{1-x}MnO_3$  is less than 5% under the same field range. The microstructural, electro- and magnetotransport properties are characterized by means of various techniques. The XRD, ICP-MS and SEM indicate that  $Y_xLa_{1-x}MnO_3$  has phase separated into the FM  $La_{1-x}MnO_3$  and insulator  $YMnO_3$ . The current-voltage and conductance characteristics demonstrate a spin-tunneling behavior across an insulating barrier. So it is argued that the insulating  $YMnO_3$  layer behaves as the barrier for the spin-polarized tunneling, resulting in enhanced magnetoresistance at low magnetic field.
- Q/PL.10** GENTLE ("DOUCE") ELECTRICAL CONTACTS TO MOLECULES: THE LIFT-OFF, FLOAT-ON (LOFO) TECHNIQUE  
Ayelet Vilan, C. Pejoux, D. Cahen, Materials & Interfaces Dept., Weizmann Inst. of Science, Rehovot 76100, Israel  
Self-assembly of functional molecular systems is a surface chemical approach to bottom-up nanotechnology and low-cost organic devices. However, electrically contacting molecularly modified surfaces without damage to the molecules is problematic. We developed a film flotation technique, adapted from TEM sample preparation, to make molecule-containing research devices. We find LOFO to be controlled rationally by surface forces. Mismatch between the surface tensions of the floating film and substrate can lead to repulsion and prevent flotation. However, adjusting the surface tension of the solvent can easily prevent this repulsion. Because after flotation a residual solvent film is left between the two solids, surface forces have a crucial effect on final film morphology (after solvent removal). We use this technique to produce metal-semiconductor junctions with molecular monolayers adsorbed at the surface of either the semiconductor, the metal or both (Au/ML/GaAs, -Si, -ZnO & Al/ML/GaAs). It is applicable with some modifications, also to other metals and to semiconductors (cf. Yablonowitz et al). We show that, with wet chemistry, we can produce molecule-containing, nm-thick, 0.5 mm wide interfaces, with electrical properties comparable to those of molecule-free, UHV-evaporated metals on semiconductors, suggesting the need to revise models for such interfaces. Using LOFO we can envision soft production of more refined structures, e.g. with colloids on molecularly patterned surfaces.
- Q/PL.11** DISSYMMETRIZATION OF SILICA PARTICLES: A FIRST STEP TOWARDS DIFUNCTIONAL MATERIALS  
Stéphane Reculusa(a), Céline Poncet-Legrand(a), Serge Ravaine(a), Christophe Mingotaud(b), Etienne Duguet(c) and Elodie Bourgeat-Lami(d), (a)Centre de Recherche Paul Pascal, CNRS, Avenue Albert Schweitzer, 33600 Pessac, France, (b)Laboratoire des IMRCP, Université Paul Sabatier, 118 route de Narbonne, 31062 Toulouse Cedex, France, (3)Institut de Chimie de la Matière Condensée de Bordeaux, CNRS, Avenue Albert Schweitzer, 33608 Pessac Cedex, France, (4)Laboratoire de Chimie et Procédés de Polymérisation, CPE Lyon, 43 boulevard du 11 novembre 1918, 69616 Villeurbanne Cedex, France  
In the area of core-shell nanoparticles, we investigate the synthesis of non-isotropic assemblies with a shell restricted to one hemisphere of the spherical core. An original self-assembly behavior of such dissymmetrical particles is then expected because of the potential attraction between hemispheres of different or similar surface nature as driving force. Recently, we reported the possibility of synthesizing silica spheres (with an average diameter around 100 nm) decorated with gold nanoclusters on one single hemisphere. The technique consisted in spreading amino-functionalized silica particles along a solution of gold nanoclusters, using the air/water interface as dissymmetrization tool. The aim of our work is to demonstrate the opportunity of generalizing this concept of interfacial dissymmetrization and to compare several interfaces with the same submicrometer system.  
For this purpose, we investigate and compare routes based on gas/liquid, liquid/solid and gas/solid interfaces derived from Langmuir, Langmuir-Blodgett and Physical Vapor Deposition (PVD) techniques, respectively. Complementary experiments with bigger silica beads were also carried out and semi-fluorescent particles were finally obtained.
- Q/PL.12** NANOVOIDS IN THE FATTY-ACID TRIGLYCERIDES  
T.A. Rashevskaya(a), M.M. Nishchenko(b), E.V. Buzaneva(c), (a)Ukrainian State University of Food Technologies, (b)Ukraine Institute for Metal Physics, (c)Kiev National University, Ukraine  
Size distribution of the nanovoids in the fatty-acid triglycerides is studied by means of the positron annihilation technique. Two types of the nanovoids are found: (i) the cages with the mean radius of 0.48 nm near the polar ends (glycerol moieties) of triglyceride molecules and (ii) the nanovoids between hydrocarbon chains,  $(CH_2)_n-CH_3$ . The radius of the latter is equal to 0.36 nm in thermodynamically equilibrium state of the triglycerides. This value coincides with the outer radius of C60 fullerene molecule.  
The positron penetrating to the interior of the nanovoids forms the bound state with electron (positronium atom). This indicates the presence of electric field at the nanovoid boundary and formation of the potential well for positively charged particles, such as the positrons, protons, and cations. The ordering of triglyceride molecules results in increased positron trapping probability by the nanovoid (by a factor of 2 to 3), which reaches 18 per cent and indicates the deepening of the potential well. Vica versa, the electron shell of the fullerene molecule forms the potential barrier for the penetration of positively charged particles into the interior. It is suggested, may lead to the formation of hybrid nanostructures with new properties.
- Q/PL.13** NEW NANOSIZED PATTERNING TECHNOLOGY BASED ON ELECTROPULSED SCANNING PROBE MICROSCOPY  
P. Brogueira and L.V. Melo, Physics Department, Instituto Superior Tecnico, Av. Rovisco Pais, 1049-001 Lisboa, Portugal  
Scanning Probe Microscopes (SPM) have been used to change surfaces at nanometer scales. User defined patterns are deposited in a controlled manner using an electropulsed SPM. The patterns were fabricated by applying -12V electrical pulses in the 10 to 40Hz range between a metal covered crystalline silicon tapping mode tip and a crystalline n-doped Si wafer. Measurements on the same surface region before and after deposition show no detectable differences suggesting negligible tip damage during deposition. Immediately after deposition the same tip is used for measuring the fabricated patterns. Typical write pixel size of the order of 30nm was measured when one isolated electrical pulse was applied. By combining write pixels, user defined patterns can be fabricated. Lines with 65nm width by 828nm length were obtained by applying electrical pulses during a 25nm x 800nm tip scan in AFM tapping mode, at 40Hz (in good agreement with the expected dimensions of 55nm x 830nm derived from the pixel size and the scan range). The height of the deposited patterns is of the order of 2 to 3nm, and was found to increase with the density of scan lines. The RMS roughness of the deposited material is shown to be strongly dependent on the electrical pulse frequency. The smoother pattern surface results from the 40Hz pulse frequency. No deposition was observed at higher frequencies.

## SYMPOSIUM Q

### Q/PL14

#### NANOTEXTURING AND NANOWEBS VIA ELECTROSPINNING

Jean S. Stephens, Silke Megelski, John F Rabolt, Department of Materials Science and Engineering, Delaware Biotechnology Institute, University of Delaware, Newark DE 19716, USA, D Bruce Chase, Central Research and Development, Dupont, Wilmington DE 19880, USA

The ability to add texture while shaping materials would reduce, if not eliminate, post-processing protocols thus saving energy and reducing cost. Our research focuses on a single step process for the formation of nanoporous fibers. These fibers were made from a series of volatile solvents using the electrospinning process. The size and density of the nanopores can be changed by varying the processing conditions. The fibers have been characterized by field emission scanning electron microscopy, atomic force microscopy, and Raman spectroscopy(1). The pores ranging in size from 20-1000 nm (having depths ranging from 50-70 nm) have been observed on the surface of both amorphous (polystyrene, polymethyl methacrylate) and semicrystalline (polycarbonate) polymer fibers(2). The nanoporous nature of these fibers is ideal for incorporating heparin binding growth factors to promote cell growth. In addition we have been able to fill the nanopores with metallic nanoparticles and polymer vesicles in order to explore their electronic, photonic, and biomedical properties. Recently we used the electrospinning process to produce webs of nanofibers of collagen, nylon, and synthetic spider silk. The fibers in the nanowebs are 20 nm in diameter, three times the width of a collagen triple helix, giving the material an ultrahigh surface area (80-1200 m<sup>2</sup>/g).

[1] JS Stephens, et al, Applied Spectroscopy, 10, 1287, 2001.

[2] JS Stephens, et al, JACS, submitted 11/01.

### Q/PL15

#### SILVER AND COPPER NANOSTRUCTURES WITHIN THE ERIONITE REGULAR LATTICE: AN INTERPLAY BETWEEN INTRA- AND EXTRA-CRYSTALLINE LOCATION

V.S. Gurin, Physico-Chemical Research Institute, BSU, Leningradskaja str. 14, Minsk 220080, Belarus, V.P. Petranovskii, N.E. Bogdanchikova, CCMC-UNAM, Apdo. Postal 2681, 22800, Ensenada, B.C., Mexico

A recently discovered specific stabilization of silver clusters within the zeolites with good geometrical fitting of the cluster and cavity [1] provided a search of novel metal-dielectric nanostructures of this type with controlled optical and electrical properties. The ion-exchangeable Si/Al-variable zeolites are the unique medium for metal species incorporation due to direct ionic interaction of metal ions with matrix. It is of great interest to assembly metal ions with subsequent in-situ reduction to the clusters and nanoparticles with formation of the secondary structures. That is principally possible in the zeolites with complicated cavity organization. On the example of erionite (sausage-like cavities of the circular cross section ~0.7nm diam and ~1.2nm long) we demonstrate features of metal incorporation via the above method. Ag<sup>8+</sup> the clusters within the erionite provide the pronounced long-wave absorption peaks (unlike any isolated Ag particles or clusters). The matrix-stabilized aggregates of the clusters are one of possible interpretations of this observation. In the case of copper the plasmon resonance is generated from the particles with size larger than a cavity and instead of the multi-peak spectra we get the fine crystalline particles with the peak position variation.

[1] Ogden J.S., e.a. Eur.J.Phys. D9 (1999) 605.

### Q/PL16

#### A SYNTHESIS AND OPTICAL FEATURES OF NANOCRYSTALLINE METASTABLE ZIRCONIA WITHIN THE GLASSY AMORPHOUS GERMANIA

E.V. Frolova, V.V. Sviridov, V.S. Gurin, L.S. Ivashkevich, Physico-Chemical Research Institute, BSU, Leningradskaja str. 14, Minsk 220080, Belarus

Composite nanomaterials can comprise both features of several constituents and effects of one component upon another, thus providing an unique system that may not be reproduced in the case of individual materials. The present report concerns the composite by the type of "nanocrystals-in-a-matrix" in which metastable nanocrystalline phase of ZrO<sub>2</sub> is stabilized by the GeO<sub>2</sub> matrix possessing complicated structure. The latter is characterized as an amorphous glass, however, it include both tetrahedral and octahedral GeO<sub>x</sub>-coordination along with the lower valence Ge states. All these structure features manage optical absorption and has been evidenced with XRD, FTIR and XPS data. The metastable zirconia can be produced in cubic, tetragonal, and monoclinic (ordinary, stable) crystalline modifications depending on the preparation route (colloidal mixing, codeposition), ZrO<sub>2</sub>/GeO<sub>2</sub> molar ratio and temperature of heat treatment. These phases are stabilized due to size effects and ZrO<sub>2</sub>-GeO<sub>2</sub> interaction. The present ZrO<sub>2</sub>-GeO<sub>2</sub> nanocomposites are of interest for optical applications, fast ionic conductors, and efficient catalysts due to appearance of new species those were not produced earlier in the individual constituents.

### Q/PL17

#### NANO-STACKING FORMATION AND CHARACTERIZATION OF HEXABEZOCORONENE DERIVATIVE

Won-Suk Chang, Silvia Mittler, Natalie Tchegotareve, and Wolfgang Knoll, Max-Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

Recently, there has been increasing interest in the fabrication of nano structures because of their potential utilization in electronics, magnetics, optical, and micro-mechanical devices [1-3] such as nano-FET (Field Effect Transistor), nanowires, nano-patterning, organic semi conductors, etc. Therefore, researchers of these fields are searching for the suitable materials.

Here, we use a candidate material for nano-structuring (nano-stacking) : a thiol substituted HBC (Hexabenzocoronene) derivatives. HBC is a flat and disk-like molecule which is made by poly-cyclic aromatic hydrocarbons. So it is able to form organic - conjugation systems by self-attracting forces to columnar stacks caused from their cholestric liquid crystal property, which may enable an effective charge carrier. For these reasons, we are studying the mono-layer or multi-layer formation and their characterization of these HBC derivative molecules on gold surfaces.

In this study, we made a mono-layer of 1-disulfide substituted HBC (1-thio HBC) at various conditions by the self-assembled mono-layer (SAM) method, and characterized the mono-layer formation properties and surface morphologies by Atomic Force Microscopy (AFM).

For this study, gold substrates are prepared by Au evaporation using cleaved mica, which are annealed at 650°C during 1 min. before and after Au evaporation. To make a SAM, the solutions are prepared with various concentrations using 1,2,4-Trichlorobenzene (TCB) and 1,2-Dichloromethane (DCM), and the Au substrates are immersed in these solutions during the various times (2, 4 days) and temperatures (room temp. and 50°C). After that, these samples are washed in the same solvents and dried under the N<sub>2</sub> stream.

As well known, AFM is a well selected tool for the characterization of materials on surface [4, 5].

From the AFM characterization, the samples show droplet shape layers on the gold surface, and their number and size are increasing with increased time and temperature in the TCB. This result means the 1-thio HBC molecules are gathering by self-attracting force, and we can find a certain condition for highly ordered droplet shape.

[1] S. Iijima, Nature, 1991, 354, 56.

[2] A.P. Alivisatos, Science, 1996, 271, 933.

[3] A.M. Morales and C.M. Lieber, Science, 1998, 279, 208.

[4] J. Li, L.T. Piehler, D. Qin, J.R. Baker, Jr., and D.A. Tomalia, Langmuir. 2000, 16, 5613-5616.

[5] T. A. Betley, M.M. Banaszak Holl, B.G. Orr, D.R. Swanson, D.A. Tomalia, J.R. Baker, Jr., Langmuir, 2001, 17, 2768-2773.

## SYMPOSIUM Q

- Q/PL18** SYNTHESIS OF AMORPHOUS / POLYMERIC SUPERLATTICE CARBON FILMS AND CONTROL OF LAYER STRUCTURE AND STRESS  
N. Laidani, L. Calliari, G. Speranza, V. Micheli, M. Anderle, Istituto di Ricerca Scientifica e Tecnologica-ITC, Divisione Fisica-chimica delle Superfici, Via Sommarive 18, 38050 Povo (Trento), Italy.  
A synthetic approach for preparing a new class of superlattice coatings which consist of periodically layered amorphous carbon (a-C) and polymeric carbon as ultra-thin films, is described. The formation of the a-C/polymer multilayers with a defined layered structure is optimised on the basis of (i) the film nucleation and growth understanding and (ii) the film thickness dependence of the internal stress, for a single material.  
The amorphous carbon layers are grown on silicon by sputtering of a graphite target in a Ar-H<sub>2</sub> plasma and the polymeric ones by plasma-enhanced chemical vapor deposition using CH<sub>4</sub> as main gas precursor.  
The chemical and microstructural properties of the films are studied by x-ray photoelectron spectroscopy (XPS) and Fourier-transform infra-red spectroscopy (FT-IR). The stress in the films are determined from the substrate curvature measurements, using a profilometer.
- Q/PL19** SYNTHESIS AND CHARACTERIZATION OF NEW POLYANILINE/NANOTUBE COMPOSITES  
W.K. Maser, A.M. Benito, A. Callejas, M.T. Martínez, Instituto de Carboquímica, CSIC, C/Miguel Luesma Castán 4, 50015 Zaragoza, Spain, J. Schreiber, M. Cochet, O. Chauvet, Institut de Matériaux Jean Rouxel, LPC, 2 rue de la Houssinière, 44322 Nantes Cedex 3, France  
New polyaniline/nanotube (PANI/NT) composites have been synthesized by "in-situ" polymerization processes using both multi-wall carbon nanotubes (MWNTs) and single-wall carbon nanotubes (SWNTs) in concentrations ranging from 2 to 50 wt% of NTs. Although no structural changes are observed using MWNTs, above a concentration of 20 wt% of MWNTs, the "in-situ" synthesis results in favorable electronic interactions between nanotubes and the quinoid-ring of PANI leading to enhanced electronic properties.  
In order to better understand the site-selective interaction process, additionally PANI/SWNT composites have been synthesized. Here, purified SWNTs with reduced amounts of amorphous carbon have been employed to achieve composites with SWNT concentrations higher than 5 wt%. The results of electron microscopy, X-ray diffraction, Raman and conductivity measurements will be presented thus comparing in detail the use of MWNTs and SWNTs in various concentrations for forming PANI/NT composites.
- Q/PL20** ORDERED ARRAYS OF NANO-HOLES OR DOTS FORMED BY COMBINATION OF NANO-INDENTATION AND ANODIC OXIDATION OF ALUMINUM FOR HIGHLY FUNCTIONAL NANOMATERIALS FABRICATION  
Shoso Shingubara, Y. Murakami, K. Morimoto and T. Talahagi, Hiroshima University, Graduate School of ADSM, 1-3-1 Kagamiyama, Higashi-Hiroshima 739-8530, Japan  
Methods to form various sizes of ordered array of nanoholes or dots were investigated by the combination of nano-indentation and anodic oxidation. Porous alumina films those were formed by Al anodic oxidation have been intensively studied to use them as molds to form nano-wires or dots by depositing various metals or semiconductors [1]. Further, we found the ordered Al hexagonal dot array formation on SiO<sub>2</sub> after selective wet chemical etching of porous alumina film. However, there are only limited conditions those are dependent on the acid species to form the ordered array of nanoholes, and it is very difficult to form the desired size of ordered nanoholes. We introduced AFM nano-indentation technique to control the initial position of nanoholes during anodic oxidation. Al film with thickness of 100 nm was sputter-deposited on SiO<sub>2</sub>. Nano-indentation was carried out on a flat Al surface to form two-dimensional periodic surface roughness, and then anodic oxidation was carried out. Tetragonal as well as trigonal arrays of nanoholes with nearest neighbor distance of 50 to 120 nm were successfully formed, although tetragonal array was known to be unstable at the self-organization conditions. Al dot tetragonal arrays as well as hexagonal arrays were formed also after selective wet chemical etching of porous alumina film. Possibilities to use these structures for fabrication of various functional nano-materials will be discussed. Further investigations to study electron tunneling between Al dots are in progress.  
[1] S. Shingubara, O. Okino, Y. Sayama, H. Sakaue, and T. Takahagi Jpn.J.Appl.Phys.vol.36 No.12 (1997) pp.7791-7795.
- Q/PL21** MORPHOLOGY CONTROL AND DESIGN OF OXIDIC NANORODS  
G.R. Patzke, S. Costanza, F. Krumeich, and R. Nesper, Laboratory of Inorganic Chemistry, ETH Zurich, 8092 Zurich, Switzerland  
Oxidic nanorods are important anisotropic materials offering unique advantages for applications in a future nanotechnology, because they transfer the manifold, fascinating properties of oxides into 1 D nanoscopic arrangements. Solvothermal synthesis is one of the most powerful and effective strategies to generate such high-quality nanomaterials, and therefore it is applied in the present study.  
MoO<sub>3</sub> nanorods are formed in an outstandingly high yield by reaction of MoO<sub>3</sub>·2H<sub>2</sub>O in acidic media. This procedure requires only little synthetic effort and can be performed within a very wide scope of experimental conditions so that it is a promising candidate for up-scaled industrial processes. Moreover, size and shape of the nanorods can gradually be tuned by appropriate choice of pH and temperature of the reaction mixture [1]. Mechanistic studies elucidate the underlying reaction pathway. MoO<sub>2</sub> nanorods are accessible as well starting from the same precursor.  
Vanadium oxide-based nanorods are generated by treatment of V<sub>2</sub>O<sub>5</sub> in alkaline media. Furthermore, a whole spectrum of different nanoscale morphologies can be generated by control of two key parameters directing this synthetic strategy: pH and choice of additional ions. [1]G.R. Patzke, F. Krumeich, R. Nesper, Angew. Chem., in print.

### Particles & Characterization

- Q/PL22** RAMAN POLARIZATIONS IN THE LOW FREQUENCY SCATTERING BY GOLD NANOPARTICLES EMBEDDED IN DIFFERENT METAL OXIDES  
Michela Ombelli, Assuntina Morresi, Paola Sassi, Rosario Sergio Cataliotti, Dipartimento di Chimica, Sezione di Chimica Fisica, Università di Perugia, Via Elce di Sotto, 8, 06100 Perugia, Italy  
Polarization measurements have been performed on the low frequency Raman signals given by the acoustic phonons propagating in gold nanoclusters dispersed in different metal oxides with catalytic activity. After subtraction of the elastic peak, the total low frequency Raman signal was deconvoluted with a two-component band fitting procedure to produce separate integrated intensities of the two low frequency components. It was then possible to measure accurate depolarization ratios for each of the two components, which allow to discriminate between radial and quadrupolar surface modes in the samples. These modes should have indeed quite different values of their depolarization ratios, being connected to  $l = 0$  and  $l = 2$  respectively, quantum numbers of the angular momentum of the surface phonons in the gold nanoclusters. The average position of the low frequency peak has been used to get particles' dimensions.

## SYMPOSIUM Q

- Q/PL23** VISUALIZATION OF SURFACE ENERGY DIFFERENCES AT ATOMIC MONOLAYER STEPS ON GRAPHITE: ATOMIC FORCE MICROSCOPY AND NUMERICAL SIMULATION  
Adam Mechler(a), Janos Kokavecz(b), Peter Heszler(c), Ratneshwar Lal(a), (a)Neuroscience Research Institute, University of California, Santa Barbara CA 93016, USA, (b)Department of Optics and Quantum Electronics, University of Szeged, Hungary, (c)Research Group on Laser Physics of the Hungarian Academy of Sciences Box 406, 6701 Szeged, Hungary  
Atomic monolayer deep etch pits formed on highly oriented pyrolytic graphite surface by oxidative etching offer an excellent model structure to examine atomic scale surface energy differences. Dynamic mode atomic force microscopy shows non-topography-originated rims at the etch pit edges. These rims presumably represent surface energy profiles whose chemical basis is not well understood. Numerical simulation suggests that the rim formation arises due to an increased surface energy zone at the edge sites. Such correlation between the atomic steps and the surface energy profiles could be used to demarkate local chemical constituents.
- Q/PL24** DIRECT MAPPING OF THE SPIN GAP IN MANGANITE FILMS BY SPIN-POLARISED STM AT AMBIENT CONDITIONS  
M. Cavallini, F. Biscarini, V. Dediu, F.C. Maticotta, P. Nozar, R. Zamboni, C. Taliani, M.Massi, J.F. Moulin, I. Bergenti, Istituto di Spettroscopia Molecolare, CNR, Via P. Gobetti 101, 40129 Bologna, Italy  
The morphological, electrical and magnetic properties of epitaxial manganite films (La<sub>0.7</sub>Sr<sub>0.3</sub>MnO<sub>3</sub>) were studied by Spin-Polarized Scanning Tunneling Microscopy (SP-STM).  
The manganites as very attractive materials for spintronics applications, like non-volatile information storage systems, spin-filters, and spin-polarised carrier-injecting materials.  
The films grown by channel spark ablation. The film consist of highly homogeneous ferromagnetic (FM) phase and paramagnetic (PM) inclusions.  
By acquiring constant-current tunnelling spectroscopy maps, PM inclusions exhibit high contrast due to its low conductivity.  
Moreover the tunnelling spectroscopy curves have strongly non-linear and metallic-like behaviour for the FM part, while being featureless and insulating-like for the PM regions. The straightforward deconvolution of tunneling spectroscopy data leads to an eg-t<sub>2g</sub> manganite band picture, in good agreement with optical and photoemission data, indicate unequivocally that the FM part of the film surface is 100% spin polarized at room temperature. These results promote the manganites as efficient spin polarized injectors.
- Q/PL25** WITHDRAW
- Q/PL26** STM-INDUCED PHOTOEMISSION AT SOLID- LIQUID INTERFACE  
K. Perronet, F. Charra, CEA-Saclay, DSM-DRECAM- SPCSI, F-91191 Gif-sur-Yvette Cedex, France.  
Photoemission of a metal sample excited by a STM tip has been studied under UHV and in air for several years. We extended STM-induced photoemission from metal surface to solid-liquid interface. A Au(111)-Au junction immersed in a liquid (hydrophobic, with a good electrochemical stability) droplet was studied with a home made STM. Five liquids were considered : octylbenzene, dodecan-4-ol, tetradecane, perfluorooctane and trichlorobenzene. The emitted light collected by a large aperture lens is detected by a silicon avalanche photodiode in single photon counting regime. Tunnel current characteristics I(V) and photon counting rates N(V), as well as I(z) and N(z) (z being along the tip axe) were recorded on different points of the sample.  
Similar counting rates were achieved with or without liquid. We observed a decrease of the voltage threshold for photoemission when adding liquid compared to air medium. This is attributed to the decrease of energy of the radiative tip-induced plasmon in a medium with index of refraction higher than one. We also deduced from I(z) a strong decrease of the apparent tunnel barrier height, especially for perfluorooctane, which is a molecule very rich in electrons and helps probably tunnel electron to go through the barrier.  
Finally, we conclude that a liquid with a small index of refraction and which is rich in electron is convenient. Our observations permit to investigate the influence on STM-induced photoemission of a self-assembled molecule monolayer formed on a Au(111) substrate.
- Q/PL27** SMALL METAL PARTICLES ON SEMICONDUCTOR SURFACE (Au/GaAs)  
N.L. Dmitruk, T.R. Barlas, O.S. Kondratenko, V.R. Romanyuk, Institute for Physics of Semiconductors NASU, prospect Nauki 45, 03028 Kyiv 28, Ukraine  
Discontinuous metal films on the semiconductor surface are very important for future application in single-electronics. Elaborated technology of chemical liquid deposition of metal from aqueous solution of gold salt allows us to obtain as well isolated nanoclusters as some nearly percolated films [1]. This process of the Au<sup>3+</sup> ions neutralization by the capture of electrons from semiconducting substrate is accompanied by the break of atomic bonds and by dissolution of semiconductor around metal clusters. Morphology and geometric parameters of metal clusters was examined by atomic force microscopy (AFM) and transmission electron microscopy (TEM).  
As optical investigations we used both the p-polarized light reflection in visible and multi-angle of incidence ellipsometry. Using the effective optical parameters obtained we have calculated the dielectric function. Various ways of theoretical description of the dielectric response of the ensemble of metal particles in the effective medium approximation is considered. The most interest is exhibited to specific optical properties due to the Mie surface plasmon resonance. By AFM and TEM measurement it was found that the Au clusters were flattened in the substrate surface. The Bruggeman's approximation for oblate spheroids is found as the most preferable in some range of the metal filling factor.  
[1] Dmitruk N.L., Dmitruk I.M., Mikhailik T.A., Romaniuk V.R., Wagner T. Scripta Materialia, 2001, V.44, p.1199-1202.
- Q/PL28** STUDY OF TRAP CENTRES IN SILICON NANOCRYSTAL MEMORIES  
A. Soufi, P. Brunkov, S. Bernardini, C. Buseret, L. Militaru, P. Masson, T. Baron and G. Guillot, LPM-INSA de Lyon, UMR CNRS 5511, France  
After the first proposal of a memory transistor using silicon nanocrystals (nc-Si) as floating gates, other works have confirmed that non volatile memories using PMOS or NMOS transistors can be achieved. In spite of the fact that non volatile memories with Si-nanocrystals have been demonstrated, it remains necessary to understand the trapping phenomena in nc-Si and the influence of other parasitic traps. For future applications like NanoFlash memories, it is also necessary to improve highly sensitive electrical measurements in. For such studies, the use of Charge Pumping and Random Telegraphic Signal technics are shown to be useful for single or few trap analysis. Our work is focussed on the determination of trap densities in NMOS transistor nanocrystal memories. Temperature dependent I-V and C-V static measurements have been used together with time domain measurements such as DLTS and Charge Pumping. The aim of the study is first to study the influence of fast traps at the SiO<sub>2</sub>/Si interface. Then, slow states related to oxide traps are measured and the maximum number of trapped electrons per dot is extracted. A comparison between reference samples and Si-dot-samples is used to distinguish between trapping phenomena in the nano-floating gates or in parasitic oxide states.

## SYMPOSIUM Q

- Q/PL.29** ZnO COLLOIDAL NANOPARTICLES BY A NOVEL NON-HYDROLITIC APPROACH: SYNTHESIS AND CHARACTERISATION  
D. Cozzoli(a), M.L. Curri(b), A. Agostiano (a,b), M. Della Monica(a,b), G. Leo(c), M. Lomascolo(c), L. Vasanelli(c), (a)Dipartimento di Chimica, Università di Bari, via Orabona 4, 70126 Bari, Italy, (b)CNR IPCF Sez. Bari c/o Dip. di Chimica, Università di Bari, via Orabona 4, 70126 Bari, Italy, (c)CNR IME, Via Arnesano, Lecce, Italy  
Nanocrystal colloids can be synthesized by a variety of methods; it has been recently demonstrated that the key for obtaining high quality nanocrystals with controlled size and size-dispersion is to separate nucleation from growth: the method based on thermal decomposition of organometallic precursors in hot coordinating solvents has been modified for the synthesis of many different materials with high crystallinity and readily exchangeable surface properties, although it has been successfully applied in the synthesis of only a few quantum-confined metal oxide nanocrystals.  
In this note a novel synthetic method of ZnO nanocrystals by thermal decomposition of zinc acetate in a high temperature mixture of a long-chain alkylamine and phosphonic acid is reported. The phosphonic acid added in small but well defined proportions, was effective in directing ZnO crystal growth in a quantum confinement regime and to control nanoparticle size distribution. The possible role of the phosphonic acid, is at present under investigation. The obtained nanoparticles, wurtzite in structure and soluble in organic solvents, have been characterised by spectroscopical and structural point of view, by means of UV-vis spectroscopy, Photoluminescence, HR-TEM, X-ray powder diffraction.
- Q/PL.30** AC AHARONOV-BOHM PHENOMENA IN MESOSCOPIC RINGS  
A. Yourdas(a), C. Cefalas(b), N. Glezos(c), S. Kobe(d), E. Sarantopoulou(b), (a)Department of Computing, University of Bradford, Bradford BD7 1DP, U.K., (b)National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, 48 Vassileos Constantinou Avenue, Athens 11635, Greece, (c)Institute of Microelectronics, NCSR Demokritos, Aghia Paraskevi, Attiki 15310, Greece, (d)Josef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia  
Mesoscopic rings with diameter ~0.1  $\mu\text{m}$  threaded by a magnetostatic flux are known to exhibit Aharonov-Bohm phenomena. The magnetoconductance is a sinusoidal function of the magnetostatic flux. We consider mesoscopic rings irradiated by microwaves and study the magnetoconductance (ac Aharonov-Bohm phenomena). The results are interpreted in terms of multiphoton absorption/emission. It is shown that this highly non-linear system could be used as a frequency converter at microwaves/THz frequencies.
- Q/PL.31** SELF-ASSEMBLED NANOWIRE FORMATION DURING Cu DEPOSITION ON VSe2 STUDIED BY MICROSCOPIC METHODS  
S. Hollensteiner, E. Spiecker, C. Dieker, W. Jäger, Center for Microanalysis, Faculty of Engineering, Christian-Albrechts-University Kiel, Kaiserstr. 2, 24143 Kiel, Germany, R. Adelung, L. Kipp, M. Skibowski, Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-University Kiel, 24118 Kiel, Germany  
Self-assembled metallic nanostructures gain increasing interest in nanotechnologies and might find potential applications in future electronic device fabrication. Upon UHV deposition of copper onto cleaved layered crystals of VSe<sub>2</sub> self-assembled networks of nanowires and nanoclusters are observed to form and found to be remarkably stable even during storage under ambient conditions and at moderately increased temperatures. Transmission and scanning electron microscopy combined with scanning tunneling and atomic force microscopy have been used to characterize the arrangements, structure and dimensions of the nanostructures and the substrates before metal deposition. On the flat parts of the substrate, self-similar nanowire networks form with wire diameters ranging from 8 nm to 250 nm and with mesh dimensions ranging from 350 to 10000 nm. The nanowires are preferentially aligned along the <1-210> crystal directions and possess polycrystalline structure. Nanoclusters are formed within the meshes of the nanowire network. A model for the self-assembled growth of nanostructures during metal deposition which takes into account the electronic charge exchange of adsorbed atoms with the substrate will be discussed. Near-surface substrate defects possibly contribute to the formation of the nanostructures during the early stages of metal deposition.  
[1] R. Adelung, L. Kipp, M. Skibowski, F. Ernst, S. Hollensteiner, E. Spiecker, W. Jäger, Adv. Mater. (2002), submitted
- Q/PL.32** SELF FORMATION OF Si NANOSTRUCTURED LAYER ON THE METAL SILICIDE/SILICON INTERFACE  
I.V.Belousov(a), Androula Nassiopoulou(b), Christos Tsamis(b), Aleksander Gorchinskiy(a), Gennadiy Kuznetsov(c), Galina Popova(a), Tatina Veblaya(a), Danila Zherebeskiy(a), Oleg Lysko(a), Oleksandr Vysokolyan(a), Eugenia Buzaneva(a), (a)Institute of Metal Physics, (b)Institute of Microelectronics NCSR 'Democritos', (c)Kiev National Taras Shevchenko University, Ukraine  
The next models of self formation of Si nanostructured layer on the metal silicide/silicon interface for the metals which have diffusion coefficient through grown silicide layer have been developed: and confirmed: (i) lowtemperature chemical reaction between metal in the nanolayer (6-10 nm) and Si on the surface of silicon wafer without structural defects, with nm roughness (template surface); (ii) the features of the interface process(i) for the silicon wafer with ordering systems of surface dislocations; (iii) the features of the interface process and the diffusion of a metal under adding local mechanical stresses in Si surface layer (imprint technique).  
The Si relief evolution as a function of annealing temperature Co/Si and CoSi<sub>2</sub>/Si as well as a profiles of nanostructured Si layers by AFM were obtained for (i),(ii),(iii) processes.  
This work is fulfilled in the frame of Kiev National Taras Shevchenko Theme N01 BF052-07 and is supported by Greek-Ukrainian Grant 2M/192 &#8211; 2001.
- Q/PL.33** COLLOIDALLY SYNTHESIZED SEMICONDUCTOR NANO-CRYSTALS IN RESONANT CAVITY LIGHT EMITTING DEVICES  
J. Roither, W. Heiss, Institut für Halbleiterphysik, Universität Linz, Austria, N.P. Gaponik, D.V. Talapin, A. Eychmüller, Institute of Physical Chemistry, University of Hamburg, 20146 Hamburg, Germany  
Colloidally synthesized semiconductor nanocrystals are chemically grown quantum dots showing unique physical and chemical properties compared with bulk materials. In particular nanocrystals with CdSe cores and ZnS shells show size tunable luminescence with efficiencies up to 40-65 % [1]. Therefore, nanocrystals are highly suitable for light emitting devices based on spontaneous emission like LEDs [2] and resonant cavity light emitting devices. The latter use vertical cavities with Bragg mirrors with modest reflectivities in order to obtain a collimated output beam. Due to the wide spontaneous emission spectrum of quantum dot systems vertical resonators with a long cavity length and thus a small mode spacing are more suitable than cavities with wavelength scale lengths.  
We fabricate vertical cavities with small mode spacing and layers of semi-conductor nanocrystals as light sources. At room temperature, by optical excitation these cavities yield highly directive luminescence with a beam divergence smaller than 2 degree and with more than 10 resonator modes within the luminescence band of the nanocrystals. This is obtained due to a large cavity length of several micrometers by the use of pristine mica substrates, embedded in between the two cavity mirrors.  
[1] M. A. Hines and P. Guyot-Sionnest, *J. Phys. Chem.* 100, 468 (1996)  
[2] V. L. Colvin, M. C. Schlamp, and A. P. Alivisatos, *Nature* 370, 354 (1994)

## SYMPOSIUM Q

- Q/PL.34** SIZE EFFECTS ON THE PHASE DIAGRAMS OF NANOPARTICLES OF VARIOUS SHAPES  
M. Wautelet, University of Mons-Hainaut, Materia Nova, 7000 Mons, Belgium  
It is well established that the melting point and other phase transitions in nanoparticles vary with their size. Some crystal phases also appear preferentially in nanoparticles. These also depend on the chemical environment and the encapsulation of nanosystems. Although their shape is usually considered to be spherical-like, nanoparticles of various shapes (disks, rods, etc.) may be prepared experimentally. In this communication, it is shown that, in the limit where thermodynamical arguments remain valid, the phase diagrams of nanoparticles is a function of both their size and shape. This is demonstrated for the cases of rods, disks and other geometrical figures. The effects of surface segregation and defects implantation are also treated. The implications for the modelling of processes involving nanoparticles are discussed.
- Q/PL.35** CHARGE TRANSFER AND TRANSPORT PROCESSES IN MESOSCOPIC PHOTOELECTRODES OF SEMICONDUCTOR NANOPARTICLES SELF- ASSEMBLED IN POLY(DIALYLDIMETHYLAMMONIUM CHLORIDE)  
Lara I. Halaoui, Department of Chemistry, American University of Beirut, Beirut 110236, Lebanon  
Polyacrylate-capped Q-CdS were synthesized and self-assembled as multilayers in poly(diallyldimethylammonium chloride) on electrode surfaces by virtue of the Coulombic attraction between the negatively charged capping agent and the cationic polyelectrolyte [1]. This protocol was also employed for assembling heterostructured films of Q-CdS and Pt nanoparticles. Factors influencing the assembly process will be discussed. Photo-induced charge transfer and transport processes at these nanostructured photoelectrodes were studied by photoelectrochemical means; revealing novel behavior markedly different from bulk solids. Either anodic or cathodic photocurrents were measured depending on the applied potential; a behavior attributed to the quantized properties of the nanoparticles. The potential at which the photocurrent reversed in direction was found to shift by -66 mV per pH unit, tracking the shift in the redox energies of water oxidation, oxygen reduction, and hydrogen evolution. Photocurrent transients were featured at the onsets of light, and are attributed to surface-states mediated charge transfer. Charge transfer and transport processes at the Q-films are modeled, accounting for the bidirectional current flow, and its dependence on the electrode potential, the Fermi levels of the redox couples, and the nanoparticles surface.  
[1] Halaoui, L. I. Langmuir, 17, 7130 (2001)
- Q/PL.36** ELECTROMAGNETICAL RESPONSE OF BINARY METALLIC NANOPARTICLES: A COMPARISON BETWEEN MODELS CHARACTERIZED BY INCREASING DEGREE OF SCHEMATICITY  
S. Bruzzone, G.P. Arrighini and C. Guidotti, Department of Chemistry, Pisa University, Via Risorgimento 35, 56100 Pisa, Italy  
The adequacy of a classical approach based on the Maxwell electromagnetic equations to describe the optical response of one-metal nanosize particles, has been broadly discussed in order to assess role and prominence of effects related to the breaking of the bulk translational symmetry as we move to extremely small-size clusters (quantum size-effects). Although the extension of this study to the case of two-metal nanoparticles has been implemented, further investigations on the subject seem useful, in view of the both academic and technological interest on the dielectric behavior of these systems (coated particles, alloys, etc).  
In this paper we propose to compare results relative to the dielectric behavior of binary nanoclusters (IB metals of the periodic table) as obtained: a) from a very schematic electronic model based on independent electrons in a cubic box, here referred concisely to as GMKMA model (from Genzel, Martin, Kreibig, Wood, Ashcroft, a few people involved in this approach); b) from a more refined (but more demanding) model implemented by Ekardt (self-consistent spherical jellium-on-jellium model).
- Q/PL.37** MICROSTRUCTURE AND MAGNETIC BEHAVIOR OF NANOSIZED Fe<sub>3</sub>O<sub>4</sub> POWDER AND POLYCRYSTALLINE FILMS  
L. Nedkov, T. Merodiiska, S. Kolev, K. Krezhov, Institute of Electronics, BAS, 72 Tzarigradsko Chaussee, 1784 Sofia, Bulgaria and Y. Kusano, J. Takada, Okayama University, 2-1-1 Tsushima-naka, Okayama 700-8530, Japan  
Magnetic interactions in two kinds of nanostructured Fe<sub>3</sub>O<sub>4</sub> are investigated - in powders and layers. The powders are prepared by soft chemistry method and the thin films by "Modified ferrite plating" technique. The influence of the technological regimes on the crystallographic structures and on the size of the crystallites which strongly influence the magnetic characteristics is studied.  
The SEM observation of the layers show that there is some arrangement of the grains and the space between them is small enough for the magnetic interactions to take place. Magnetic measurements (VSM and SQUID) show that the films behave as bulk material while the powders exhibit a reduced magnetization and a "without hysteresis" curve which is typical for superparamagnetic interactions.

### Biotech & Environment

- Q/PL.38** SYNTHESIS AND BIOCHEMICAL STUDY OF FULLERENE-BASED COMPOSITES FOR BIONANOTECHNOLOGY  
O.A. Golub(a), O.P. Matyshevska(b), S.V. Prylutska(b), Yu.I. Prylutskyi(c), Kyiv National Shevchenko University, Department of (a)Chemistry, (b)Biochemistry and (c)Biophysics, Volodymyrska Str., 64, Kyiv 01033, Ukraine, P. Scharff, Technical University of Ilmenau, Institute of Physics, 98684 Ilmenau, Germany  
The composites on the basis of fullerenes with the previously provided geometrical structure [1] were synthesized. The stability and the biological activity of such composites were investigated using the electrochemical, thermogravimetric, spectroscopic and biochemical measurements. In particular, the photosensitivity of fullerene containing composites was studied under the different conditions for irradiation. Their pro-oxidant activity was evaluated too. The irradiation conditions for the composites under which is manifested their ability to accelerate the splitting of DNA and apoptosis of cells were selected.  
Due to the size and innate properties, it is planned to use the fullerene-based nanomaterials obtained as a new class of pharmacological compounds, for example: 1) for the correction of oxidative stress and pathologic states, caused by excessive formation of the oxygen containing active radicals; 2) for the photodynamic therapy of the transformed cells; 3) for the intensification of the authenticity of the therapeutic preparations delivery into the hydrophobic compartments of cells and tissues.  
[1] O.A. Golub, V.M. Sysoev, Yu.I. Prylutskyi and L.L. Ped?, Reports of NAS of Ukraine, 2001, 6, 132.

## SYMPOSIUM Q

- Q/PL.39** SYNTHESIS AND STRUCTURE OF NIR-SENSITIVE Au-Au<sub>2</sub>S NANOPARTICLES FOR DRUG DELIVERY  
Lei Ren and Gan-Moog Chow, Singapore-MIT alliance, National University of Singapore, 119260, Singapore  
The “water window” of the near-infrared (NIR) light is a gap in the absorption spectrum of tissue that exists between the absorption spectra of the chromophores (<650 nm) and that of water (>1200nm). This special range is non-destructive to human tissues, and hence the NIR light in controlled dose has been used for medical applications. In this study, NIR-sensitive Au<sub>2</sub>S-Au nano-colloid was investigated as a novel drug delivery carrier. Au<sub>2</sub>S-Au nano-colloids were prepared by mixing the aqueous solutions of chloroauric acid (HAuCl<sub>4</sub>·4H<sub>2</sub>O) and sodium sulphide (Na<sub>2</sub>S·9H<sub>2</sub>O). The reaction was monitored by using UV-visible spectroscopy. It is shown that Au<sub>2</sub>S-Au nano-colloids have unique optical activity: the optical resonance of gold can be dramatically shifted from the visible region (520nm) into the infrared over a wavelength range (> 700nm), which spans the region of highest physiological transmissivity. The structure of Au-Au<sub>2</sub>S nano-colloids was investigated by transmission electron microscopy (TEM) and electron diffraction. The properties and structures of Au-Au<sub>2</sub>S nano-colloids depend on the compositions. This unique NIR-sensitive property of Au<sub>2</sub>S-Au may be exploited for drug delivery carrier. It is suggested that illuminating the NIR-sensitive Au-Au<sub>2</sub>S nano-colloids at their resonance wavelength may thermally control the drug release from the nano-colloids.
- Q/PL.40** ADJUNCTION OF AVIDIN TO A SELF-ASSEMBLED MONOLAYER OF THIOL FOR IMPEDIMETRIC IMMUNOSENSOR  
O. Querghi(a,b), A. Touhami, C. Martelet(b), N. Jaffrezic-Renault(b), H. Ben Ouada(a), (a)IFOS-PCI UMR CNRS 5621, Ecole Centrale de Lyon, BP 163, 69131 Ecully Cedex, France, (b)Laboratoire de Physique des Interfaces, Faculté des Sciences de Monastir, Tunisie  
Cysteamine was adsorbed onto gold electrodes according to self-assembling procedures. Treatment of the cysteamine-modified gold electrode with glutaraldehyde generates an active monolayer that will be further coupled to avidin. The immobilization of the antibody (anti-Human IgG biotin conjugated) to the subsequent functionalized electrode was achieved by taking advantage of the strong bond formed between avidin and biotin. The different steps of the electrode modification were characterised by both cyclic voltammetry and impedance spectroscopy. The binding of a specific antigen (Human IgG reagent) to the prepared recognition layer have been monitored by measurement of the impedance changes. In order to avoid non-specific effects, all measurements were performed in the presence of BSA. The resulting immunosensor showed a linear range of 100-900 ng.ml<sup>-1</sup> of antigen and a detection limit of 10 ng.ml<sup>-1</sup>.
- Q/PL.41** ENGINEERING DNA NETWORKS ON NANOCARBON/NANOSILICON CHIP: ANALYSIS AND UNDERSTANDING OF PATHWAY INTERACTION DNA/NANOCARBON, DNA/NANOSILICON  
E. Buzaneva, Ya. Shtogun, A. Karlash, Yu. Prilutskyy, O. Matishevska, A. Gorchinskiy, G. Popova, Kiev National Taras Shevchenko University, Semiconductor and Biological Department, 64 Volodimirskaya Str., 01033 Kiev, Ukraine, P.Scharff, K. Risch, L. Carta-Abelmann, Institute for Physic, TU Ilmenau, 98684 Ilmenau, Germany  
DNA networks as nanosystems in chip are receiving increasing interest as a possible tool for monitoring the developmental and reproductive impact of xenobiotics, for example, on wildlife populations as well as for design electrical and optical nanosystems. Our research has been focused on the application of UV-vis, Raman, IR spectroscopy, XPS, AFM and I-V methods to recognize and predict these molecular interactions based on primary structure and associated physico-chemical properties. This report will summarize the predictive methodology and present result obtained on both DNA/nanocarbon and DNA/nanosilicon interaction data sets: nanocarbon (C<sub>60</sub>, nanotube) forms the bridges between DNA molecules under UV light, DNA is adsorbed on Si &#8211; surface through &#8211; O &#8211; Si bonds.  
This work is fulfilled in the frame of Kiev National Taras Shevchenko Theme N01 BF052-07 and is supported by Greek-Ukrainian Grant 2M/192 &#8211; 2001.
- Q/PL.42** POLYMER LANGMUIR-BLODGETT FILMS CONTAINING METAL  
N.I. Voronkina, N.A. Kireyeva, A.V. Tolmachev  
The condition of poly(styrene-maleic anhydride) monolayers forming at the liquid-air interface were investigated. Bidistilled water and water solutions with different concentrations of CdCl<sub>2</sub> were used as a liquid subphase. The influence of pH of the liquid subphase, barrier velocity, amount of polymer, Cd<sup>2+</sup> concentration on the monolayer properties were studied. As a result, optimal conditions of monolayer formation with Cd<sup>2+</sup> concentration from 0,5 to 5 % at. were selected. The dissociation reactions of anhydride groups and concentrations of joined Cd<sup>2+</sup> ions to the monolayer were regulated by varying of pH of liquid subphase. The equations of state of the monolayers and their thermodynamic parameters were obtained on the basis of experimental P-A isotherms. Addition of organic amphiphilic luminophores to the monolayer allows to get functional Langmuir-Blodgett films which are sensitive to a low-energy ionized radiation
- Q/PL.43** Withdraw
- Q/PL.44** ENGINEERING DNA NETWORKS ON NANOCARBON/NANOSILICON CHIP: ANALYSIS AND UNDERSTANDING OF PATHWAY INTERACTION DNA/NANOCARBON, DNA/NANOSILICON  
E. Buzaneva, Ya. Shtogun, A. Karlash, Yu. Prilutskyy, O. Matishevska, A. Gorchinskiy, G. Popova, Kiev National Taras Shevchenko University, Ukraine  
DNA networks as nanosystems in chip are receiving increasing interest as a possible tool for monitoring the developmental and reproductive impact of xenobiotics, for example, on wildlife populations as well as for design electrical and optical nanosystems. Our research has been focused on the application of UV-vis, Raman, IR spectroscopy, XPS, AFM and I-V methods to recognize and predict these molecular interactions based on primary structure and associated physico-chemical properties. This report will summarize the predictive methodology and present result obtained on both DNA/nanocarbon and DNA/nanosilicon interaction data sets: nanocarbon (C<sub>60</sub>, nanotube) forms the bridges between DNA molecules under UV light, DNA is adsorbed on Si &#8211; surface through &#8211; O &#8211; Si bonds.  
This work is fulfilled in the frame of Kiev National Taras Shevchenko Theme N01 BF052-07 and is supported by Greek-Ukrainian Grant 2M/192 &#8211; 2001.
- Q/PL.45** ADHESION OF MICROSPHERES ON NANO-ENGINEERED SURFACES IN A PARALLEL PLATE FLOW CHAMBER  
Elena Martines, University of Glasgow, Electrical Engineering-CCE (Centre for Cell Engineering), Glasgow, U.K.  
Cell adhesion under flow conditions has been extensively studied because of its important role e.g. in the immune and developmental system (1). Since topographic cues have been shown to influence cell adhesion to surfaces (2,3), our aim is to elucidate the mechanisms for the changes in adhesion onto nanometrically engineered surfaces. Because of the complicated receptor-ligand driven nature of cell adhesion, we started by investigating the adsorption/desorption rate of spherical beads (2.8 microns diameter) in a laminar flow over a plane array of nanopillars (80 nm height, 300 nm centre-to-centre). The sphere-to-surface collision efficiency was measured, and compared to the sphere-to-surface collision efficiency on a smooth surface of the same material (PMMA). Finally, data analysis and the experimental procedure are detailed and discussed.  
[1] Anne Pierres et al., J. Imm. Meth., 1996  
[2] Matt Dalby et al., Biomater., in press  
[3] Adam Curtis et al., Biophys. Chem., 2001

## SYMPOSIUM Q

- Q/PL.46** THE AFFECTS OF IRREGULAR NANOTOPOGRAPHY ON MAMMALIAN CELL ADHESION AND BEHAVIOUR  
M.A. Wood(a), A.S.G. Curtis(a), C.D.W. Wilkinson(b), (a)Centre for Cell Engineering, IBLS, (b)Dept. El. Engineering, University of Glasgow, G2 8QQ, U.K.  
Microtopography is one of the four main factors capable of affecting cell adhesion[1]. Recent investigations concerning the affects of regular nanotopographies on cell behaviour have also shown a reduction in cell adhesion[2]. However, are the affects of nanotopography only encountered when features are symmetrical?  
Through the utilisation of a natural lithography technique[3] where colloidal gold particles are deposited on a substrate and consequently used as an etch mask, it is possible to create irregularly pillared or beaded nanosurfaces[4].  
Both endothelial cells and fibroblasts have exhibited a preference for planar surfaces when confronted with a choice of flat and irregularly pillared nanostructures. Cell morphology is also altered in these cell types when grown on pseudo-random nanopillars. Length and breadth is altered, with cells grown on irregular nanopillars exhibiting fine sensing mechanisms such as microspikes and exaggerated filopodia. Actin appears unable to polymerise on these surfaces, and tubulin is disorganise  
[1] Wilkinson, Curtis Dev. In Nanotechnology 1996, 3, 19-  
[2] Curtis, Casey, Gallagher, Pasqui, Wood, Wilkinson Biophys Chem 2001, 94, 275-  
[3] Deckman, Dunsmuir Appl. Phys. Lett 1982, 41, 4, 377-379  
[4] Wilkinson, Riehle, Wood, Gallagher, Curtis Mat Sci Eng C 2002 263-269
- Q/PL.47** SnO<sub>2</sub>:Ru AS A NANOSYSTEM FOR ENVIRONMENTAL APPLICATION  
Raúl Diaz, Jordi Arbiol, Ismael Jimenez, Guilhem Dezanneau, Joan R. Morante, Electronic Materials and Engineering, Department of Electronics, University of Barcelona, Martí i Franques 1, 08028 Barcelona, Spain; Fausto Sanz, Department of Physical Chemistry, University of Barcelona, Martí i Franques 1, 08028 Barcelona, Spain  
Ru presents interesting properties as a catalytic metal. Deposited in small clusters of a few nanometers modify the surface reactivity of some active surface like that of the nano tin dioxide crystal. Therefore, the study of the nanosystem Ru-SnO<sub>2</sub> offers an alternative combination to stimulate the reaction of reducing gas molecules onto the SnO<sub>2</sub> surface. In this work we present a detailed study of this nanosystem that has been focused to achieve high sensitivity and fine selectivity for gas sensing applications taking into account the characteristics introduced by the presence of Ru onto the SnO<sub>2</sub> surface. Sensing mechanisms and gas detection performances will be presented and discussed.  
Thereby, SnO<sub>2</sub> with Ru coming from a solution containing K<sub>2</sub>RuCl<sub>5</sub> and SnCl<sub>2</sub> is obtained. Different Ru and tin salt concentrations and different annealing temperatures are used to study their influence on the samples. The characterization of these materials by means of XPS, ICP, Raman, XRD and HRTEM is discussed. Metallic Ru nanoclusters of a few nanometers are present on the SnO<sub>2</sub> surface, with formation of RuO<sub>2</sub> after annealing in air at high temperature. The presence of Ru-Sn compounds has also been detected and their characterization is discussed. The tests of the gas sensor response show high stability, low noise level and fast response.
- Q/PL.48** HYDROGEN STORAGE IN CARBON NANOSTRUCTURED MATERIALS  
Chen Xiaohong, Ursula Dettlaff, Miroslav Haluska, Martin Hulman, Michael Hirscher, Siegmur Roth, Germany  
Hydrogen adsorption isotherms of various carbon nanostructured materials including active carbon, carbon nanotubes (single walled and multi walled), carbon nanofibers and graphite were measured by the means of volumetric method at the temperatures of 295 K, 273 K, 200 K and 77 K.  
The highest hydrogen storage capability obtained was 2.9 wt % at 77 K and 55 bar in single walled carbon nanotube. The relation between specific surface area and hydrogen storage capability in carbon nanostructured materials were also shown.
- Q/PL.49** OXIDE (CuCo<sub>2</sub>O<sub>4</sub>/La<sub>2</sub>O<sub>3</sub>/ZrO<sub>2</sub>) THIN FILM CATALYST DEPOSITED ON A STAINLESS STEEL SUBSTRATE  
D. Panayotov(a), D. Stoychev(b), I. Avramov(a), G. Tyulie(a), Ts. Marinova(a), (a)Institute of General and Inorganic Chemistry, (b)Institute of physical Chemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev str. Bl. 11, 1113 Sofia, Bulgaria  
Although less commonly used than their ceramic counterparts, metal catalyst substrates are very perspective in automotive applications. Here we report for the first time on the preparation of CuCo<sub>2</sub>O<sub>4</sub>/La<sub>2</sub>O<sub>3</sub>/ZrO<sub>2</sub> oxide thin films. They are promising as catalysts for environmentally related reactions such as NO + CO, O<sub>2</sub> + CO and HC-SCR of NO. Recently, an electrochemical method for deposition of thin zirconia films on stainless steel (SS) has been developed. An impregnation technique has been employed for deposition of Cu-Co/La oxide thin films. BET, XPS, SEM, ICP and TPD methods are applied to their characterization. The surface composition of catalysts was determined by XPS analysis. Cobalt is found mainly as Co<sup>3+</sup> and copper, as Cu<sup>2+</sup>. The data from XPS, TPD and ICP studies indicate the formation of a Cu-Co oxide spinel on the surface of a La-modified zirconia support as revealed by the shape of the copper photoelectron line. Preliminary data on the activity of the CuCo<sub>2</sub>O<sub>4</sub>/La<sub>2</sub>O<sub>3</sub>/ZrO<sub>2</sub>/SS catalyst system towards the NO + CO, O<sub>2</sub> + CO and HC-SCR of NO reactions are also given.
- Q/PL.50** ELECTROCHEMICAL GROWTH OF La<sub>2</sub>O<sub>3</sub> FILMS ON ZIRCONIA SURFACES  
D. Stoychev(a), I. Valov(a), P. Stefanov(b), G. Atanasova(b) and Ts. Marinova(b), (a)Institute of Physical Chemistry and (b)Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Sofia 1113, Bulgaria  
During the past years the interest in zirconia films considerably increased due to their specific chemical and physical properties. ZrO<sub>2</sub> is widely used as a high-performance ceramic in nuclear and high-temperature applications as well as in gas-sensing, electron-optical, corrosion-resistant and catalytic applications. In particular, ZrO<sub>2</sub> is very interesting as catalyst support for selective catalytic reduction (SCR) of NO<sub>x</sub>, CO etc. An advantage of the zirconia films as compared to the remaining supports is their perfect adhesion to metal substrates over a very wide temperature range. In addition, doping of the zirconia surface with La<sub>2</sub>O<sub>3</sub> significantly improves the catalytic activity of the active phase in the low-temperature range of the SCR reaction and enhances the mechanical strength of the whole catalytic system. The presence of 5-30% of La<sub>2</sub>O<sub>3</sub> on the zirconia support promotes the formation of a (CuCo)<sub>x</sub>O<sub>y</sub> spinel type catalyst.  
A new electrochemical method using new electrolyte composition and electrolysis regime is proposed for direct preparation of La<sub>2</sub>O<sub>3</sub> films from a nonaqueous electrolyte. Precise data are given on the kinetics of the electrochemical processes and the SEM and XPS studies of the morphology, structure, dispersion and chemical composition of the La<sub>2</sub>O<sub>3</sub> obtained.



## SYMPOSIUM Q

- 11:30      **Q-VIII.2**      **CONTROL OF MOLECULAR EXCITATIONS IN NANOTUBE-HETEROSTRUCTURE TRANSISTORS**  
Per Hyldgaard, Department of Applied Physics, Chalmers University of Technology and Goteborg University, 41296 Goteborg, Sweden  
Current-induced molecular excitations play an important role in molecular-electronics devices. This is true even for the stiff (nanoscale) carbon-nanotube devices such as, e.g., the resonant-tunneling transistor [Solid State Comm. 116, 569 (2000)] in which a nanoscale nonconducting barrier traps a tunneling orbital between metallic-nanotube leads. The nonlinear transport stimulates local molecule vibrations: injecting electrons into a molecular orbital of nanoscale extension changes the internal bonding and overall molecular conformation. We present first-principle density-functional theory calculations to characterize current-induced excitation modes of the nanotube resonant-tunneling transistor. In addition, we use conserving out-of-equilibrium Green function calculations to predict the resulting current-induced molecular stimulation as a function of the excitation frequency, the applied bias, and the electrostatic-gate potential. We document that the out-of-equilibrium operating conditions voids the traditional (detailed-balance) transition rules (relating spontaneous and stimulated emission/absorption). Finally, we show that the out-of-equilibrium results for the current stimulation permits a frequency-selective excitation of the nanotube-transistor vibrations.  
Research funded by the Swedish Foundation for Strategic Research (SSF) through ATOMICS.
- 11:50      **Q-VIII.3**      **MODELIZATION OF GOLD ISLAND NANOSTRUCTURES AND SIMULATIONS OF THEIR ELECTRICAL CHARACTERISTICS**  
Anne-Sophie Cordan and Yann Leroy, ENSPS - ERM/PHASE, Bd Sébastien Brant, 67400 Illkirch, France  
Power dissipation and integration issues are of paramount importance for future ultralarge scale integrated circuits. Single electron devices based on the Coulomb blockade effect will probably overcome these difficulties, with applications to memory devices.  
We study here tunnel multijunction arrays, composed of nanometer-size gold dots on a SiO<sub>2</sub> substrate, and we present a simple geometrical model to take into account size and interdot distance dispersions, stemming from experimental measurements. Junction capacities and tunnel resistances are then calculated.  
We focus on three major targets for future integration: devices have to work at room temperature; their electrical characteristic dispersion should be much smaller than 10%, and the only kind of noise should be shot noise.  
Multijunction arrays seem to be good candidates for the first point. For the second point, we simulate the electrical response in statistical sets of random devices, and we propose a design modification to reduce the dispersion. Finally, we show that telegraphic noise can be observed in some devices, and we propose again a design modification to quench these noise fluctuations.
- 12:10      **Q-VIII.4**      **AB INITIO MODELLING OF METAL ADHESION TO CERAMICS**  
Eugene A. Kotomin(a,b), Joachim Maier(a), Yuri F. Zhukovskii(b), David Fuks(c) and Simon Dorfman(d), (a)MPI FKF, Heisenbergstr.1, 70569 Stuttgart, Germany, (b)Inst. of Solid State Physics, 8 Kengaraga str., Riga 1063, Latvia, (c)Mat. Eng. Dept., BGU, Beer-Sheva 84105, Israel, (d)Dept. of Physics, Technion, IL-32000 Haifa, Israel  
Results of ab initio slab calculations are presented for Ag adhesion to MgO and Al<sub>2</sub>O<sub>3</sub> (corundum) surfaces. We demonstrate that the point surface defects on MgO surface increase considerably the adhesion energy and cause redistribution of the electron density across the interface. The results for electron (F<sub>s</sub>=O vacancy with two trapped electrons) and hole (V<sub>s</sub>=Mg vacancy with two holes trapped by nearest O ions) centers in the Ag atom adhesion at different MgO surface coverages are analysed. We have considered also both Al- and O-terminated corundum substrate surfaces. The dependence of the adhesion energy on the interfacial distance has been analyzed for the two most favorable Ag adsorption positions over corundum and for two different metal coverages (a 1/3 monolayer (ML) of the Ag(111) crystallographic plane and a full Ag(111) monolayer). The two different terminations (Al- and O-) give rise to qualitatively different results. In the former case the small adhesion energies per Ag atom (0.15-0.25 eV for 1 ML and 0.40-0.55 eV for 1/3 ML) are accompanied by minor interfacial charge transfer, indicating physisorption. In contrast, for O-terminated corundum, substantial adhesion energies (3-5 eV per Ag atom at 1 ML coverage and 6-11 eV for 1/3 ML) combined with noticeable charge transfer from Ag atoms towards the substrate (0.5-0.9 e) are clear indications of chemisorption. The latter case could be naturally considered as Ag adhesion on a defective Al-terminated corundum surface.
- 12:30      **LUNCH**

## SYMPOSIUM Q

Thursday, June 20, 2002  
Jeudi 20 juin 2002

Afternoon  
Après-Midi

Session IX: Nanoelectronics  
Session Chair: H. Bernas

- 14:00           **Q-IX.1**           NANOMACHINES: MONO-MOLECULAR ELECTRONICS AND MONO-MOLECULAR ROBOTICS  
**C. Joachim**, CEMES-CNRS, 29, Rue J. Marvig, BP 4347, 31055 Toulouse Cedex 16  
A single large molecule potentially hold enough internal degrees of freedom to perform by itself useful functions like computing, moving, transducing a signal restructuring a surface. It remains to learn the intramolecular and interface physics to design and synthesized a very molecule per function. It remains also to develop new nano-communication strategies to exchange information with this very molecule. For computing, examples will be given of our progresses from hybrid electronic towards the design, synthesis and ultra clean atomic scale contact of a single intramolecular molecule logic gate. This requires new intramolecular circuit rules and intramolecular switches at the nanoscale and the development of a picotechnology for the interconnects. For mechanical functions, advances towards an unimolecular barrow will be presented, insisting in our progresses toward information exchange between a very molecule and the macro-driver of this barrow. Single molecule surface restructuring is presented in another section (see the EMRS F. Rosei et al. contribution). Finally, the possibility of designing an intramolecular transducer will be given.
- 14:40           **Q-IX.2**           MAPPING CHARGE TRANSPORT PATHWAYS IN ORGANIC FIELD EFFECT TRANSISTORS  
**P. Levy**, M. Cavallini, M. Murgia, F. Dinelli, C. Albonetti, F. Biscarini, CNR-ISMN, Via P. Gobetti 101, 40129 Bologna, Italy, D. De Leeuw, Philips Research Lab, Eindhoven, The Netherlands  
Charge transport in organic thin films is one of the most interesting non-equilibrium phenomena nowadays, for its fundamental implications and impact into new emerging technologies. Fundamental questions concern the different transport mechanism in a Field Effect Transistor (FET) with respect to a single crystal, in terms of mobility, temperature dependence, correlation with order and morphology of the active layer. In this context, we have devised a new tool, based on a scanning probe configuration, where the conductive tip of a force microscope acts as a moving drain electrode in a FET configuration. Our idea is to explore the scaling behaviour of the response in organic thin film FETs as the channel length decreases as the tip (drain) is placed closer to the source electrode. Moreover, this moving drain configuration allows us to assess direct correlation between mobility and morphology of the active layer in the channel. We show three important results: 1) the transport mechanism changes as the gate voltage is turned on; 2) the characteristics averaged across the channel yield a mobility of about  $0.01 \text{ cm}^2/\text{Vs}$ ; and 3) in a real organic FET, preferential pathways for current transport exist within the channel that follow the domain boundaries. Our evidence suggests that in the case of thin films, FET transport is strongly percolative, rather than being through domains. This work is supported through EC-GROWTH Project G5RD-2000-00349 MONA-LISA.
- 15:00           **Q-IX.3**           BUILDING BRIDGES BETWEEN MICROELECTRONICS AND MOLECULAR ELECTRONICS -- FUNCTIONALISATION OF THE (100) SURFACE OF SILICON  
**G.F. Cerofolini**, C. Galati, L. Renna, STMicroelectronics, Stradale Primosole 50, 95121 Catania, Italy  
The continuous size reduction associated with the development of microelectronics, so regular as to take the name of 'law' (Moore's law), will sooner or later (but anyway in the time scale of 10 years) face the need of manipulating single molecules addressing and contacting them to wanted regions of the device.  
The manipulation of individual molecules is already possible using scanning tunnel microscopes and their functional characterization is usually achieved for thiol-terminated terminated molecules grafted to gold nanoparticles. Both the process (individual management by scanning tunnel microscopy) and material (gold) are not compatible with the integrated-circuit (IC) technology. Batch processing requires that the molecules are addressed to (photographically predefined) regions by a difference of chemical potentials. In turn that requires the ability to control the chemical terminations of the surfaces of the most important IC layers: Si,  $\text{SiO}_2$ , and  $\text{Si}_3\text{N}_4$ .  
This work is addressed to study (mainly via x-ray photoemission spectroscopy) how the (100) surface of silicon can be functionalised by grafting of alkane or alkene chains to hydrogen-terminated silicon via hydrosilation of 1-alkenes, 1-N-alkenes and 1-alkynes.
- 15:20           **Q-IX.4**           NANOPATTERNING OF CONJUGATED MOLECULAR THIN FILM BY UNCONVENTIONAL PARALLEL LITHOGRAPHY  
**Massimiliano Cavallini**, Massimiliano Massi, Ivano Bilotti, Mauro Murgia, Fabio Biscarini, CNR - ISM, Via P. Gobetti 101, 40129 Bologna, Italy  
We present different fabrication techniques for organic nanostructures which are based onto parallel, large area, and possibly one-step processes.  
The first approach allows one to pattern thin films of conjugated molecular materials with submicron resolution by modified micro-transfer molding  $\mu\text{TM}$ . As representative material we consider the Tris-(8-hydroxyquinoline)-aluminum (III) (AlQ3) which is one of the most widely used materials for its high luminescence efficiency in organic light-emitting devices.  $\mu\text{TM}$  process is made in one step and takes a few minutes. The film is formed during the transfer process and does not exhibit signs of stress or rupture. After applying a drop of AlQ3 solution to the surface, we placed it on surface of the sample without removing the excess ink. The film is formed during the process. In this manner, it is possible to obtain a patterned homogeneous film with nanometer-size features by a single step, with no change to its adhesion and mechanical properties. Since there is not any specificity between the mold and AlQ3, we suggest that our procedure may be of general impact for conjugated materials.  
The second approach involves thermally induced spinodal dewetting of conjugated thin films grown in a layer-by-layer fashion. Lateral resolution is controlled through film thickness, and polydispersity of nanodroplets is related to the film roughness, viz. the out-of-plane disorder. A characteristic wavelength of 60 nm can be achieved.

## SYMPOSIUM Q

15:40

**BREAK**

Session X: Nanomagnetism & Spintronics

Session Chair: A.M. Stoneham

16:10

**Q-X.1**

**SPIN AND SIZE DEPENDENT EFFECTS IN SEMIMAGNETIC SEMICONDUCTOR NANOSTRUCTURES**

A.I. Savchuk, S.Yu. Paranchych, M.V. Kurganetski, I.D. Stolyarchuk, Yu.V. Tanasyuk, Dept. of Phys. Electronics and Nontraditional Energetics, Chernivtsi National University, 58012 Chernivtsi, Ukraine, A. Perrone, M.L. DeGiorgi, Dept. of Physics, University of Lecce, National Institute of Matter Physics, 73100 Lecce, Italy

The interest in  $\text{II}_{1-x}\text{Mn}_x\text{VI}$  semimagnetic semiconductors and related nanostructures recently has renewed strongly because they open the way for a new class of electronic devices, in which electron's spin can be manipulated. For such kind of devices the most important is possibility for spin transport across different interface regions. We report on heterointerface properties of multiple quantum well structure CdTe/CdMnTe. The nanostructures with different composition and different quantum well and barrier widths have been grown by pulsed laser ablation technique on sapphire and Si substrates. Optical and magneto-optical spectroscopy has been used for characterization of the obtained systems. The observation of narrow exciton peaks in the absorption spectra at low temperatures demonstrates the high quality of the deposited semiconductor layers and related interfaces. In the Faraday rotation of the CdTe/Cd<sub>0.64</sub>Mn<sub>0.36</sub>Te superlattice structure nonmonotonic size (thickness of nonmagnetic wells and magnetic barriers, number of layers) dependence has been revealed. These results are explained in terms of several available models including the effect of the enhanced interface paramagnetism on the Faraday rotation in semimagnetic semiconductor nanostructures.

16:30

**Q-X.2**

**POSITION-CONTROLLED NANODEPOSITION OF MAGNETS USING AN ELECTROPULSED SCANNING PROBE MICROSCOPE**

L.V. Melo and P. Brogueira, Physics Department, Instituto Superior Tecnico, Av. Rovisco Pais, 1049-001 Lisboa, Portugal

The development of increasingly small magnetomechanic devices stresses the need for new fabrication processes. Scanning Probe Microscopes (SPM) have been used to change surfaces at nanometer scales. We report the deposition of magnets in user defined patterns using an electropulsed SPM. The patterns were fabricated by applying electrical pulses between a commercial CoCr-covered Si tip and a crystalline n-doped Si wafer. Immediately after deposition the tip and nanodeposited magnets were magnetized, and the same tip was used for performing AFM and MFM measurements on the fabricated patterns. Applying one isolated electrical pulse results in a pixel with a typical size of the order of 30nm as measured by AFM. By combining the scanning ability of the SPM with the atmospheric deposition induced by electrical pulses on the tip, user-defined patterns can be fabricated. For example, by applying electrical pulses during a 100nm x 400nm and 200nm x 400nm tip scans performed side by side in AFM tapping mode, at 40Hz, rectangles with 119nm x 417nm and 214nm x 417nm respectively were obtained (in agreement with the dimensions expected from the pixel size and the scan range). The MFM measurements performed in different scanning directions show a preferential magnetization direction as shown by the higher fringe fields from the rectangles longer edges. The height of the deposited patterns is of the order of 2 to 3nm, and was found to increase with the density of scan lines.

16:50

**Q-X.3**

**SPIN-COHERENCE AND -MANIPULATION in Si/SiGe QUANTUM WELLS**

Z. Wilamowski, Inst. Physics, Polish Academy of Sciences, 0668 Warsaw, Poland, W. Jantsch, N. Sandersfeld, F. Schäffler, Inst. F. Halbleiter- und Festkörperphysik, Johannes-Kepler-Universität, 4040 Linz, Austria and S. Lyon, Dept. Electrical Engineering, Princeton University, Princeton NJ 08544, USA

Spintronic devices require the possibility to manipulate individual spins within the coherence time. In this contribution we show from ESR investigations on Si quantum wells that the transverse (T2) and the longitudinal (T1) spin relaxation times of the confined electrons are of the order of microseconds, whereas the time required for a spin flip by a resonant microwave pulse is of the order of nanoseconds. We investigate T1 and T2 as a function of the inclination angle of the magnetic field and the carrier density. We show that the results for high mobility samples can be explained consistently in terms of the Rashba field and the D'yakonov-Perel mechanism related to the former. This result implies that materials with small spin orbit coupling are better suited for such devices.

We also show that the g-factor depends on the carrier density and on Ge-alloying in the channel, which opens the possibility to turn resonance on or off by means of a gate voltage in a suitable structure thus allowing individual spin manipulation.

## SYMPOSIUM Q

17:10-18:30

### POSTER SESSION II

#### Polymers

##### Q/PIL.01

**SMALL ANGLE NEUTRON SCATTERING OBSERVATION OF NANOCANNELS IN NUCLEAR MEMBRANES**  
G. Pépy(a), A. Kuklin(b), A. Appel(b), (a)Laboratoire Léon Brillouin, CEA Saclay, 91191 Gif sur Yvette Cedex, France, (b)JINR, 141980 Dubna, Russia

Nuclear membranes are thin polymer foils (typically 10m thick) irradiated by heavy ions which create defects located along the ions trajectory, the track. It is possible to open rather monodisperse channels by chemical etching (0.25N NaOH at 80°C for PolyEthyleneTerephthalate).

Small Angle Neutron Scattering (SANS) experiments have been performed in LLB (PAXE) and ILL (D11) on PET membranes prepared in the FLNR (JINR, Dubna), and later in GANIL. Small Angle X-ray Scattering (SAXS) experiments have been performed on PET and polycarbonate (PC) in the ESRF (ID01). Previously only a Gaussian approximation was used [1,2] for the data treatment. A new experimental protocol allows to obtain more fully interpretable spectra. For the biggest channels we could observe the oscillations of the Bessel function (radial part of a cylinder form factor), up to the 4th oscillation in SAXS. The rotation of the sample around a vertical axis provides 3 dimensional information about the channel shape.

We shall review the advantages and limits of both SANS and SAXS and describe an extended model for the channel shape.

[1] R. Spohr, Nuclear Instrument and methods, 173 (1980) 229-236

[2] D. Albrecht thesis, (1983), GSI report 83-13, Darmstadt, Germany

##### Q/PIL.02

**MORPHOSYNTHESIS OF STRUCTURED INORGANIC CRYSTALS DESIGNED BY BLOCK COPOLYMER**

Shu-Hong Yu, Helmut Cölfen, Markus Antonietti, Max Planck Institute of Colloids and Interfaces, Department of Colloid Chemistry, MPI Research Campus Golm, 14424 Potsdam, Germany

A systematical morphosynthesis of inorganic crystals such as barium chromate, calcium carbonate, cadmium tungstate particles has been performed by using double-hydrophilic block copolymers(DHBCs), which consist of a hydrophilic solvating block and a hydrophilic binding block. Several kinds of DHBCs with different functional groups were explored for crystallization and morphology control of barium chromate. Similarly, big CaCO<sub>3</sub> spherules with well-defined surface structures and sizes ranging from several hundreds of nanometers and micrometers can be easily fabricated through a slow gas-liquid diffusion reaction at room temperature in the presence of DHBCs. Such big spherules with complex surface structure of the calcite rhombohedra are not easily produced by conventional solution growth methods. In addition, very thin CdWO<sub>4</sub> nanorods and 2-dimensional sheet-like nanocrystals are obtained in presence of double hydrophilic block copolymer. Both the 1d- and 2d polymer modified species show highly increased fluorescence efficiency. The morphology formation process was time resolved and the formation mechanism were proposed. Our results demonstrated that the integration of using DHBCs with taking advantages over the experimental conditions, such as the crystallization sites, temperature, pH value, reactant concentration, will extend the possibilities for controlling the shape, sizes, and microstructures of inorganic crystals via a simple mineralization process.

##### Q/PIL.03

**STM AND AFM INVESTIGATION OF COILED CARBON NANOTUBES PRODUCED BY LASER EVAPORATION OF FULLERENE**

A.A. Koos, Research Institute for Technical Physics and Materials Science, P.O.Box 49, 1525 Budapest, Hungary, R. Ehlich, Max Born Institut für Nichtlineare Optik und Kurzzeitspektroskopie, Max Born Str.2A, 12489 Berlin, Germany, Z.E. Horvath, Z. Osvath, J. Gyulai, Research Institute for Technical Physics and Materials Science, P.O.Box 49, 1525 Budapest, Hungary, J.B. Nagy, Facultés Universitaires Notre-Dame de la Paix, Rue de Bruxelles 61, 5000 Namur, Belgium and L.P. Biro, Research Institute for Technical Physics and Materials Science, P.O.Box 49, 1525 Budapest, Hungary

Carbon nanotubes were grown by the evaporation in vacuum of a fullerene/Ni particle mixture, using 532 nm laser pulses of 12 - 28 mJ from a Nd YAG laser. The evaporated material was deposited on freshly cleaved graphite (HOPG) surface in a similar way like in earlier experiments [1]. The samples were investigated by STM and AFM without any further manipulation. Straight, Y-branched and coiled carbon nanotubes were produced. In the present work we focus on the Y-branched [1] and on the coiled carbon nanotubes, similar to the ones produced by catalytic decomposition of hydrocarbons [2]. The observed coils are regular and present stable coiling over distances of the order of 100 nm. The most frequently found distance between neighboring pitches of coiled nanotubes is in the range of 4 nm. Both the Y-junctions and the coils suppose the incorporation of non-hexagonal rings in the graphitic network. The regularity of the observed coils is an indication that the incorporation of the P and H occurred in a very regular way. This rises the question if in coiled structures these non-hexagonal rings should be regarded as defects, or as regular building blocks, like in the case of haeckelite type structures [3].

[1] P. Nagy et al., Appl. Phys. A. 70 (2000) 481

[2] L. P. Biro et al., Europhys. Lett. 50 (2000) 494

[3] H. Terrones et al., Phys. Rev. Lett. 84 (2000) 1716

##### Q/PIL.04

**INVESTIGATION OF CONDUCTING POLYMERS AS MICROVALVE SEALS**

Qi Fang, (a)School of Engineering, University of Warwick, UK, (b)Department of Chemistry, Southampton University, UK

Conducting polymers are undoubtedly of growing importance as an enabling material for microsystems and MEMs. For example, their compliance and sealing properties could be advantageous in making micro-valves and micro-pumps for fluidic chips or even a Lab-on-a-chip. We report here on the first investigation into the behaviour of conducting polymers as seals for micro-valves. Poly(pyrrole) is known to be reasonably stable in air and is also one of the easiest to synthesise either by electrochemical or by chemical polymerisation. It is known to offer interesting tribological properties and so is chosen as the exemplar material here. Poly(pyrrole) films with one of three dopants – sodium dodecyl sulphate (SDS), methylphosphonic acid (MPA) and 1-butanephosphonic acid (BSA) – were deposited electrochemically with a thickness between 0.5 µm and 1.5 µm. The test structures, used analogously to O-rings, were annuli of 1 mm internal diameter and breadth 0.1 to 1.0 mm grown onto platinum electrodes on silicon. Test results show that leakage rate of the PPY films can be down to 0.5 ml/min. The PPY films doped with MPA have the best performance. The electrochemical deposition conditions and morphology of the PPY films will be described and the effect on the leakage rate of film thickness and counter-ion discussed. Final comments on the potential of these materials revealed by this study will be accompanied by an indication of the next phase of the research into their properties.

## SYMPOSIUM Q

- Q/PIL.05** NOVEL FLUORESCENT THREE - COMPONENT LB FILMS  
N.I. Voronkina, K.B. Vodolazhskiy, A.V. Tolmachev  
The peculiarities of mixed monolayers polyvinylcarbazole (PVC) - low molecular organic luminophores (oxadiazole derivatives) formation on a water surface were established. The thermodynamic stability and mechanisms of phase formation in dependence of composition were studied. The optimal conditions of monolayer formation for functional LB films were determined. By the deposition of monolayers the three - component LB structures were prepared. It is found, that under irradiation of film by UV 254 nm, the band corresponds to POPOP fluorescence spectra is observed. It is connected with cascade transfer of excitation energy from PVK to POPOP across PBD.
- Q/PIL.06** THE INFLUENCE OF SUBSTRATE ON THE GROWTH OF CARBON NANOTUBES FROM NICKEL CLUSTERS - AN INVESTIGATION USING STM, FE-SEM, TEM AND RAMAN SPECTROSCOPY  
A.C. Wright, Y. Xiong and N. Maung, Advanced Materials Research Laboratory, PP19, MRIC, North East Wales Institute, Mold Rd, Wrexham, U.K., S.J. Eichhorn and R.J. Young, Manchester Materials Centre, Grosvenor St, Manchester, U.K.  
Chemical Vapour Deposition (CVD) is now a well established route to the growth of carbon nanotubes. Generally, a transition-metal such as nickel dispersed as clusters on a non-reactive substrate acts as a catalyst for growth from carbon-bearing gases such as acetylene. While the diameter of the tubes is closely linked to the size of the metal clusters, the nature of the substrate itself influences the size and size distribution of the clusters themselves. Using Scanning Tunneling Microscopy (STM) to study the clusters and high resolution Field Emission Scanning Electron Microscopy to study the resultant nanotubes, we show that nickel clusters created on TiN coated SiC substrates have a much narrower size distribution than MoSi<sub>2</sub> coated SiC substrates. This is reflected in the nanotube diameter after CVD growth. Raman spectroscopy and Transmission Electron Microscopy (TEM) has been used to provide further data on the nature of the nanotubes grown onto these substrates.
- Q/PIL.07** PECULIARITIES OF PERCOLATION TRANSITION IN POLYISOPRENE-CARBON BLACK NANOCOMPOSITES - PROSPECTIVE DEFORMATION SENSOR MATERIALS  
M. Knite, V. Teteris, Technical Physics Institute, Riga Technical University, 14 Azenes St., Riga 1048, Latvia and A. Vitinsh, I. Aulika, Institute of Solid State Physics, University of Latvia, 8 Kengaraga St., Riga 1063, Latvia  
Recently efforts have been made [1] to obtain active polymer composites the electroconductivity of which would be strongly dependent on external thermodynamic parameters &#8211; pressure, temperature, and other. Such materials might set up basis for a new generation of cheap large-size sensors.  
New interesting properties are expected in case the composite contains dispersed nano-size conducting particles. In our earlier studies [2] a giant tensor-resistive effect was observed in the polyisoprene-carbon black (CB) nanocomposite. Presently reported is an analysis of conductivity and dielectric permittivity as functions of applied AC frequency revealing features displayed at percolation transition in polyisoprene-CB composites. The experimentally determined values of the power indices  $x = 0,70 \pm 0,07$  and  $y = 0,32 \pm 0,05$  describing dependence of conductivity  $G \sim f^x$  and capacity  $C \sim f^y$  on AC frequency  $f$  in composite in the vicinity of percolation threshold are consistent with the general scaling principle of the percolation theory  $x + y = 1$ . The obtained values of  $x$  and  $y$  are in agreement with the mechanism of intercluster polarisation. On the other hand the anomalous behavior of capacity above the percolation threshold were found. It may be explained due to special behaviour of CB nanoparticles.  
1. L.Flandin et al., J. of Applied Polymer Science, 76, (2000), 894-905.  
2. M.Knite et al., Materials Science & Engineering C, 19, Iss.1-2, (2001), 15-19.
- Q/PIL.08** VERWEY TRANSITION AND SPIN POLARIZED TUNNELING IN Fe<sub>3</sub>O<sub>4</sub> NANO DEVICES  
Pankaj Poddar, Tcipi Fried and Gil Markovich, School of Chemistry, Tel Aviv University, Tel Aviv 69978, Israel  
We have prepared tunneling junctions of stacked monolayers of monodispersed, organically functionalized Fe<sub>3</sub>O<sub>4</sub> nanocrystals of 5.5 nm average diameter, where arrays of magnetite nanocrystals separated by the fatty acid molecules adsorbed to their surfaces were deposited in vertical tunneling junctions between gold electrodes using the Langmuir-Blodgett technique.  
Current-voltage characteristics of the junctions were studied as a function of temperature and magnetic field. We observed a sharp increase in resistance on cooling below 96K. This is attributed to the Verwey metal-insulator transition in the nanocrystals. Above 96 K, the I-V curves reflect the density of states of the narrow conduction band. This conductance peak is sensitive to the external magnetic field and exhibits large magnetoresistance (upto~300%), which holds promise for device applications. We have also measured the magnetic susceptibility of iron-ferrite monolayers, multilayers and particles frozen in liquids to compare the effect of dimensionality on the dipolar interaction between iron-ferrite nanoparticles.
- Q/PIL.09** COLLOIDAL OXIDE NANOPARTICLES FOR THE PHOTOCATALYTIC DEGRADATION OF ORGANIC DYE  
Davide Cozzoli(a), Roberto Comparelli(a), M. Lucia Curri(b), Angela Agostiano(a,b), Mario Della Monica(a,b), (a)Dipartimento di Chimica, Universita di Bari, via Orabona 4, 70126 Bari, Italy, (b)CNR IPCF - Sez Bari c/o Dip. di Chimica, Universita di Bari, via Orabona 4, 70126 Bari, Italy  
Dyes represent an abundant class of organic compounds of relevant environmental danger, due to their intensive color and toxicity. Recent studies have established the effectiveness of semiconductor photocatalysis for the complete degradation of dye in environmental remediation. Among the metal oxides, anatase TiO<sub>2</sub> is at the moment the most utilized photocatalyst, although ZnO appears very promising for degradation of organic solutes in aqueous systems. Small, monodisperse, easily processable and high quality nanoparticles of TiO<sub>2</sub> and ZnO have been obtained by using an original hot coordinating solvent method, by thermal decomposition of metal precursor in a high temperature mixture of solvents and extensively characterised. The photocatalytic efficiency of nanocrystalline ZnO and TiO<sub>2</sub> has been compared to that of the bulk material commercially available in order to achieve the degradation of the commercial dye Methyl Red. The experiments have been carried out using metal oxides both in suspension and immobilised on substrates, under UV and visible light illumination. The influence of various experimental factors have been investigated. The results show that nanostructured ZnO and TiO<sub>2</sub> present a higher efficiency for dye photodegradation compared with their commercial equivalent, and nanostructured ZnO shows enhanced capability with respect to TiO<sub>2</sub> nanoparticles in degradation treatment, conversely to what reported for commercial TiO<sub>2</sub> and ZnO.

## SYMPOSIUM Q

- Q/PIL.10** THE ROLE OF SOLID-STATE AGGREGATION ON THE EMISSION IN MOLECULAR CRYSTALS AND RELATED POLYMERS  
S. Destri, M. Pasini, U. Giovanella, W. Porzio, Istituto per lo studio delle Macromolecole del C.N.R., via E. Bassini 15, 20133 Milano Italy  
In nanotechnologies the need of the control of the molecular structure and its solid state aggregation becomes more and more crucial to address the optoelectronic properties. In this view, conjugated molecular crystals, showing relevant emission properties, hence used as active layers in LED devices, constitute an exemplary case. However the knowledge of the relationships between the optical properties and solid state aggregation allowed to put forward some drawbacks to be solved, particularly the photoluminescence (PL) quenching.  
In this contribution we report on the recent study of differently packed oligomers based on mixed fluorene-thiophene derivatives and on substituted thiophene oligomers, star molecule included, with particular reference on the influence of the overall solid state aggregation onto the PL.  
On the other hand the preparation of polymers based on the cited oligomers with changed aggregation can enhance the emission property.  
The combined use of crystal structure analysis, powder diffraction analysis and molecular mechanics/crystal packing calculations allowed us to envisage a relation between PL emission and solid state aggregation, in its turn related to chemical structure.  
Moreover some indications confirming the conclusions reached on the previous topics, will be presented from LED device measurements.
- Q/PIL.11** DESIGN AND SYNTHESIS OF ORGANIC-INORGANIC NANOSTRUCTURED COLLOIDS IN MULTIPHASE SYSTEMS  
Stéphane Reculusa(a), Céline Poncet-Legrand(a,b), Serge Ravaine(a), Christophe Mingotaud(c), Etienne Duguet(b) and Elodie Bourgeat-Lami(d), (a)Centre de Recherche Paul Pascal, CNRS, 115 avenue du Dr Schweitzer, 33600 Pessac, France, (b)Institut de Chimie de la Matière Condensée de Bordeaux, CNRS, 87 avenue du Dr Schweitzer, 33608 Pessac Cedex, France, (c)Laboratoire des IMRCP, Université Paul Sabatier, 118 route de Narbonne, 31062 Toulouse Cedex, France, (d)Laboratoire de Chimie et Procédés de Polymérisation, CNRS-CPE Lyon, Bâtiment 308 F, BP 2077, 69616 Villeurbanne Cedex, France  
In the last few years, there has been a growing interest in the synthesis of multifunctional materials consisting in organic and inorganic components associated into unique composite nanoscale materials. Among the various strategies, multiphase polymerizations offer versatile routes to control the size and shape of the nanosized objects. Herein, we describe some selected strategies involved in the elaboration of hybrid colloids with controlled morphologies (core-shell, polynuclear or raspberry-like...). One approach involves the use of capping agents (with methacryloyl and vinyl end-groups), previously grafted on silica nanoparticles. Their role is to promote anchoring of the polymer chains at the inorganic surface during polymerization. Nanoparticles obtained by this procedure are either of the core-shell type with polymer homogeneously covering the surface of the oxide particles or polynuclear with multiple silica beads embedded into the polymer particles. More irregular and exotic morphologies may also result depending on the concentration and type of the capping agent. Another approach deals with the physico-chemical adsorption of a cationic initiator and a methylmethacrylate terminated poly(ethyleneoxide) macromonomer via electrostatic and hydrogen-bonding interactions, respectively. In both cases, organic-inorganic colloids with raspberry-like morphologies are produced in situ which indicates successful interaction of the polymer particles with the silica surface.
- Q/PIL.12** MACROMONOMER-MEDIATED SYNTHESIS OF RASPBERRY-LIKE SILICA-POLYSTYRENE COLLOIDS  
Stéphane Reculusa(a), Céline Poncet-Legrand(a,b), Serge Ravaine(a), Christophe Mingotaud(c), Etienne Duguet(b) and Elodie Bourgeat-Lami(d), (a)Centre de Recherche Paul Pascal, CNRS, 115 avenue du Dr Schweitzer, 33600 Pessac, France, (b)Institut de Chimie de la Matière Condensée de Bordeaux, CNRS, 87 avenue du Dr Schweitzer, 33608 Pessac Cedex, France, (c)Laboratoire des IMRCP, Université Paul Sabatier, 118 route de Narbonne, 31062 Toulouse Cedex, France, (d)Laboratoire de Chimie et Procédés de Polymérisation, CNRS-CPE Lyon, Bâtiment 308 F, BP 2077, 69616 Villeurbanne Cedex, France  
Colloidal nanocomposites have attracted considerable attention in recent years as new functional materials with unusual properties that originate from both their organic and inorganic counterparts. Among the important aspects is the characteristic of the interphase between the two components. In that work, we report on an original approach for the synthesis of raspberry-like hybrid organic-inorganic materials consisting of spherical silica beads supporting smaller polystyrene through a heterophase polymerization process. In a first step, silica particles of various sizes were synthesized according to procedures inspired from the literature. In a second step, a poly(ethylene glycol) macromonomer was adsorbed on the surface of the silica beads. Finally, polymerization of styrene was achieved using a non-ionic surfactant as an emulsifying agent and sodium persulfate as an initiator. Scanning and transmission electron microscopies show that the presence of the macromonomer at the water/silica interphase is a determining parameter in order to get the raspberry-like morphology.
- Q/PIL.13** CONDUCTING POLYMER THIN FILMS AND HETERO-FILMS OBTAINED BY CVD  
Núria Ferrer-Anglada, Vicente Gomis, Lina A. Kossykh, Lucien Tuinstra, Departament de Física Aplicada, UPC, Campus Nord B4, 08034 Barcelona, Spain; Ma Paz Diago, Salvador Borros, Institut Químic de Sarrià, Universitat Ramon Llull, Barcelona, Spain; Joan Esteve, Dept. Física Aplicada i Òptica, Universitat de Barcelona, Diagonal 645, 08028 Barcelona, Spain  
Conducting conjugated polymers like polypyrrole (PPy), polyaniline (PA) and Polythiophene (PTh) have revealed to be very interesting as new materials for electronic devices, sensors[1], inert or biocompatible coatings[2]. They are usually obtained electrochemically showing a dendritic surface, the size of dendrites and the amorphicity depending on the electrochemical conditions [3].  
Obtaining these polymers by CVD can be a best method to attend nanometric scale and homogenous films, or nanostructures based on these polymer films. We present here our work on PPy, PA, PTh obtained by plasma enhanced chemical vapour deposition (PECVD), both doped and undoped, and characterise them by AFM, and FTIR. The conditions are optimised in order to obtain the best films, both homogenous and thinner.  
[1] "Handbook on conducting polymers", T.A. Skotheim, R.L. Elsenbaumer, J.R. Reynolds editors, 2nd ed. (1998) Marcel Dekker.  
[2] E. De Giglio, M.R. Guascito, L. Sabbatini, G. Zamboni, Biomaterials 22 (2001) 2609.  
[3] A. Chaibi, N. Ferrer-Anglada, J.A. Gorri, L. Fajarí, M.C. Anglada, Appl. Magn. Reson. 12 (1997), 575.

## SYMPOSIUM Q

- Q/PIL.14** **FORMATION OF A NANOSTRUCTURE OF BUTTER: POLYSACCHARIDE OF INULINE COMPOSITE**  
T.A. Rashevskaya, I.S. Gulyi, Ukrainian State University of Food Technologies, O.I. Lysko, O.P. Vysokolyan, T.S. Veblaya, E.V. Buzaneva, Kiev State University, Ukraine  
Technology of formation molecular composite with the butter and polysaccharide of inuline was developed. The results of electron scanning microscopy (SEM) and IR spectroscopy confirmed what: (i) inuline promotes the formation of dendrite structure on the surface of monomolecular crystalline fatty layers, which connected between itself for principle "top to hollow", (ii) aggregates of crystals between globules of fatty structure of butter consist from polyhedrons, which are created by monomolecular crystalline layers, which also have dendrite structure and include the nanoparticles of water phase, (iii) inuline promotes increase the quantity not destroyed fatty globules, (iiii) the quantity of fatty globule increases that is connected with formation additional concentric monomolecular crystalline layer on globule surface. Monomolecular layers is forms of consequence of hydrogen-inuline bonds with components of hydrated shells fatty globules.  
It is developed mechanism of formation an dendrite structure fatty phase of butter.
- Q/PIL.15** **SELF-ASSEMBLY OF POLYDIACETYLENE NANOWIRES IN ULTRA-THIN FILMS**  
M. Alloisio, D. Cavallo, C. Dell'Erba, C. Cuniberti, G. Dellepiane, INFN/INSTM, Dipartimento di Chimica e Chimica Industriale, Universita di Genova, Genova, Italy  
Here we report on the nanowires organization in ultra-thin films prepared from polydiacetylenes (PDAs) with cylindrical molecular shapes. PDAs are themselves one-dimensional semiconducting polymers that exhibit very interesting electronic and optical properties. These properties, related to the conjugated polymer backbone made of alternating double and triple bonds, can be modulated by the appropriate choice of the chemical nature of the double bond substituents. One of the most interesting member of this class of conjugated polymers is polyDCHD, in which the side groups are given by photoconductive carbazolyl rings. We have recently prepared novel PDAs from diacetylenes homologous to DCHD carrying long alkyl or acyl substituents at the 3,6 positions of the carbazolyl groups. Ultra-thin polymeric films have been prepared on different substrates by spin-coating of polymers or monomers solutions. The films organization has been studied by SEM, AFM and X-rays diffraction.
- Q/PIL.16** **EXPERIMENTS FOR INORGANIC-ORGANIC HYBRID SOL-GEL FILMS FOR MICRO- AND NANO-PHOTONICS**  
A. Jitianu(a), M. Gartner(a), M. Zaharesu(a), D. Cristea(b), E. Manea(b), (a)Institute of Physical Chemistry, Romanian Academy, Splaiul Independentei 202, 77208 Bucharest, Romania, (b)National Institute for R&D in Microtechnologies, PO Box 36-160, 72225 Bucharest, Romania  
Inorganic/organic hybrid materials can offer multifunctionality and allow properties tailoring from subnanometer (atomic) to submillimeter (mesoscopic) length scales. That is why these films could play a significant role in the field of micro and nanophotonic devices (waveguides, emitting devices, quantum dot devices, photonic band gaps, holographic materials).  
The organic groupings can modify the inorganic backbone by reducing the connectivity of gel network allowing thick film deposition and lessening the processing temperature.  
In order to follow the sol-gel chemistry in the case of substituted alkoxides that influence the molecular species present in solution at the moment of deposition, model compositions based on tetraethoxysilane, vinyl-triethoxysilane and methyl-triethoxysilane, were investigated. The hybrid inorganic-organic sol-gel based photonic components were realized starting with phenyl-triethoxysilane.  
The composition and the process were optimized to allow a better control of the optical parameters (losses, refractive index, transmission), to reduce the processing temperature and to improve photosensitivity (to allow a direct device definition through a suitable mask and washing away undeveloped regions of the glass with simple inexpensive organic solvents).
- Q/PIL.17** **EFFECT OF THE POLYMER MOLECULAR WEIGHT ON THE FORMATION AND EVOLUTION OF SILVER-POLYMER NANOCOMPOSITE THIN FILMS**  
Luisa D'Urso, Giuseppe Compagnini and Orazio Puglisi, Dipartimento di Scienze Chimiche Università di Catania and Istituto Nazionale per la Fisica della Materia, Viale A. Doria 6, 95125 Catania, Italy  
Silver-polymer nanocomposite thin films (0.1-1  $\mu\text{m}$ ) have been obtained by "in situ" self reduction of an organometallic compound formerly embedded in the polymer structure. The reduction has been obtained through thermal treatments around 200 °C and laser annealing processes, leading to the formation of Ag particles in the size range 5-30 nm, homogeneously dispersed in the film structure. These films shows suitable optical properties to be candidate for applications in integrated optics. Moreover the possibility to change the host matrix (polystyrene, PMMA and polysiloxanes) and the concentration of particles in a large range render these materials once more interesting. In this frame we observed that the change of the molecular properties of the host polymer is essential in the understanding of the properties of the final nanocomposite material. In particular changes in the polymer molecular weight produce different particle size distributions which drive the film properties. In this work we discuss this kind of structure-property relations with particular emphasis to the nanoparticles size distribution and the optical properties in the UV-visible wavelength range.

### Beam Techniques

- Q/PIL.18** **NANOSCALE POWDERS OF DIFFERENT IRON-OXIDE-PHASES PREPARED BY CONTINUOUS LASER IRRADIATION OF IRON PENTACARBONYL-CONTAINING GAS PRECURSORS**  
L. Morjan, R. Alexandrescu, F. Dumitrache, I. Sandu, I. Soare, I. Voicu, A. Crunteanu, National Institute for Lasers, Plasma and Radiation Physics, P.O.Box 36, 76900 Bucharest, Romania, E. Vasile, S.C. METAV S.A., Str.Zapada Mieiilor 16-18, Bucharest, Romania, S. Martelli, Centro Sviluppo Materiali, Via di Castel Romano 100, 00128, Rome, Italy, 100, I-00128, Rome, Italy  
Silver-polymer nanocomposite thin films (0.1-1  $\mu\text{m}$ ) have been obtained by "in situ" self reduction of an organometallic compound formerly embedded in the polymer structure. The reduction has been obtained through thermal treatments around 200 °C and laser annealing processes, leading to the formation of Ag particles in the size range 5-30 nm, homogeneously dispersed in the film structure. These films shows suitable optical properties to be candidate for applications in integrated optics. Moreover the possibility to change the host matrix (polystyrene, PMMA and polysiloxanes) and the concentration of particles in a large range render these materials once more interesting. In this frame we observed that the change of the molecular properties of the host polymer is essential in the understanding of the properties of the final nanocomposite material. In particular changes in the polymer molecular weight produce different particle size distributions which drive the film properties. In this work we discuss this kind of structure-property relations with particular emphasis to the nanoparticles size distribution and the optical properties in the UV-visible wavelength range.

## SYMPOSIUM Q

- Q/PIL.19** A LASER-COOLED ATOM BEAM FOR NANOLITHOGRAPHY APPLICATIONS  
A. Camposo, F. Cervelli, A. Piombini, F. Tantussi, F. Fuso, M. Allegrini, and E. Arimondo, INFN, Dipartimento di Fisica, Università di Pisa, 56127 Pisa, Italy  
Atom lithography is a recently introduced nanofabrication technique which exploits laser manipulation of neutral particles. An atom beam is made to cross a region of stationary e.m. field at wavelength  $\lambda$ . Dipolar forces guide atoms towards maxima (or minima) of the field, producing a spatial segregation of the beam. Atoms can then be either directly deposited onto a substrate, or used to impress a particle-sensitive resist. Regular arrays, with a  $1/2$  periodicity, can thus be produced. Since particle beams are used, with typical de Broglie wavelength  $< 1$  nm, diffraction effects can be ruled out, opening the way to nanostructure fabrication in the tens of nm range.  
We have developed a setup for atom lithography based on a cesium laser-cooled beam. A pyramidal magneto-optical trap is the main component of the apparatus, which allows flux of the order of  $10^{11}$  atoms  $s^{-1} cm^{-2}$ . The beam has been fully characterized by optical diagnostics. The reduced longitudinal beam velocity leads to an increased interaction time in the guiding process. Furthermore, the low kinetic energy of the impinging particles affects the dynamics of the atom/substrate interaction, in particular by reducing particle mobility. Both effects are expected to improve the lateral resolution of the produced nanostructures down to the 10 nm range.  
Work supported by EC through RTD-IST "Nanocold", and by CNR through Progetto Applicativo "Nanotecnologie: Nanolitografia".
- Q/PIL.20** ETCHING DAMAGE EVALUATION OF THE LOW ANGLE FORWARD REFLECTED NEUTRAL BEAM ETCHING  
D.H. Lee, M.J. Chung and G.Y. Yeom, Department of Materials Engineering, Sungkyunkwan University, Suwon 440-746, Korea  
Plasma etching is one of the key technologies in the fabrication of deep submicron silicon based integrated circuit. However, plasma etching has a serious disadvantage due to the energetic charged particles such as positive ions and photons generated in the plasma which causes radiation damage causing physical defect, increased gate oxide breakdown, charging, etc. To avoid these charge-related and physical impact-related damages, several low-damage processes have been proposed. One possible alternative to avoid these problems is a low energy neutral beam etching. In a previous study, a prototype neutral beam etcher of a low angle forward reflected neutral beam etching apparatus with the reflector attached to the ion source as a grid system has been developed. In this etcher, all of the low energy reactive ions extracted from an ion gun impact on a flat surface with 5 to 15 degree to produce near-parallel radical beam flux. In order to obtain a large number of reactive ions, inductively coupled plasma was used as the plasma source for the ion gun. In this study, we investigated the etch rates and the etch properties of SiO<sub>2</sub> with fluorine-based gases using the low angle forward reflected neutral beam etching system. Also, possible neutral beam induced damage was examined through electrical characteristics such as C-V, I-V, and breakdown voltage of the gate oxide and the Si-SiO<sub>2</sub> interface after the etching.
- Q/PIL.21** SELECTIVE DE-ALLOYING IN BIMETALLIC NANOCCLUSERS  
G. De Marchi, G. Mattei, C. Maurizio, P. Mazzoldi, S. Padovani, M. Parolin, C. Sada INFN, Dip. di Fisica, Università di Padova, via Marzolo 8, 35131 Padova, Italy, G. Battaglin, E. Cattaruzza, A. De Lorenzi, F. Gonella, INFN, Dip. di Chimica Fisica, Università di Venezia, Dorsoduro 2137, 30123 Venezia, Italy  
Sequential ion implantation in glass is a very effective technique to obtain composite materials containing bimetallic alloy nanoclusters. The interest on such systems stems from their relevant nonlinear optical features, i.e., an enhanced third-order optical nonlinearity (which turns out to be composition dependent) with respect to the pure matrix. In this work we report on the stability and on possible de-alloying paths for Au-Cu and Au-Ag alloy nanoclusters obtained by sequential ion implantation in silica. Two mechanisms for controlling the clusters composition have been investigated: thermal annealing in oxidizing atmosphere and irradiation with light elements. In both cases, a selective effect on the alloy composition has been evidenced: in the Au-Cu case, after thermal oxidation, alloy decomposition takes place via Cu extraction and oxidation, whereas after irradiation with light elements a preferential coming out of Au from the alloy clusters is found, with a modification of the cluster size distribution similar to an inverse Ostwald ripening. Samples analysis has been performed with complementary techniques: optical absorption, transmission electron microscopy (TEM), extended X-ray absorption fine structure (EXAFS), Rutherford backscattering spectrometry (RBS).
- Q/PIL.22** NITROCELLULOSE MEMBRANES WITH 15 nm HOLES IN LOW-TEMPERATURE HELLIUM FLOW EXPERIMENTS  
Sergey Pereversev, Sergiy Putselyk, Georg Eska, Physikalische Institute, Universitaet Bayreuth, Germany  
We describe the production of 15nm diameter holes in 15nm thick nitrocellulose membranes. These membranes were mounted on TEM-grids and were covered in one side with 2nm Au islands. Prior to irradiation with fission products of <sup>252</sup>Cf-source the membranes were defect free (helium leak-tight). Radiation damage by secondary electrons, produced in the Au, leads to 15nm circular-shaped holes (no chemical etching of tracks is required).  
Flow of quantum fluids through such structures is of great experimental importance for investigation of superfluid analogue of Josephson effect. We present first results of He<sup>3</sup> flow through these holes in wide temperature range 0.3mK-1K.
- Q/PIL.23** ELECTRONIC PROPERTIES OF NOBLE, TRANSITION AND SEMI -METAL NANOPARTICLES AND ULTRATHIN FILMS  
G. Peto, G. Molnar, Cs. Daroczi, Institute of Technical Physic and Materials Science, P.O. Box 49, 1525 Budapest, Hungary and J. Kanski, Exp.Phys Dept. Chalmers Univ. of Tech. Goteborg, 42196. Sweden and Z. Paszti, L. Guczi, Department of Surface Chemistry and Catalysis, Institute of Isotopes and Surface Chemistry, CRC, HAS, P. O. Box 77, 1525 Budapest, Hungary  
Nanoparticles and very thin films of Au, Co and Sn were prepared by large variety of thin film and surface technology like thin film depositions in UHV, laser ablation, ion implantation and ion beam erosion. The substrates and the environment of these metal nanosize elements are Si and C in avoiding the metal/support chemical interaction. The electronic properties are investigated by means of photoemission using He (I), He (II), Alka light sources together with synchrotron radiation. The morphology was measured by atomic force microscopy. Density of states in the valence band changes with the size of all nanoparticles, but in different ways at the different metals, especially, in the cases of Co and Au. Position of the atomic levels is also size dependent characterized by shifts towards higher binding energy vs. decreasing particle size. For the very thin film the redistribution of the valence band density of the states along with some new states are observable at the Fermi level. The new states maybe correlated to electron confinement.  
The size dependence of the valence band can be observed in the size range of 1-10 nm of nanoparticles and the electron confinement in thickness range of 6-10 nm. The size dependent atomic levels of the ion implanted Sn into Si may be interpreted by the formation of atoms, clusters and nanoparticles.

## SYMPOSIUM Q

- Q/PIL.24** A COMPARATIVE STUDY OF SIZE-DISTRIBUTION OF NANOPARTICLES GENERATED BY LASER ABLATION OF GRAPHITE AND TUNGSTEN  
Zs. Marton(a), L. Landström(b), M. Boman(b) and P. Heszler(c), (a)Department of General Physics and Laserspectroscopy, University of Pecs, 7624 Pecs, Hungary, (b)Department of Materials Chemistry, The Angstrom Laboratory, Uppsala University, P.O. Box 538, Uppsala 751 21, Sweden, (c)Department of Solid State Physics, The Angstrom Laboratory, Uppsala University, P.O. Box 534, Uppsala 751 21, Sweden  
Nanoparticles were generated by excimer laser ablation (193 nm) of graphite and tungsten targets in N<sub>2</sub> and Ar ambient at atmospheric pressure. The size-distribution of the particles was monitored in-situ by a scanning mobility particle sizer system, based on a differential mobility analyser (DMA). The DMA classifies the particles based on their electrical mobility. The size-distributions in the 70-133 nm diameter range are presented for different laser fluences, repetition rates and ablated areas, respectively.  
The size-spectra showed increasing concentration with decreasing size below ~ 15 nm for both carbon and tungsten for any laser fluence. Decreasing concentration with increasing size above ~ 15 nm was found for laser fluences below the ablation thresholds. However, a broad peak in the size-distributions appeared at ~ 60-70 nm for fluences above the ablation threshold. This broad peak was less pronounced for tungsten.  
Increasing laser repetition rate results in decrease of the concentration of particles below size of ~30 nm for carbon, due to the fact that laser pulses interact with the particles generated by previous pulses. This effect could not be observed for tungsten. Evaporation rate calculations at elevated temperatures for the nanoparticles are performed to explain this effect in accordance with nanoparticle emissivity (absorptivity) estimations.  
Material analysis was performed by Raman and photo-electron (XPS) spectroscopy.
- Q/PIL.25** HYDROGEN ENHANCED CLUSTERISATION OF CARBON IN CRYSTALLINE SILICON  
Yu.V. Gorelkinskii, Kh.A. Abdullin, B.N. Mukashev and G.O.Tojibaev, Institute of Physics and Technology Kazakstan Ministry of Education and Science 480082 Almaty, Kazakstan  
In the report is revealed for the first time strongly hydrogen-enhanced clusterization of carbon atoms impurity along with self-interstitial atoms in hydrogen-implanted silicon. As object of researches was used EPR a signal of the earlier not identified EPR defect (S=1/2)  $\gamma_4$ , which was for the first time observed in FZ silicon irradiated with fast neutrons [1]. We note that in usual FZ - silicon with low content of carbon irradiated with fast neutrons, by protons or alpha-particles even traces of  $\gamma_4$  signal is not observed. However, after H- implantation and annealing of the same samples at 850K secondary H- implantation leads to creation of the PK4. H-implantation in Fz samples enriched with carbon generate most prominent signal of the defect. We have reliably identified hyperfine interaction (hfi) with an isotope <sup>29</sup>Si. Three groups of hf satellites were revealed: 1) - one equivalent Si atom with localization (~42%) of resonant wave function and A - tensor of tetragonal symmetry; 2) - four equivalent Si atoms, each of which possesses ~4% of wave function; 3) - weak hfi which can be caused by an isotope of <sup>13</sup>C (abundance 1.11%) if in structure of the defect are involved four equivalent carbon atoms. We have found that electronic structure of this defect corresponds to the double donor in a positive charge state. Uniaxial stress experiments reveal that activation energy for atomic reorientation is very large (2.8 eV) and as well as data of piezoelectric tensor are in good agreement with cluster's nature of the defect. Details of experiments and discussion will be presented in report. The carried out researches represent interest for development of the diffusion theory and impurities gettering in Si, as have the important applied aspect connected to development of semiconductors nanotechnology  
[1] E. Mu, J.C. Wao, M.X.Yan, G.G.Qin, Phys.Lett A 118 (1986) 347
- Q/PIL.26** OPTICAL AND STRUCTURAL PROPERTIES OF HOLLOW Ni, Cu AND Ag NANOCCLUSERS IN SiO<sub>2</sub>  
J.K.N. Lindner(a) P.S. Chung(b), S.P.Wong(b), W.K. Lee(c) and C.W. Chan(c), (a)Universität Augsburg, Institut für Physik, 86135 Augsburg, Germany, (b)The Chinese University of Hong Kong, Dept. of Electronic Eng., Hong Kong, China, (c)The Chinese University of Hong Kong, Dept. of Physics, Hong Kong, China  
Metallic nanoparticles in silica are known to exhibit various non-linear (intensity dependent) optical properties, some of which are ascribed to size effects. Ion implantation is a well-suited technique to form such nanoparticles, as their size and size distribution can be easily controlled by the implantation parameters.  
We used MEVVA implantation of Ni, Cu and Ag ions at doses between 8 and 20 x 10<sup>16</sup> ions/cm<sup>2</sup> to form near surface layers of nanoclusters in SiO<sub>2</sub>. The nonlinear optical properties of the implanted samples were studied by the z-scan method, using a self mode-locked Ti:sapphire laser delivering linearly polarized pulses of 130 fs long at a wavelength of 790 nm at 76 MHz. In order to correlate the nonlinear optical properties to the microstructure, the depth distribution of nanoclusters, their particle size distributions and the crystalline state were investigated by cross-sectional TEM and electron diffraction. Both, in Cu and Ni implanted samples, nanoparticles (< 30 nm) are detected which frequently exhibit a core/shell structure. Electron diffraction indicates that the particles consist of a single element (Cu or Ni) and using energy-filtered TEM it is shown that these nanoparticles are hollow. These observations put a new light on the formation of hollow-core nanoclusters, as such particles have so far been detected only in compound nanoclusters (CdS [1] or Ag<sub>2</sub>S [2] in SiO<sub>2</sub>) formed by sequential implantation of two elements but not in single element implantations such as Cu in SiO<sub>2</sub> [3].  
Financial support of this project by the HK-Germany joint research scheme of DAAD and RGC of HKSAR is gratefully acknowledged.  
[1] A. Meldrum et al., Nucl. Instr. and Meth. B 178 (2001) 7.  
[2] E. Cattaruzza et al., Nucl. Instr. and Meth. B 148 (1999) 1007.  
[3] N. Kishimoto et al., *ibid.* 1017.
- Q/PIL.27** EFFECT OF ION IRRADIATION ON THE STRUCTURE AND MAGNETIC PROPERTIES OF MBE ORDERED CoPt ALLOYS  
M. Abes(a), O. Ersen(a), D. Muller(b), A. Dinia(a) and V. Pierron-Bohnes(a), (a)Institut de Physique et de Chimie des Matériaux de Strasbourg, UMR 7504 CNRS, ULP-ECPM, 23 rue du Loess, 67037 Strasbourg, France, (b)Laboratoire PHASE, CNRS UPR 292, 23 rue du Loess, 67037 Strasbourg, France  
Thin layers of CoPt alloy have been prepared in co-deposition by sputtering or MBE (Molecular Beam Epitaxy) on a MgO(001) substrate with a Pt(001) buffer layer. We obtain a layer with the L<sub>1</sub><sub>0</sub> tetragonal structure, ordered in the growth direction. This equiatomic L<sub>1</sub><sub>0</sub> phase is a "natural" multilayer which consists in a stacking along the [001] direction of pure Co and pure Pt monolayers. In this case, we can get an easy magnetization direction perpendicular to the layer plane which is the required configuration for the perpendicular recording. The order state of thin films has been modified locally by a low energy ion irradiation. The structural and magnetic properties have changed for chosen ion energy and flux. For a 40keV energy and a 4.10<sup>16</sup> ions/cm<sup>2</sup> flux, the chemical order and, the coercitive field diminish by a factor of 2. Such results show that it is possible to locally change the magnetic properties which is promising for applications.

## SYMPOSIUM Q

### Theory

- Q/PIL.28** COMPUTER SIMULATION OF IRRADIATION EFFECT ON THE MODIFICATION OF CARBON NANOSTRUCTURES  
M.V. Makarets, M.P. Kulish, O.P. Dmytrenko, Yu.I. Prylutsky\*, Kyiv National Shevchenko University, Department of Physics and \*Biophysics, Volodymyrska str., 64, Kyiv 01033, Ukraine, P. Scharff, Technical University of Ilmenau, Institute of Physics, D-98684 Ilmenau, Germany and T. Braun, Institute for Inorganic and Analytical Chemistry L. Eotvos University, 1443 Budapest, Hungary  
In the present report the computer simulation of the ionic low energy irradiation influence on the carbon nanostructures such as fullerenes and nanotubes is carried out. The spatial distribution of vacancies and its dependence on the projectile energy and energy of defect formation, and also the deposition energy into the electronic subsystem of target were examined and analyzed in detail using the molecular dynamics calculations. In particular, it was found that the formation of fixed local defects in the carbon nanotube configuration under irradiation can lead to the appearance of heterojunction in its structure. The theoretically predicted effect is very important for nanoelectronics.
- Q/PIL.29** THE FORMATION OF THE LOW-DIMENSIONAL POROUS SILICON - BASED STRUCTURES WITH EXTREMELY HIGH VALUE OF EXCITON BINDING ENERGY  
A.V. Sarikov and V.G. Litovchenko, Institute of Semiconductor Physics, National Academy of Sciences of Ukraine, 45 prospekt Nauki, Kiev 03028, Ukraine  
The formation of porous silicon in the course of electrochemical dissolution is considered by the method of computer modelling. The processes of transport of holes in silicon wafer and reagent inside the pores are taken into account as well as their mutual reactions. The morphology of the porous layer is traced throughout all its thickness. The formation of quantum dots is shown if the definite technological regimes of dissolution are applied. The parameters of the exciton transitions in the structures with quantum dots are investigated using non-temperature method based on the Froelich-Hopfield relation. The high value of the exciton binding energy in crystallites of porous Si is demonstrated by this method which is in good agreement with these values obtained from first-principles calculations.
- Q/PIL.30** QUANTUM THEORY OF TOPOLOGICAL KINK-BOUNDARY CONSTRAINTS IN MECHANISMS OF NANOSYSTEM STABILIZATION  
S.A. Beznosyuk, Altai State University, Lenin Pr. 61, 656099 Barnaul, Russia  
One of the most fundamental concepts for theoretical investigation of nanosystems seems to be the quantum topology. In which it was shown that a single finite chemical particle (an atom, a molecule, a micro-crystal, a single electron, etc.) within a material could be described as a compact quantum mechanical swarm of kinematics electron-density waves depends on set of topological kink-density boundary constraints. The role of these kink-boundary constraints for self-organization processes taking under consideration in nanotechnologies is the main purpose of this report. First of all they provide the possibility of practical manipulation with the chemical particle as unified one. Secondly, they reveal some fine quantum mechanical mechanisms of stabilization of very different nanosystems such as supramolecules, nanostructured solids in a special cluster form, which consists of divers set of single chemical particles. In particular, we proved that both a quantum-mechanical &#8220;collapse&#8221; of a compact chemical particle and a quantum-statistical decomposition of nanoscale cluster of chemical particles are prevented by a special form of topological kink-density boundary constraints. Thirdly, one can introduce a theoretical description of kink-boundary effects by taking into account a &#8220;surface energy&#8221; of the compact quantum mechanical swarm of kinematics electron-density waves, which is confined by kink-density boundary of the compact chemical particle.
- Q/PIL.31** QUANTUM TOPOLOGY THEORY AND COMPUTER SIMULATION OF BOSE-EINSTEIN CONDENSATE BLOBS SPREADING IN SUPERCOOLING NANOSYSTEMS OF ATOMS  
S.A. Beznosyuk, D.A. Mezentsev Altai State University, Lenin Pr. 61, 656099 Barnaul, Russia, T.M. Zhukovsky, Altai Technical State University, Lenin Pr.46, 656099 Barnaul, Russia  
Theoretical description of the nanoscale blob of Bose-Einstein condensate of atoms is given according to the quantum topology approach describing the electron-nuclei density distributions. Basic effects resulted from degeneration of electrons and nuclei degrees of freedom in the Bose-Einstein condensate of atoms and the presence of indeterminacy principles for quantum mechanical process proceeding interior of the compact blob is taken under consideration. In the thermostat a complete number of thermalized degrees of freedom of each condensate &#8220;super atom&#8221; blob is equal to its in a single one. A subsystem of absolutely identical atoms interior the &#8220;super atom&#8221; blob forms degenerate a quantum-mechanical swarm, which is described by using of quantum-statistical order parameter in the form of the kinematical wave of density. Some restrictions for charge density on the boundaries of the condensate blob confining of atoms are resulted from kinematics structure requirements for quantum mechanical observability. The blob was computer simulated for case of a compact &#8220;super atom&#8221; confined inside cubic-form space block. Its density distribution is described with finite functions. On the contrary to the case of confined single atom in a real physical space of the condensed state of matter there is a limit case of kink-boundary form of density without cuspsingularities of electron density distributions on nuclear positions interior the compact blob.
- Q/PIL.32** NANOISLAND NUCLEATION IN THERMAL SPIKES AT SURFACES IRRADIATED WITH SWIFT HEAVY IONS AND FEMTOSECOND LASER PULSES  
Alexander E. Volkov, Michael V. Sorokin, Institute of General and Nuclear Physics, Russian Research Centre 'Kurchatov Institute', Moscow 123182, Russia  
Swift heavy ions ( $E > 1 \text{ MeV/amu}$ ) and intense femtosecond laser pulses considerably excite electronic subsystem of targets while the ionic subsystem remains practically unperturbed at initial moments. Subsequent energy transfer from the excited electrons to target atoms results in the temperature increase, which can stimulating structure transformations in the SHI tracks and laser spots.  
We investigate the effect of such thermal spike on decay of a supersaturated solution of adatoms/impurity atoms resulting in the nucleation of nanoislands in the vicinity of SHI inlets and laser spots. Manifesting new possibilities of monitoring the island kinetics, the effect can be interesting for technologies aimed to manufacturing of ordered low-dimension nanostructures.  
The model is based on the fact that the temperature dependence of the nucleation time of 2D nanoclusters has generally an abrupt minimum at the characteristic temperature depending on the system parameters. In this paper we analyze the temperature dependence of the nucleation time and indicate the values of matrix parameters and irradiation conditions where the nucleation time becomes shorter than that of the spot cooling down. Spatial distribution of nucleated nanoclusters in the spot is also investigated.

## SYMPOSIUM Q

- Q/PIL.33** MODEL OF NANOCUSTER NUCLEATION IN A SUPERSATURATED SOLID SOLUTION UNDER CONTINUOUS GENERATION OF A SOLVENT COMPONENT  
Alexander E. Volkov, Institute of General and Nuclear Physics, Russian Research Centre 'Kurchatov Institute', Moscow 123182, Russia  
In the last ten years an increasing progress in the field of new soft magnetic materials is observed which is related to a development of new technologies of material production [1].  
In the present paper the Fe-X-Si-B and Fe-Cu1-X-Si-B alloys (X - alloy addition or their combination) obtained by melt spinning technique were investigated. As quenched samples were in amorphous state. In order to obtain a nanocrystalline phase the examined samples were annealed at temperatures from the range 300 ? 900 K for 1 h. For annealed samples magnetic properties (permeability, coercive field, magnetisation) as well as electric properties were measured at room temperature. The structural changes were examined by applying X-ray diffraction method and electron microscopy observations (HREM-JEM 3010). These examinations were supplemented by measurements of electrical resistivity and magnetic permeability ?in situ? with linear heating rates (0.5-10 K/min). These measurements allow to study the crystallisation processes (first and second stages, activation energy), and to determine the Curie temperature. The observed magnetic permeability enhancement can be explained by Herzer model which take into account formation of nanocrystalline phase supplemented by two terms ? i.e. magnetoelastic energy and stabilisation energy connected with presence of microvoids [2].  
[1] L. K. Varga, F. Mazaleyrat, J. Kovac, A. Kakay, JMMM 215-216 (2000) 121  
[2] G. Herzer, L. L. Varga, JMMM 215-216 (2000) 506
- Q/PIL.34** PECULIARITIES OF NANOCUSTER NUCLEATION CAUSED BY SWIFT HEAVY IONS IN SUPERSATURATED SOLID SOLUTIONS  
Alexander E. Volkov, Denis N. Korolev, Institute of General and Nuclear Physics, Russian Research Centre 'Kurchatov Institute', Moscow 123182, Russia  
Many types of high-Tc superconducting (HTSC) fault current limiter (FCL) have been suggested. But they have difficulty with the application of power system, because of a material weakness. The proposed fault current limiter consists of two coils wound on the same core and high-Tc superconducting thin film and can control the initial limiting current level with the number of winding. It could be examined by computer simulation that the initial current level decreased more effectively with this type HTSC-FCL. With this type FCL, it could be expected to overcome the material restriction which high-Tc superconducting material has in applying to FCL.
- Q/PIL.35** STM OBSERVATION OF Y-BRANCHED CARBON NANOTUBES AND NANO-KNEES PRODUCED BY THE ARC DISCHARGE METHOD  
Z. Osvath, A.A. Koos, Z.E. Horvath, J. Gyulai, Research Institute for Technical Physics and Materials Science, 1525 Budapest, P.O.Box 49, Hungary, A.M. Benito, M.T. Martinez, W. Maser, Instituto de Carboquimica, CSIC, C/Miguel Luesma Cast-n 4, 50015 Zaragoza, Spain and L.P. Biro, Research Institute for Technical Physics and Materials Science, 1525 Budapest, P.O.Box 49, Hungary  
The influence of deposition conditions on the sp<sup>3</sup> content, intrinsic stress, and elastic modulus in hard amorphous carbon (a-C) films was studied at the atomic scale. Simulation of ion beam deposition of carbon films was performed by the molecular-dynamics method with a modified analytical hydrocarbon potential of Brenner. Deposition of films with a thickness of up to 10 nm was computed for ion energies E = 10-80 eV, and for substrate temperatures ranging from 100 to 900 K. The dependence of the sp<sup>3</sup> content and the intrinsic stress on substrate temperature was found to be in qualitative agreement with experiment. At low substrate temperatures and low ion energies, the sp<sup>3</sup> fraction increases with ion energy, giving at E > 30 eV a highly sp<sup>3</sup> bonded tetrahedral amorphous carbon (ta-C) with a high level of intrinsic compressive stress. This trend also remains at room temperature, however with lower values of sp<sup>3</sup> content, whereas at T > 200 °C a transition to graphite-like a-C with dominating sp<sup>2</sup> bonding was found.
- Q/PIL.36** ENGINEERING OF SILICON AND SILICON-GERMANIUM NANOHETEROSTRUCTURE  
A. Efremov, A.Klimovskaya, A. Sarikov, V. Litovchenko, Institute of Semiconductor Physics NAS, Ukraine  
Much attention was paid last decade to the methods based on a self-organization. However, many problems exist in the way of engineering homogeneous nanoheterostructures. The aim of the present work is to show how controlling growth conditions may be used to engine nanoheterostructures with desired properties. To correctly account for all the processes taking place during the growth of nanoheterostructures, we use computer modeling. Results of the modeling are compared with experimental ones.
- Q/PIL.37** FREE-ROTATING MOLECULAR JOINT BASED ON THE HOMO-LUMO INTERACTION OF HALOGENATED HYDROCARBON WITH AN ANIONIC VACANT SITE ON HYDROGENATED (111) SURFACE OF DIAMOND: A THEORETICAL PROPOSAL FOR NANOTECHNOLOGY  
Shojiro Komatsu, Katsuyuki Okada, Yusuke Moriyoshi\*, and Mamoru Mitomo  
Here we propose a molecular free-rotating joint (or ball-bearing) on hydrogenated (111) surface of diamond, by utilizing the HOMO-LUMO interaction of a surface anionic site with a hydrogenated hydrocarbon. In this study, we used the restricted Hartree-Fock semi-empirical molecular orbital method based on parametrization known as PM3. The sleeve, bearing-ball, and shaft are made of the diamond surface, a halogen atom, and hydrocarbon (diamond cluster here), respectively. The halogen atom is supported by an anionic vacancy on hydrogenated (111) surface of diamond, where a surface hydrogen atom is absent but a lone pair of electrons exist.  
This molecular nanostructure proved to have thermochemical stability of about 40 kcal/mol for the case of a bromine bearing-ball. The activation energy for rotation has a sinusoidal form with the period of 60 degrees and the absolute value was below 0.2 kcal/mol.
- Q/PIL.38** NANOSCALE SI-LAYERED SYSTEMS FOR THIRD GENERATION PHOTOVOLTAICS  
Z.T. Kuznicki, M. Ley, Laboratoire PHASE, CNRS-STIC, 23 rue du Loess, 67037 Strasbourg cedex 2, France  
Solar cells based on classical Si materials have achieved their photovoltaic conversion limits. Nevertheless, Si still conserves its attraction for many photovoltaic applications. Question : is there any method allowing Si exploitation in the 3rd generation of solar cells, i.e. is any transformation of this material possible from the optoelectronic viewpoint ? The answer is, yes, it can be done by nanoscale engineering.  
To combine progress in material knowledge with the latest device concepts we are exploring a multi-interface design based on a nanoscale Si-layered system. Active substructures and active interfaces can be controlled by bandgap, defect and stress engineering that permits, considerably extending existing limits. Results indicate that the practical realization of the postulated PV improvements on adequate materials seems to be possible. Some new generation mechanisms are shown on model devices.

## SYMPOSIUM Q

Friday, June 21, 2002  
Vendredi 21 juin 2002

Morning  
Matin

Session XI: Nanoparticles  
Session Chair: W. Jantsch

- 9:00           **Q-XI.1**           CORRELATED, SELF-ORGANIZED PbSe QUANTUM DOTS IN VERTICAL CAVITIES: ABSORPTION AND STIMULATED EMISSION  
**W. Heiss**, G. Springholz, T. Schwarzl, M. Böberl, T. Fromherz, A. Raab, Institut für Halbleiterphysik, Universität Linz, Altenbergerstraße 69, 4040 Linz, Austria, J. Fürst, M. Aigle, H. Pascher, Experimentalphysik I, Universität Bayreuth, Universitätsstraße 30, 95447 Bayreuth, Germany, H. Krenn, Institut für Experimentalphysik, Universität Graz, Universitätsplatz 5, 8010 Graz, Austria, I. Vavra, Institute of electrical Engineering, Slovak Academy of sciences, 84239 Bratislava, Slovakia  
The self-organized growth of pyramidal shaped PbSe quantum dots embedded in strain symmetric PbEuTe/PbSe superlattices results in the formation of three-dimensional quantum-dot crystals [1]. In this crystals the correlated growth leads to a homogenization of the quantum dot sizes which is advantageous for optoelectronic device applications. Therefore, here we study the optical properties of vertical cavities with two high reflectivity Bragg interference mirrors and a highly ordered quantum-dot crystal in its active region. A cavity length of about 10  $\mu\text{m}$  is chosen in order to sustain a large number of cavity resonances within the stop band of the dielectric Bragg mirrors. This enables us to determine the absorption coefficient of the self-organized quantum dots by analyzing in detail the widths of the cavity resonances. By this, a quantum dot absorption peak can be clearly identified in agreement with the energy of the stimulated emission observed under optical excitation.  
[1] G.Springholz, V. Holy, M. Pinczolit, G. Bauer, Science 282, 734 (1998)
- 9:40           **Q-XI.2**           NANOMETALLIC MICROPHOTONICS  
Ch. Strohhofer, J.P. Hoogenboom, A. van Blaaderen and A. Polman, FOM-Institute AMOLF, Amsterdam, The Netherlands  
Metallic nanoparticles show unique optical properties that are related to their surface plasmon resonance. We have fabricated Ag nanocrystals in SiO<sub>2</sub> by using ion irradiation of a commercial BK7 glass that was first doped with Ag ions using a Na<sup>+</sup> Ag ion exchange process. The Ag cluster size (2-10 nm), concentration (up to 1 at.%), and depth distribution (up to 0.5 micron) were precisely tuned by the irradiation conditions. From optical reflection and transmission it is found that the layers are highly dispersive, with the refractive index varying between  $n=1.6$  and  $n=2.8+0.15i$  over the 350-800 nm wavelength range. Channel waveguide were made, based on Ag ion exchanged glass, in which controlled sections of 150-275  $\mu\text{m}$  length were irradiated with Xe ions to selectively nucleate Ag nanocrystals. The nanocrystal doped sections serve as passive filters with tunable absorption cut-off. By using the non-linear optical effect, an all-optical switch may be made. Next, two-dimensional micropatterns of Ag-doped glass were made by using an irradiation mask fabricated by colloidal self-assembly. A two-dimensional hexagonal colloidal crystal was first grown on the Ag-doped glass using a controlled drying method. Next, the structure was irradiated with Xe ions. After removal of the colloidal mask, a hexagonal index profile was observed in the glass, both in optical reflection and diffraction. These highly dispersive Ag nanocrystal micropatterns may serve as (switchable) photonic crystals in the visible. Using smaller colloids this selective ion irradiation technique can be used to fabricate structures with dimensions down to the 10 nm range.
- 10:00           **Q-XI.3**           PREPARATION, STRUCTURE, AND MAGNETISM OF BIMETALLIC COLLOIDAL PARTICLES I: THE NON-ALLOYING SYSTEM Co/Ag  
N.S. Sobal, M. Hilgendorff, M. Giersig, Hahn-Meitner-Institut Berlin, Glienicker Str. 100, 14109 Berlin, Germany and M. Spasova, M. Farle, Institut für Halbleiterphysik und Optik, Technische Universität Braunschweig, Mendelssohnstr. 3, 38106 Braunschweig, Germany  
Fundamental studies of synthesis, structure, and magnetism of Co/Ag composite nanocrystals prepared using methods of colloid chemistry are presented. Our results show the possibility to create condensed matter with novel structures and properties, not found in bulk materials. The availability of such materials as well as differences in aging behavior between wet and dried particles is dependent on the enlarged dispersivity of nanosized crystals. Successes and problems concerning the interpretation of results from HRTEM-, XRD-, and magnetic measurements of Co/Ag-core-shell particles and metastable Co/Ag "quasi-alloys" in solution and deposited on substrates are critical discussed with respect to published results.
- 10:20           **BREAK**

## SYMPOSIUM Q

Session XII: Polymers  
Session Chair: U. Valbusa

- 10:50      **Q-XII.1**      **FUNCTIONAL POLYMERS ON MOLECULAR BASIS**  
**W. Knoll**, Max-Planck-Institut für Polymerforschung, Ackermannweg 10, 55128 Mainz, Germany  
Based on novel dendritic chemical structures a number of (bio-) functional polymeric building blocks became recently available for the construction of nanostructured hybrid materials. In addition to their perfectly monodisperse molecular weight, chemical identity and, in some cases, shape persistency they offer a broad variety of different functionalities located in the core, the outer shell or at the surface of the dendrimer. Particularly interesting are the optical properties of chromophore-functionalized dendrimers, as well as, the additional attachment of bio-affinity labels like peptide or oligonucleotide sequences. We will first discuss the build-up of multilayer architectures from dendrimers with anionic or cationic groups at the surface. The alternate deposition (by a simple adsorption step from solution) of these polyelectrolytes allows for the construction of functional polymer coatings with precise structural engineering of the inner architecture at the nanometer level.  
The combination of these organic multilayers with functional modules prepared from inorganic materials, e.g., Au nanoparticles or semiconducting nanocrystals "quantum dots" opens up new avenues for the construction of multifunctional hybrid materials with applications in optoelectronics, biosensors, or in medical devices.
- 11:30      **Q-XII.2**      **SOLVENT-ASSISTED PHYSICAL AND CHEMICAL MODIFICATION OF POLYMER SURFACES USING THE SFM**  
**Tom Dickinson**, Ryan Leach, and Forrest Stevens, Washington State University, Dept. of Physics, Pullman WA 99164, USA  
Patterning and chemically modifying polymer surfaces on a nanometer size scale has potential applications in the area of bio-nano-technology. Producing functionalized platforms for binding selected biomolecules is one example. We have been carrying out fundamental studies of the consequences of the simultaneous application of mechanical stress and solvents to polymer films. The stress is applied by the tip of a scanning force microscope (SFM) measured normal or as normal and lateral forces; the same tip is then used to image in situ the changes in the polymer surface in the region of applied stress. Using standard Si<sub>3</sub>N<sub>4</sub> tips, polymers such as PMMA and polystyrene and solvents such as ethanol, we find that in most cases the polymer responds by locally swelling rather than wear. Large scans (a few hundred nm) generate positive relief mogul patterns on ~30 nm size scale, running normal to the scanning direction. We present the responses as a function of solvent strength, molecular weight, applied stress and mechanistic models for the observed behavior. In addition, we have begun studies which reveal a form of nanometer scale inoculation of polymer surfaces. By introducing dye (Rhodamin 6G) into the solvent, we show that tip-induced mechanical stimulation locally introduces dye into the polymer surface.
- 11:50      **Q-XII.3**      **FUNCTIONAL FILMS OF WATER-SOLUBLE POLYPHENYLENE DENDRIMERS BY ELECTROSTATIC SELF-ASSEMBLING PROCESS**  
**J.L. Hernandez-Lopez**, S. Mittler-Neher, W. Knoll, T. Weil and K. Müllen, Max-Planck-Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany  
SAMs on metal, semiconductor, and insulating substrates have been studied extensively for use in corrosion passivation, biochemical and chemical sensors, wetting, and lithography. However, for some applications they have significant disadvantages, for example, strictly two-dimensional surfaces and limited stability due to monopodal surface attachment being necessary to increase their dimensionality, to enhance their functional group density and to improve their substrate adhesion and stability. Due to the unique properties of dendrimers, they have the ability to serve as perfect building blocks for self-assembling nanofabrication of supramolecular architectures providing the desired properties at the interfaces. In this study, a polyphenylene dendrimer decorated with 16 carboxy groups was adsorbed on charged surfaces that consist of poly(allylamine hydrochloride) (PAH)/3-MPA on gold substrates. The self-assembly process was characterised by surface plasmon resonance (SPR), UV-Vis spectroscopy, ellipsometry and small-angle X-ray reflectivity. The results demonstrate that dendrimers can be deposited directly onto self-assembled monolayers of the appropriate charge density and can be built up to a final multilayer architecture of any desired thickness and functionality.
- 12:10      **Concluding Remarks**