4TH NANOSPAIN WORKSHOP

SEVILLA SPAIN - MARCH 12-15 2007

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On behalf of the Advisory and Technical Committees, we take great pleasure in welcoming you to Sevilla for the fourth meeting of the Spanish Nanotechnology Network NanoSpain.

During the last two decades, a revolutionary scientific new age, based on the capacity to observe, characterise, manipulate and organise matter in the nanometer scale, is appearing. In this scale, physics, chemistry, materials science, computational theory, and engineering converge towards the same theoretical principles and experimental findings that are basically governed by the laws of the Quantum Mechanics. Nanotechnology involves these interdisciplinary areas of knowledge and methodologies in order to study, manufacture and characterise functional structures with dimensions of tens of nanometers.

The NanoSpain network aims to agglutinate and coordinate the efforts made in the field of Nanoscience & Nanotechnology by Spanish groups from universities, research institutes and companies. In addition, this network helped Spanish government institutions in defining potential actions and plans referring to this area. Currently, the network comprising 202 Spanish groups with approximately 1300 researchers in total is one of the widest Spanish scientific networks.

As a direct and most effective way to enhance interaction between network members, three meetings were organised in San Sebastian (2004), Barcelona (2005) and Pamplona (2006) with respectively 210, 260 and 262 participants. Due to this success, the network decided to organise this year its fourth meeting in Sevilla with a similar format.
Its objective will be to facilitate the dissemination of knowledge, promote interdisciplinary discussions among the different NanoSpain groups and enhance industrial participation. In order to organise the various sessions and to select contributions, the meeting will be structured in the following thematic lines although interactions among them will be promoted:

1. NanoBiotechnology / Nanomedicine
2. NanoMaterials
3. NanoChemistry
4. NanoElectronics / Molecular Electronics
5. Nanomagnetism
6. Nanotubes
7. NEMS / MEMS
8. Scanning Probe Microscopies (SPM)
9. Scientific Policy
10. Simulation at the nanoscale

Parallel Thematic Sessions related with the Network Working Groups (WG) will also be organised to enhance information flow between network partners and in particular to:
- Exchange information of current work in specific research areas
- Solve particular technological problems
- Look for areas of common ground between different technologies
- Provide contributions to specific reports

The following sessions will be organised:
1. Molecular Electronics (Coordinators: Julio Gómez & Pablo Ordejon)
2. NanoBiotechnology (Coordinator: Josep Samitier & Angel Rubio)
3. NanoFabrication (Coordinators: Francesc Pérez-Murano & Fernando Briones)
4. Industrial (Coordinators: Jose Luis Viviente & Emilio Prieto)
5. NanoChemistry (Coordinators: Jaume Veciana & Nora Ventosa)

Another objective of this meeting will be to evaluate the situation of Nanotechnology in Spain and to reach conclusions concerning the future of the NanoSpain network, in order to guarantee its continuity by means of concrete proposals.

Finally, thanks must be directed to the staff of all organising institutions whose hard work has helped the smooth organisation and planning of this conference.

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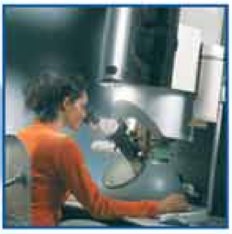

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4^{th} NANOSPAIN WORKSHOP

SCIENTIFIC PROGRAMME

SCIENTIFIC PROGRAMME

Monday March 12, 2007

08h00-09h00	***Registration and Welcome***
(Session: Nanobiotechnology / Nanomedicine) **Chairman: Juan Jose Saenz**	
09h00-09h50	**Albert van den Berg (Twente University, Netherlands)**
(page 19)	"From Lab on a Chip to a Lab-in-a-Cell"
09h50-10h10	**Elena Martinez Fraiz (PCB-UB, Spain)**
(page 47)	"Production of functionalised micro and nanostructured polymer surfaces to trigger mesenchymal stem cell differentiation"
10h10-10h30	**Celia Rogero (INTA, Spain)**
(page 67)	"Characterization of functionalized Si surfaces for biosensor applications"
10h30-10h50	**Gerardo Goya (Universidad de Zaragoza, Spain)**
(page 39)	"Magnetically-charged dendritic cells as vectors for Magnetic Hyperthermia therapy"
10h50-11h50	***Poster Session / Coffee Break & Instrument Exhibition***
(Session: Nanobiotechnology / Nanomedicine) **Chairman: Jesus M De la Fuente**	
11h50-12h40	**Paulo Freitas (INESC, Portugal)**
(page 7)	"Magnetoresistive biosensor platforms"
12h40-13h30	**Gunter Reiss (University of Bielefeld, Germany)**
(page 15)	"Magnetoresistive Sensors and Magnetic Nanoparticles for Biotechnology"
13h30-15h30	***Lunch***
(Session: Nanomagnetism) **Chairman: Antonio Garcia Martin**	
15h30-16h20	**Jos de Jongh (Leiden University, The Netherlands)**
(page 11)	"Decoherence crossovers in molecular magnetic qubits wth tunable quantum tunneling rates"
16h20-16h40	**Xavier Batlle (Universidad de Barcelona, Spain)**
(page 25)	"Fe3O4 nanoparticles with bulk magnetic properties"
16h40-17h00	**Francisco Rivadulla (Universidad de Santiago de Compostela, Spain)**
(page 63)	"Magnetic relaxation of γ-Fe2O3 dispersions and electronic phase-segregated systems"
(Session: Scientific Policy) **Chairman: Arturo Dominguez**	
17h00-17h15	**Jose Rivas Rey (USC, Spain)**
(page 65)	"The international iberian nanotechnology laboratory (INL)"
17h15-17h30	**Jose Maria Pitarke (CIC nanoGUNE Consolider, Spain)**
(page 61)	"CIC nanoGUNE Consolider"
17h30-17h45	**Albert Figueras (Institut Catalá de Nanotecnologia, Spain)**
(page 33)	"NanoScience and Nanotechnology Research Center – CIN2 (CSIC-ICN)"
17h45-18h00	**Rodolfo Miranda (UAM, Spain)**
(page 53)	"IMDEA-Nano: A new Institute devoted to research in Nanoscience and Nanotechnology in Madrid"
18h00-20h00	***Poster Session / Coffee Break & Instrument Exhibition***
20h30	***Reception***

SCIENTIFIC PROGRAMME
Tuesday March 13, 2007

(Session: SPM / NanoMetrology)
Chairman: Emilio Prieto

09h00-09h50	**Paulo Samori (Universite Louis Pasteur, France)**
(page 17)	"Scanning Probe Microscopies beyond imaging: a journey into the nanoscale world"
09h50-10h40	**Hans-Ulrich Danzebrink (Physikalisch-Technische Bundesanstalt, Germany)**
(page 5)	"Dimensional Measurements at Nanoscale – Application of SFM for the Calibration of Dimensional and Analytical Standards"
10h40-11h00	**Jose Abad (Universidad de Murcia, Spain)**
(page 23)	"Structural and electrical properties of poly(3-octylthiophene) (P3OT) films: A scanning probe microscopy study"
11h00-12h00	***Poster Session / Coffee Break & Instrument Exhibition***
12h00-13h15	**Thematic Sessions - Part 1**
13h15-14h45	***Lunch***
14h45	***Bus departure to: "Sierra de Aracena" + Conference Dinner***

Programme Thematic Session Part 1 - Tuesday March 13, 2007
Molecular Electronics / Nanoelectronics

12h00-12h30	**Adrian Bachtold** (Centro Nacional de Microelectrónica)
(page 77)	"Mechanical detection of carbon nanotube resonator vibrations"
12h30-13h00	**Cristina Gomez Navarro** (Max Planck Institute for Solid State Research)
(page 105)	"Electronic transport of carbon nanotubes with induced defects"
13h00-13h15	**Fernando Langa** (Universidad Castilla La Mancha)
(page 111)	"Fullerene Based Molecules with low HOMO-LUMO gap"

Programme Thematic Session Part 1 - Tuesday March 13, 2007
Nanochemistry

12h00-12h30	**Tomas Torres** (Universidad Autónoma de Madrid)
(page 127)	"Towards phthalocyanine-based molecular materials"
12h30-13h00	**Concepció Rovira** (Instituto de Ciencias Materiales de Barcelona)
(page 121)	"Surface self-assembled monolayer of a multifunctional organic radical"
13h00-13h15	**José Mª Gallego** (Universidad Autónoma de Madrid)
(page 97)	"The nanoscale spider-web: A molecular self-assembly due to substrate-molecule interactions"

Programme Thematic Session Part 1 - Tuesday March 13, 2007
Nanobiotechnology / Nanomedicine

12h00-12h30	**Jesús Maria de la Fuente** (CICIC-CSIC)
(page 87)	"Glyconanotechnology: a methodology to prepare biofunctional nanoparticles with application in Nanomedicine"
12h30-12h45	**Neus Gómez Bastus** (Instituto Catalán de Nanotecnología)
(page 103)	"Rational Design of Inorganic Nanoparticle Conjugates for Biomedical Applications"
12h45-13h00	**Alejandro Pérez de Luque** (IFAPA-CICE)
(page 115)	"Localization of nanoparticles in plant tissues: potential use as smart delivery systems"

Programme Thematic Session Part 1 - Tuesday March 13, 2007
Nanofabrication

12h00-12h30	**José-Luís Prieto** (Universidad Politécnica de Madrid)
(page 119)	"Sub-10nm Nanolithography at the CT-ISOM"
12h30-12h45	**Alvaro Blanco** (ICMM-CSIC)
(page 79)	"Three Dimensional Polymeric Photonic Crystals"
12h45-13h00	**Celia Polop** (Universidad Autónoma de Madrid)
(page 117)	"Kinetic control in the surface assembly of one-dimensional coordination polymers"
13h00-13h15	**Xavier Cartoixa** (Universidad Autónoma de Barcelona)
(page 81)	"Novel approach to the fabrication of ordered arrays of quantum wires"

SCIENTIFIC PROGRAMME	
Wednesday March 14, 2007	
(Session: Nanomaterials) Chairman: Asuncion Fernandez	
09h00-09h50	**Rainer Hillenbrand (Max-Planck-Institut für Biochemie, Germany)**
(page 9)	"Scattering-type near-field microscopy: From nanoscale infrared material recognition to superlens studies"
09h50-10h10	**Rodolfo Miranda (UAM, Spain)**
(page 51)	"Quantum size effects in metallic nanostructures"
10h10-10h30	**Renaud Caillard (ICMM-CSIC, Spain)**
(page 27)	"Organic molecular nano-wires and nano-ladders"
10h30-10h50	**Antonio Garcia Martin (IMM-CSIC, Spain)**
(page 35)	"Ferromagnetic nanowire arrays: enhanced magneto-optics and size effects"
10h50-11h10	**Jose A. Sanchez Gil (IEM-CFMAC-CSIC, Spain)**
(page 71)	"Surface plasmon photonics on metallic nanostructures: SERS substrates and nano-antennas"
11h10-11h30	**Jordi Faraudo (UAB, Spain)**
(page 31)	"Discontinuous transitions in nanostructured liquid/liquid interfaces: Computer Simulation studies"
11h30-12h00	***Poster Session / Coffee Break & Instrument Exhibition***
(Session: Nanoelectronics / Molecular Electronics) Chairman: Fernando Briones	
12h00-12h20	**Gabino Rubio-Bolliger (UAM, Spain)**
(page 69)	"Electronic Transport and Mechanical Properties of suspended atomic chains of gold"
12h20-12h40	**Jia Grace Lu (University of Southern California, USA)**
(page 41)	"Nanoscale Electronics and Sensors Built on Semiconducting Nanowires"
12h40-13h00	**Santos Merino (Tekniker, Spain)**
(page 49)	"A new way of manufacturing high resolution optical encoders by Nanoimprint Lithography"
13h00-13h30	**Flash Contributions – Part 1**
13h30-15h30	***Lunch***
15h30-17h00	**Thematic Sessions – Part 2**
17h00-17h30	**Flash Contributions – Part 2**
17h30-20h00	***Poster Session / Coffee Break & Instrument Exhibition***
20h30	***Reception***

Poster Flash Contributions Part 1 - Wednesday March 14, 2007: 13h00-13h30		
Ana Borras (ICMSE-CSIC, Spain)	**Nanomaterials**	"Growth at low temperatures of Ag@TiO2 nano-fibers by plasma deposition"
Jose Gonzalo (IO-CFMAC-CSIC, Spain)	**Nanomaterials**	"Self-organized oriented Ag nanocolumns: Structure and optical properties"
Marisol Martin (IMM-CNM-CSIC, Spain)	**Nanomaterials**	“Porous alumina in the control of position and shape of nanostructures”
Virginia Ruiz (University of Burgos, Spain)	**Nanomaterials**	"A multiresponse approach to the study of electrochemical processes in nanostructured materials"
Estefania Guerrero (ICMSE-CSIC, Spain)	**Nanomaterials**	"Preparation and characterisation of thiol- and phosphine functionalised gold clusters and nanoparticles: An X-ray absorption spectroscopy study"

Poster Flash Contributions Part 2 - Wednesday March 14, 2007: 17h00-17h30		
Jose Maria de Teresa (UNIZAR, Spain)	**Nanoelectronics**	"Magnetoresistance and Hall effect of Fe3O4 thin films on MgO substrates"
Aritz Retolasa (TEKNIKER, Spain)	**Nanoelectronics**	"The use of automatic demolding in nanoimprint lithography processes"
Javier Mendez (ICMM-CSIC, Spain)	**SPM**	"Manipulation of Organic Nanostructures by field gradient diffusion induced with STM"
Celia Rogero (INTA, Spain)	**SPM**	"Self-organized submonolayers of S-cysteine on Au(111)"
Luis Fernandez Barquin (UNICAN, Spain)	**Nanomagnetism**	"Neutron spin-echo evidence of inter-particle spin correlations of Fe(Cu) nanoparticles in a Ag matrix"

Programme Thematic Session Part 2 - Wednesday March 14, 2007 Molecular Electronics / Nanoelectronics	
15h30-16h00	**Marivi Fernandez-Serra** (CECAM - ENS Lyon)
(page 95)	"Conductance, surface traps and passivation in doped silicon nanowires"
16h00-16h15	**Eduardo Castro** (Universidade do Porto)
(page 83)	"Biased graphene bilayer: a tunable gap semiconductor"
16h15-16h30	**Luis Fernandez Barquin** (Universidad de Cantabria)
(page 93)	"Neutron spin-echo evidence of inter-particle spin correlations of Fe(Cu) nanoparticles in a Ag matrix"
16h30-16h45	**Teresa Gonzalez** (Universität Basel)
(page 107)	"Understanding conductance histograms of single molecular junctions"
16h45-17h00	**Discussion and concluding remarks**

Programme Thematic Session Part 2 - Wednesday March 14, 2007 Nanochemistry	
15h30-16h00	**Abderrazzak Douhal** (Universidad Castilla La Mancha)
(page 89)	"Ultrafast Dynamics within Nanocavities and Nanochannels"
16h00-16h15	**Fernando Langa** (Universidad Castilla La Mancha)
(page 109)	"Efficient Photoinduced Electron Transfer in Fullerene Based Molecular Wires"
16h15-16h30	**Isabel Sole Font** (IIQAB - CSIC)
(page 125)	"Nano-emulsion formation in ionic surfactant systems by the phase inversion composition method (PIC): optimization through an experimental design"
16h30-16h45	**Catalina Ruiz** (Universidad La Laguna)
(page 123)	"Influence of the substituent in the crystal packing of copper(II) malonates"
16h45-17h00	**Discussion and concluding remarks**

Programme Thematic Session Part 2 - Wednesday March 14, 2007 Industrial - Creation of technology-based start ups	
15h30-15h50	**Javier Garcia Diez** (AENOR, Spain)
(page 99)	Title to be defined
15h50-16h10	**Carles Escolano** (Willems & van den Wildenberg, Spain)
(page 91)	"Creation of technology-based start ups"
16h10-16h20	**Juan Castro** (CSIC-OTT, Spain)
(page 83)	Title to be defined
16h20-16h30	**Wolfgang Maser** (Nanozar, Spain)
(page 113)	"Influence of the substituent in the crystal packing of copper(II) malonates"
16h30-16h50	**Adriana Gil** (Nanotec, Spain)
(page 101)	"Nanotec: an experience from the university lab to the nanotechnology market"
16h50-17h10	**Luis Mª Alonso** (Nanogap, Spain)
(page 75)	"The importance of the spin-offs on Spanish universities"
17h10-17h30	**Discussion and concluding remarks**

Programme Thematic Session Part 2 - Wednesday March 14, 2007 Nanofabrication	
15h30-17h00	**Discussion and concluding remarks**

Programme Thematic Session Part 2 - Wednesday March 14, 2007 Nanobiotechnology / Nanomedicine	
15h30-17h00	**Discussion and concluding remarks**

SCIENTIFIC PROGRAMME	
Thursday March 15, 2006	
(Session: Nanotubes) **Chairman: Arturo Dominguez**	
09h00-09h50	**Maurizio Prato (Universita' di Trieste, Italy)**
(page 13)	"Carbon Nanotechnology: Organic Functionalization and Applications"
09h50-10h10	**Edgar Muñoz (ICB-CSIC, Spain)**
(page 55)	"Multifunctional carbon nanotube/polymer composite fibers"
10h10-10h30	**Maria Jose Esplandiu (UAB, Spain)**
(page 29)	"Counting and manipulating single electrons in a Au nanoparticle using a carbon nanotube transistor"
10h30-10h50	**Maria Carmen Gordillo (Universidad Pablo de Olavide, Spain)**
(page 37)	"Effects of the existence of vacancies in the adsorption of quantum gases in the interchannels of a bundle of carbon nanotubes"
10h50-11h10	**Alicia Maroto (Rovira i Virgilii University, Spain)**
(page 45)	"Detection of Salmonella with carbon nanotube field effect transistors"
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(Session: Nanochemistry) **Chairman: Jaume Veciana**	
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(page 57)	"Synthesis and Electrochemical Characterization of Catalytic Activity of Polymer Stabilized Pt and Pt@Cu Core-shell Nanoparticles"
12h10-12h30	**Rebeca Marcilla (CIDETEC, Spain)**
(page 43)	"Applications of functional and polymeric ionic liquids in nanotechnology"
12h30-12h50	**Roberto Otero (UAM, Spain)**
(page 59)	"Organic Donor/Acceptor Mixed Thin Films Segregate into Nanoscale Interdigitated Areas on Au (111): Towards an Optimum Solar Cell Heterojunction Morphology."
12h50-13h40	**Fabio Biscarini (CNR-Istituto per lo Studio dei Materiali Nanostrutturati (ISMN), Italy)**
(page 3)	"Functional Nanostructures and Devices of Self-organising Multifunctional Materials"
13h40-13h45	**Concluding Remarks / NanoSpain2008 announcement**

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KEYNOTE CONTRIBUTIONS

FUNCTIONAL NANOSTRUCTURES AND DEVICES OF SELF-ORGANISING MULTIFUNCTIONAL MATERIALS

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Abstract

Multifunctional materials, designed for electronic and optical properties, recognition and sensing, actuation, can be patterned into arrays of lines and dots by exploiting self-organisation in confined environments defined by an external agency, either a stamp, nanofluidic channel, or a nanofabricated template. In this manner, it is possible to fabricate memory storage elements, field effect transistors, sensors where the active component is made of nanostructures exactly defined in terms of size, shape and position (Fig.1). The control on the smaller length scales is intrinsic to the self-organisation process, whereas the larger length scales are imposed by the external agency. A variety of examples of materials (polymeric and organic semiconductors, liquid crystals, rotaxanes, coordination compounds and clusters, CNTs), fabrication approaches and devices will be presented as a contribution to the development of a technological platform for multifunctional materials. Finally, I will discuss our recent work aimed to integrate biomolecules (Fig. 2) and cells (Fig. 3) with organic semiconductors, towards the development of a new class of organic electronic transducers of biological phenomena in vitro.

I would like to acknowledge my collaborators: M. Cavallini, C. Dionigi, P. Stoliar, E. Bystrenovà, C. Albonetti, A. Lazar, S. Milita, M. G. Cacace in CNR-ISMN; F. Zerbetto and A. Brillante, Univ. of Bologna; C. Martini and I. Tonazzini, Univ. of Pisa; E. Madarasz and M. Jelitai, Inst. Exp. Medicine Budapest; D. de Leeuw, Philips Research Labs; Y. Geerts, Univ. Libre de Bruxelles; R. Lazzaroni, Univ. Mons-Hainaut; D. Leigh, Univ. of Edinburgh; K. Muellen, MPI Mainz; R. Garcia CSIC IMM Madrid and J. Veciana CSIC-ICMAB Barcelona.

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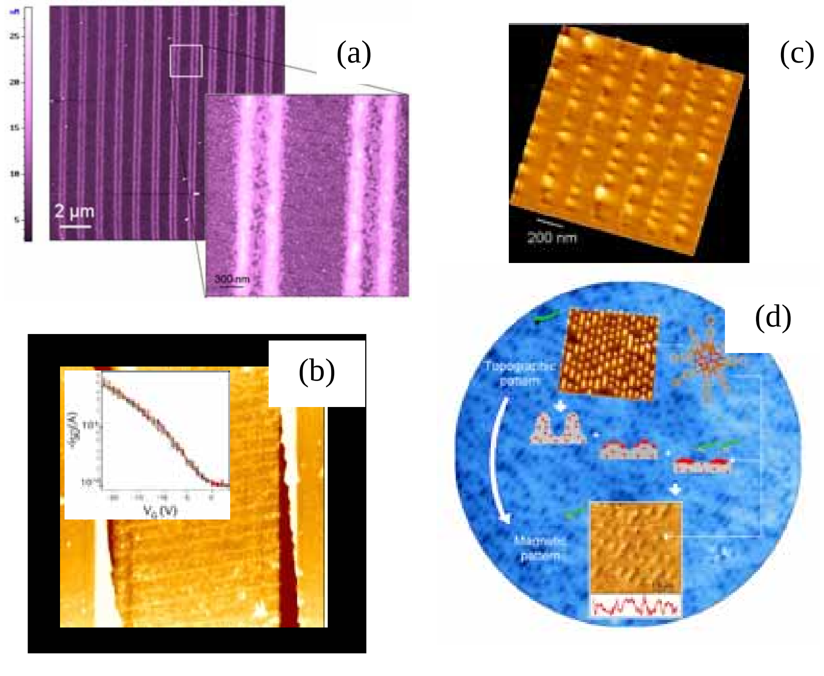

Fig. 1: Examples of self-organised patterns and devices:
(a) two monolayer high stripes by lithographically-controlled wetting of terthiophene-bisfluorene (T3F2) on silicon oxide;
(b) FET working with self-organised stripes of T3F2;
(c) array of benzylic amide rotaxane nanodots by AFM-triggered self-organisation;
(d) patterns of Mn_{12} single molecule magnets on polymer film surfaces.

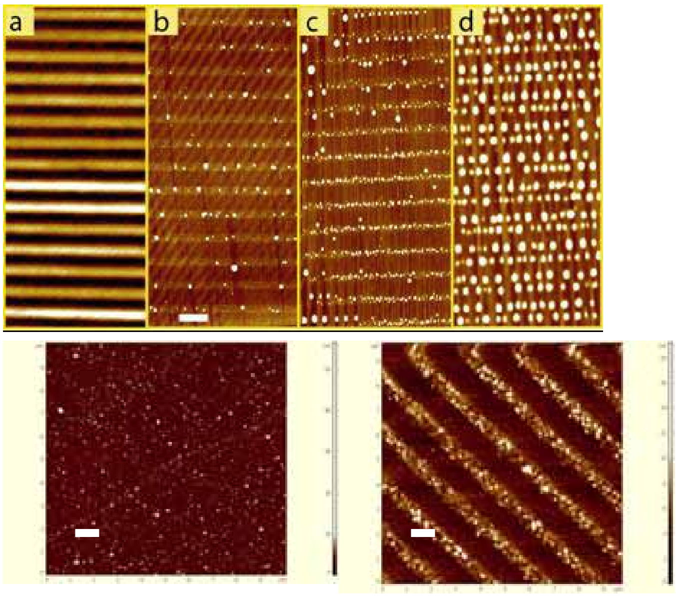

Fig. 2: Controlled deposition of biological molecules in microfluidics conditions:
(top) sequence of lambda-DNA aggregates on mica obtained by varying the DNA concentration for the same buffer concentration;
(bottom) left, aggregation of b-amyloid 1-40 peptide deposited on silicon oxide at pH7 from 12.5 mg/ml water solution; right, same in mesoscopic channels.

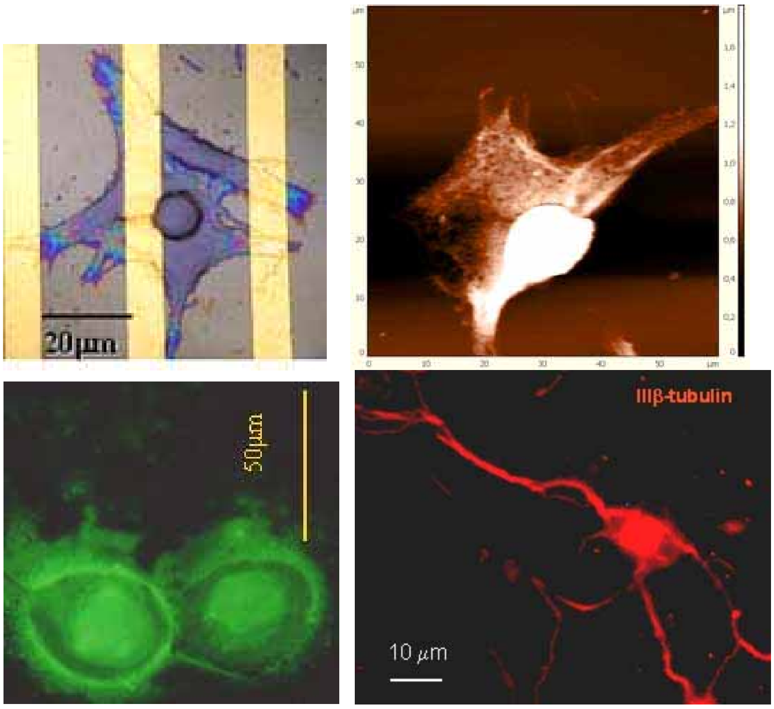

Fig.3: Optical micrograph, AFM in liquid and fluorescence microscopy images obtained on astrocytoma and neural cells grown on organic ultra-thin films.

DIMENSIONAL MEASUREMENTS AT NANOSCALE – APPLICATION OF SFM FOR THE CALIBRATION OF DIMENSIONAL AND ANALYTICAL STANDARDS

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Introduction

Nanotechnology is coming together of material and dimension at nanometre scale. Here the material can or may show properties which are not observed at atomic scale or in bulk materials. To achieve knowledge about its properties it is mandatory to investigate geometrical as well as analytical properties in the nanometre range. A tool to investigate dimensional properties is the scanning probe microscope. The capability to investigate surfaces with unprecedented resolution introduced a large variety of techniques using probes that exploit different tip-sample interactions in order to probe sample properties. On the other side the dimension is only one part of nanoparticels. Analytical instruments are necessary to resolve elemental properties at nanometre scale. Such surface analytical techniques are XPS, AES, ESCA, etc. But it is necessary to test the resolution of such instruments.

Scanning Force Microscopy and its Properties

SPMs have become important for the measurement of small structures in dimensional metrology [1], like e.g. pitch, step height, particle diameter, line width, roughness, hardness and nano-indentation, as these techniques achieve high spatial resolution. The uncertainties for step height and pitch measurements are now in the sub-nanometre and picometre range, respectively [2]. The main contributions to the uncertainty are still due to some properties of the scanning and positioning apparatus. However, on the nanometre scale, effects due to the tip shape or tip wear together with interaction forces between tip and sample, that cause elastic or plastic deformations of tip and sample, have to be taken into account. For scanning probe microscopes the fine tip is crucial to the spatial resolution of structures on the sample, but it must be accepted that this tip is naturally not infinitely fine. Thus the geometry and the physical characteristics of the probe together with the interaction between probe and sample are of substantial importance for the measurement. For dimensional metrology within the range of atomic dimensions, knowledge of tip sample interactions is therefore essential for accurate dimensional metrology.

Novel Standards for Dimensional Calibration

For dimensional calibration e. g. of Scanning Probe Microscopes (SPM), a novel 3D standard has been developed by BAM and PTB [3], which uses sub-microscopic features as nanometre-sized landmarks. Unlike step height and lateral standards already established, this new method allows a complete 3D calibration with just one type of standard, i. e. the coupling of all three axes can be determined easily and automatically corrected. This novel 3D standard has proven to be well suited also for other high-resolution microscopy techniques.

Novel Standards for Analytical Instruments

Standards for the calibration, beam alignment & resolution determination of spatial-analytical instruments such as Energy Dispersive X-Ray Spectroscopy (EDX), X-ray Photoelectron-Spectroscopy (XPS), Secondary Ion Mass Spectrometers (SIMS) and Auger Electron Spectroscopy (AES) should show clear material contrasts while being topography-free. Two different concepts have been realized at PTB and BAM with success:

Firstly, a system of alternating layers of well-defined thicknesses in the range from a few nm to several hundred nm has been deposited by MOVPE, which is then cleaved so that a 1D stripe pattern becomes accessible [4]. Special polishing techniques ensure that the cleavage face is topographically flat.

Secondly, 2D analytical standards have been fabricated by placing patterns of well-defined geometry and size consisting of metal Au in Ag matrix. While AFM is used to check to what extend these samples are really topography-free and to calibrate their lateral scales, these standards are now used by AES and XPS manufactures as high-resolution reference samples.

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MAGNETORESISTIVE BIOSENSOR PLATFORMS

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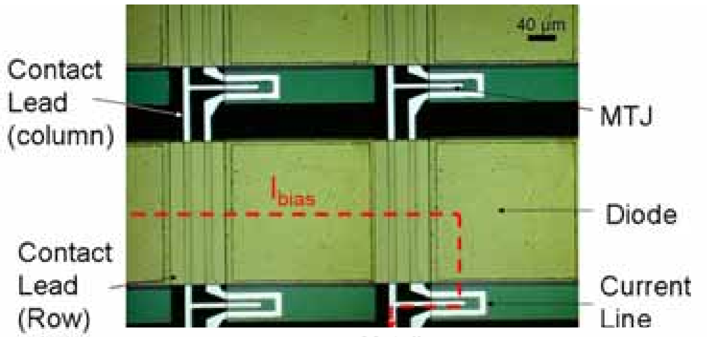
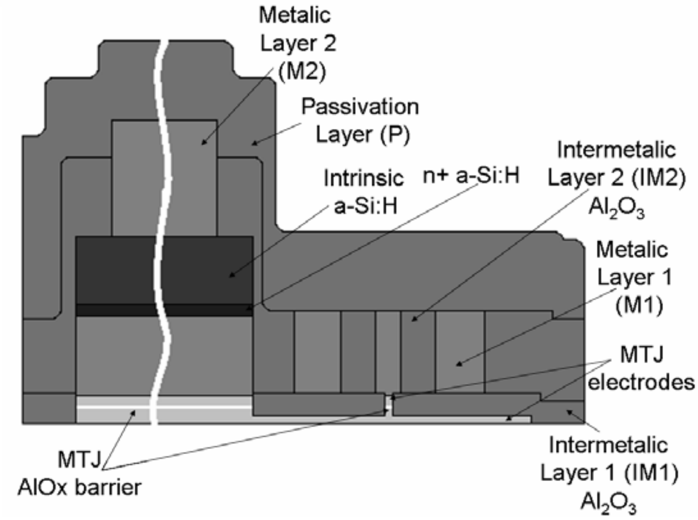
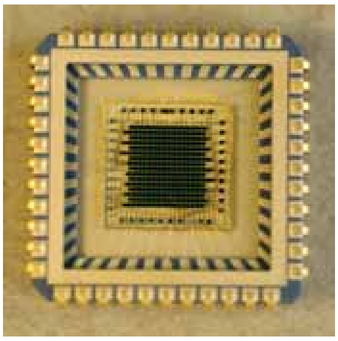
Magnetoresistive based biosensor platforms are being developed to address DNA-cDNA biomolecular recognition events (gene chips) and to detect antibody-antigen binding (protein or cell-chips). Examples in our lab include cystic fibrosis gene mutation or SNIP detection, Salmonella or e-Coli detection in water, Stem cell separation and differentiation. In these bioassays, biomolecular probes are immobilized over the sensing sites on the chip, and magnetically labeled biomolecular targets are driven over the immobilized probes. Magnetic nanoparticles are used as labels (50nm up to 2.8um in diameter). The present sensor generation includes either 24 sensing sites using spin valve sensors, or 256 sensing sites in a matrix, where each matrix element includes a thin film diode and a magnetic tunnel junction. The sensor dynamic range (number of labels detected) and the sensor ultimate resolution (minimum number of labels of a certain dimension that can be detected) depend on the application. Typically with 250nm magnetite labels, sensor width up to 100um2 active areas are sensitive to a single label and can detect up to few thousand labels. Improving sensor performance by changing from spin valves to MgO based magnetic tunnel junctions leads to a sensitivity increase of a factor of 20, meaning that smaller labels (few nm in diameter) will become measurable. S/N ratio issues will be addressed. An integrated system incorporating the hybridation detection platform, the microfluidics assaying chamber, and the electronics control board has been fabricated. This portable biodetector kit, than conveys all assay information to a PDA. Finally, other spintronic biomedical applications will be discussed, such as cell separation platforms, and hybrid sensors for biomedical imaging applications.



4th generation INESC MR biochip
256 TFD-MTJ matrix





Caption: 4th generation INESC MN MR biochip. A 256 probe matrix having at each probe site a thin film diode and a magnetic tunnel junction.

SCATTERING-TYPE NEAR-FIELD MICROSCOPY: FROM NANOSCALE INFRARED MATERIAL RECOGNITION TO SUPERLENS STUDIES

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The development of novel nanoelectronic and photonic structures requires ultrahigh-resolution optical microscopy for characterization and mapping of local material properties and nanoscale confined light fields. I will demonstrate such an optical microscopy technique providing a spatial resolution of about 10-20nm independent of the wavelength. It is based on elastic light scattering from the probing tip of an atomic force microscope (scattering-type near-field optical microscopy, s-SNOM [1]). Besides a short introduction of the technique, I will give an overview on infrared s-SNOM applications in material sciences [2-4], nanoparticle imaging [5,6] and subwavelength-scale photonics [7].

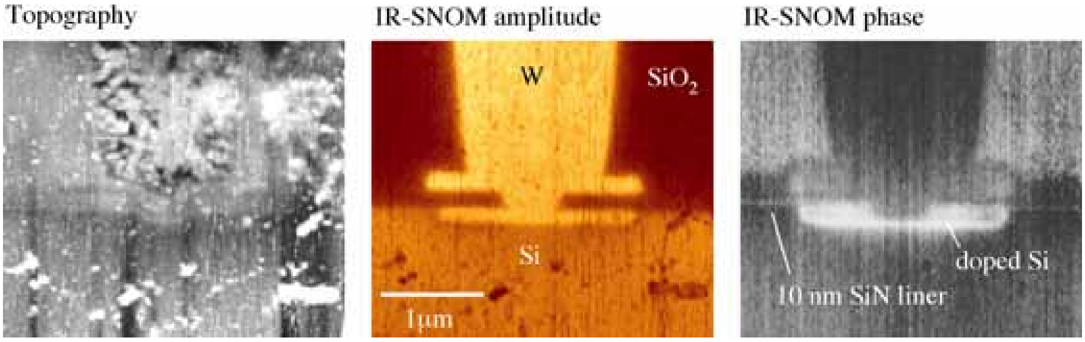

Fig. 1: Example of infrared s-SNOM application: Nanoscale mapping of different materials and electron concentrations in a cross section of a MOS-transistor drain contact at 930 cm^{-1}. Pseudoheterodyne detection yields infrared amplitude and phase images simultaneously to topography.

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DECOHERENCE CROSSOVERS IN MOLECULAR MAGNETIC QUBITS WITH *TUNABLE* QUANTUM TUNNELING RATES

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Decoherence in the low-temperature (< 0.5 K) quantum tunneling regime of molecular magnetic qubits such as Fe_8 or Mn_{12}-ac, arises primarily from entanglement of the molecular cluster spins with environmental nuclear spins**[1,2]** on the magnetic atoms and the surrounding ligands. The hyperfine coupling to these localized modes, the ***"nuclear spin-bath"***, involves intriguing novel decoherence mechanisms, such as ***topological and precessional decoherence***, differing fundamentally from traditional ***oscillator-bath-controlled decoherence***[2]. In addition, it leads to a fully unexpected new mechanism of quantum relaxation by ***nuclear-spin-mediated-tunneling***[1] (NSMT), in which the intrinsic dynamics of the nuclear spin bath is able to bring the tunneling levels of the cluster spins temporally into resonance, in spite of the very small quantum tunneling splittings $\Delta_o/k_B \approx 10^{-7}$ K of the magnetic ground doublet. This value is six orders of magnitude smaller than the bias fields acting on these doublet levels, arising from the hyperfine interaction itself and from the intercluster dipolar coupling between spins on neighboring clusters. Recent magnetization**[3,4]**, specific heat**[5,6]** and NMR**[7]** experiments on Fe_8 or Mn_{12}-ac have confirmed the occurrence of NSMT, and also evidenced the quantum-classical crossover that is found when, with increasing temperature, one enters the classical thermal activation regime (> 1K), where phonon-assisted tunneling processes through excited levels control the spin dynamics.

In addition another unique and unparalleled type of crossover is offered by these molecular magnetic qubits through the possibility of ***continuously tuning*** the Δ_o by applying a transverse magnetic field, $B_\perp$. Since Δ_o varies as $\sim (B_\perp)^{2S}$, with S the cluster spin (S=10), a moderate $B_\perp$ of a few T can already increase Δ_o/k_B to 0.1 – 1 K, thus exceeding the hyperfine- and intercluster biases. Applying such a field is thus predicted**[8]** to lead to a ***"decoherence crossover"***, from fully incoherent NSMT at small Δ_o, to coherent tunneling with ***spin-bath-controlled decoherence*** for $\Delta_o/k_B \geq 0.1$ K. For still larger Δ_o, the increasing coupling to phonons leads back to fully incoherent tunneling, this time however through ***oscillator-bath-controlled decoherence***. Thus an optimum field regime can be found where decoherence is at a minimum. On basis of the known spin-Hamiltonian parameters for Fe_8 and Mn12-ac, one may estimate this optimum to be reached around $\Delta_o/k_B \approx 0.2$ K, corresponding to $B_\perp \approx 3\text{-}4$ T and $B_\perp \approx 7$ T for, respectively, Fe_8 and for Mn12-ac.

As expected, NMR can probe ***locally*** the dynamics of ***both*** the nuclear and electronic spins involved in the above processes, the nuclear relaxation being directly related to the fluctuations of the electronic (cluster) spins arising from tunneling and/or thermal activation. In addition, time-dependent magnetization and specific heat studies have clearly demonstrated the role of the electron spin-phonon coupling. We shall review the relevant experimental data and show how these nicely confirm (and sometimes extend!) the above-mentioned theoretical predictions.

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CARBON NANOTECHNOLOGY: ORGANIC FUNCTIONALIZATION AND APPLICATIONS

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Carbon nanotubes (CNT) have generated great expectations due to their electronic and mechanical properties. However, high molecular weights and strong hydrophobic forces keep CNT together in bundles, making their manipulation, characterization and analytical investigation very difficult. The organic functionalization offers the great advantage of producing soluble and easy-to-handle CNT. Within this contribution, we will review our most recent achievements in the field of synthesis of functionalized carbon nanotubes and their applications in materials science and medicinal chemistry. Not only can CNT function as useful components in photovoltaic devices, but they are excellent carriers for drug delivery and ideal substrates for neuronal growth.

MAGNETORESISTIVE SENSORS AND MAGNETIC NANOPARTICLES FOR BIOTECHNOLOGY

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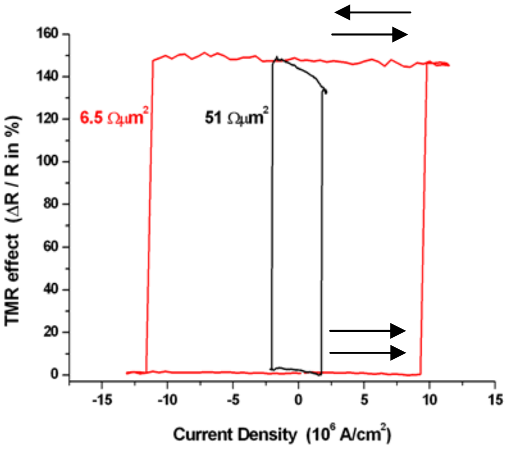
The detection as well as the manipulation of single molecules on a common technological platform is of great interest for both basic research on biological or chemical systems as well as for applications in, e.g., antibody detection. A promising approach is the detection of small magnetic carriers[1] with the newly developed magnetoresistive sensors which would be capable of creating a completely electronic measurement system[2]. Moreover, this system would be addtionally compatibel with an important development in microelectronics, namely the so called MRAM. Both the principles of the measurement technique as well as new achievements in the preparation of magnetic carriers are demonstrated.

It is shown that paramagnetic beads can be detected by highly sensitive magnetoresistive sensors yielding a purely electronic signal. New materials like magnetic Heusler alloys and MgO tunneling barriers have recently increased the potential capabilities of these sensors dramatically. Even the magnetic switching by direct spin transfer from the current running through the devices seems now applicable, avoiding problems with downscaling and power consumption (fig.1).

Figure 1: Dependence of the resistance of magnetic tunneling cells on the density of current pulses applied prior to the resistance measurement at 19mV bias voltage.
The two curves are for extremely low (red) resistive and medium resistive (black) tunneling cells with MgO barriers[3].
The high resistance state corresponds to antiparallel and the low resistance state to parallel alignement of the magnetization of the ferromagnetic electrodes (indicated by arrows).



Besides the use of such devices in storage or logic microelectronic circuits, they can measure magnetic fields with a high sensitivity. In particular, stray fields arising from magnetic markers from biomolecules and thereby the molecules themselves can be detected[2]. Different configurations are discussed and the results for Giant Magnetoresistance sensors are compared to an analysis of the same biological systems marked with fluorescence dyes. This shows, that down to a conentration of about 10 pg/µl of, e.g., DNA molecules, the magnetoresistive technique is competitive to nowadays standard analysis methods. The capability of the Tunneling Magnetoresistance sensors to detect even single markers is additionally demonstrated.

The magnetic carriers detected by the sensors are mostly paramagnetic magnetite beads embedded in a polymer matrix with sizes from some µm down to about 100nm. They are linked to, e.g., DNA or proteins (often by a avidin-biotin bond) and thereby enable highly specific detection of complementary molecules. These magnetic particles often suffer from their broad size distribution and the relatively small magnetic moment. With the new colloidal synthesis of superparamagnetic or ferromagnetic Co, CoFe and FePt nanocrystals by, e.g., pyrolythic decomposition of CVD precursor molecules, magnetic markers with superior magnetic moments, smaller size and size distribution can be produced[1]. Here, the question about their potential to replace magnetite is addressed. Starting from a magnetic analysis of the corresponding magnetophoretic mobility of Co and FeCo based alloys their synthesis and resulting microstructural and magnetic properties as function of the underlying particle size distribution and the stability of the oleic acid ligand are discussed.

Moreover, the magnetic particles offer an additional feature: They can be manipulated on chip via magnetic field gradients running through specially designed line patterns[4]. If additionally a microfluidic environment is used for transportation, even the separation of different species within one fluid seems possible[5] (fig. 2)

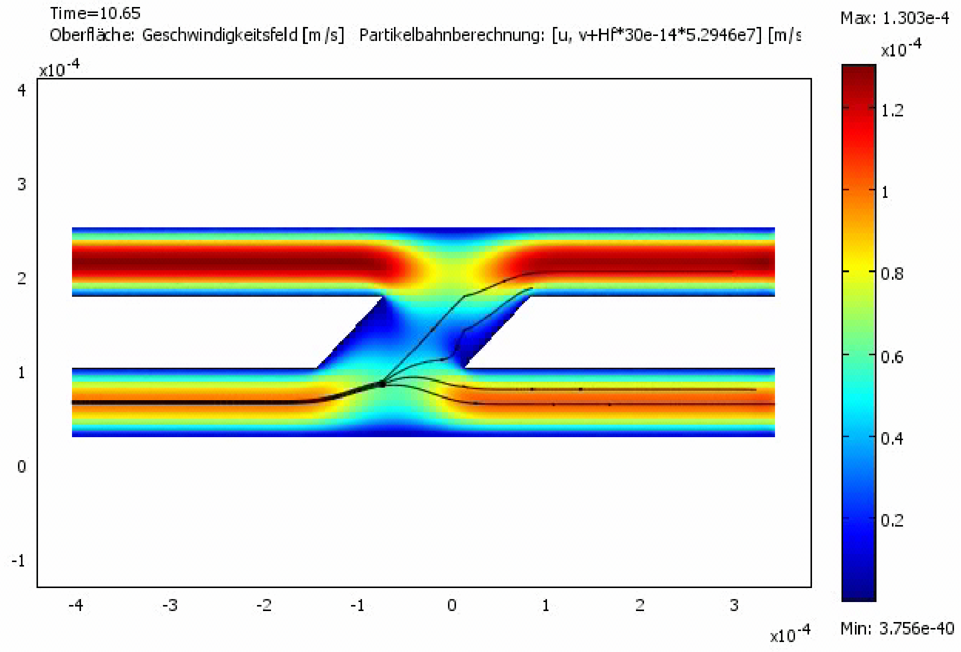


Figure 2: Two micofluidic channels with different flow velocities (color bar) connected by a small bridge with a magnetic gradient field. The traces of the particles are shown as black lines. The gradients of the flow velocity and the magnetic field separate the particles coming from the left side into small particles in the lower and large ones in the upper channel.

We show, that this manipulation can be performed in a precise and reproducible manner, enabling locally enhanced concentration or even the measurement of binding forces with very low loading rates.

Thus, magnetic markers in combination with magnetoresistive sensors are a promising choice for future integrated lab-on-a-chip Systems.

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SCANNING PROBE MICROSCOPIES BEYOND IMAGING: A JOURNEY INTO THE NANOSCALE WORLD

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Scanning Probe Microscopies (SPMs) are unique tools which make it possible to unravel different physico-chemical properties of supramolecular architectures across multiple length scales, thus they can provide crucial information for the optimization of multifunctional materials for nanotechnology.

My lecture will review recent progress in the use of SPMs beyond imaging on soft materials,[1] with a particular emphasis on the Atomic Force Microscopy studies of mechanical properties of isolated polymer chains rigidified by non-covalent interactions.[2] In addition Kelvin Probe Force Microscopy [3] investigations were carried out in order to explore the (dynamic) electronic properties of single [4] and multi-component functional nanostructures, such as photovoltaic blends. [5] On the other hand, Scanning Tunnelling Microscopy (STM) provided direct insight into the perturbation of the electronic states of molecules adsorbed at surfaces. Detailed understanding on the contrast in sub-molecularly resolved STM images of a monolayer of an azatriphenylene derivative physisorbed on graphite was accomplished relying on the assistance of quantum chemical calculations.[6] I will also present a strategy to fabricate prototypes of mechano-chemical switches triggered by light irradiation: Significantly, the photochemical switching of a new terminally thiolated azobiphenyl rigid rod, forming a single component SAM on metallic surfaces, was found by STM to be complete over a molecular 2D crystal and to operate according to a domino-effect. [7]

Furthermore, the processing of nanomaterials with non-conventional protocols to obtain ordered multifunctional architectures is of key technological relevance. I will introduce three approaches we recently developed in our lab. First, millimetre long crystalline fibers of an organic semiconductor, i.e. perylene-bis-dicarboximide (PDI), were formed using solution processing assisted by solvent vapour annealing post-treatments to foster long-range molecular re-organization on surfaces. This versatile, cooperative and reversible self-assembly was found to comply with an Avrami type nucleation governed growth. The millimetre long fibers revealed a ten-fold increase in conductivity if compared to the pristine PDI thin layer [8]. Second, electrophoretic approaches were successfully employed to nanomanipulate, on a pre-patterned surface, supramolecularly engineered nanofibers pre-programmed to possess an intrinsic high dipole moment.[9] Third, we devised a new general approach to process giant (macro)molecules into ultra-pure and highly ordered structures at surfaces, which relies on the soft-landing of ions generated by solvent-free matrix assisted laser desorption/ionization (MALDI). [10]

Overall, the possibility to develop ultra-pure, well-defined and highly ordered functional supramolecular architectures, combined with the ability of SPM to visualize and manipulate nano-objects on the sub-molecular scale, opens new exciting avenues for the exploration and optimization of smart materials, which may be of interest for the fabrication of future organic electronic nanodevices and sensors.

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FROM LAB ON A CHIP TO A LAB-IN-A-CELL

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Over the past 15 years, the concept of Lab on a Chip (LOC) has been developed to a great level of maturity. These microfluidics systems are nowadays employed in a variety of applications in physics, analytical chemistry, medical applications and recently more and more in biological ones. We will show that there is an increasing interest in experiments with single cells, and it will be shown that there are great opportunities for doing so.

In this presentation, first an example will be given of a LOC for the analysis of lithium, a drug frequently used by manic-depressive patients, in whole blood [1]. Subsequently, we will present a sensor system for the monitoring of cultivation parameters such as temperature, oxygen content, pH and cell growth. This system is intended to be used for monitoring of micro-cell cultures, and is compatible with the standard 96 well-plate format [2]. An another example, a million-chamber Petri-dish will be shown for cultivation of bacterial cultures [3].

In a following example, a microfluidic cell trap enabling time-lapse experiments with U937 cells undergoing apoptosis studied with confocal microscopy [4]. The use of chemically modified Qdots is shown for photo-stable cell-imaging of the same apoptotic process [5]. This is particularly important if long time-lapse experiments are carried out, that would normally suffer from bleaching of conventional fluorescent probes.

Finally, a cell-trap chip is shown for gene transfection into individual cells using electroporation. More specifically, the transfection of the GFP-ERK1 construct and subsequent translocation from the cytosol to the nucleus of human mesenchymal stem cells under influence of external bFGF signals is demonstrated [6]. The last example demonstrates that there is an important future role for experimentation with single cells on a chip, or using the cell as experimentation space in a new paradigm: the Lab-in-a-Cell.

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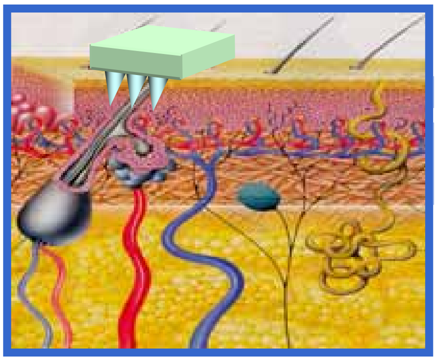

Fig. 1 Schematic presentation of microneedle array sampling blood for lithium analysis.

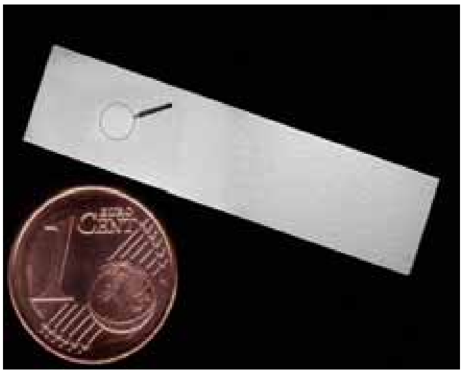

Fig. 2. Picture of the anapore substrate, subdivided in > 1 million, 7x7 um cultivation chambers.

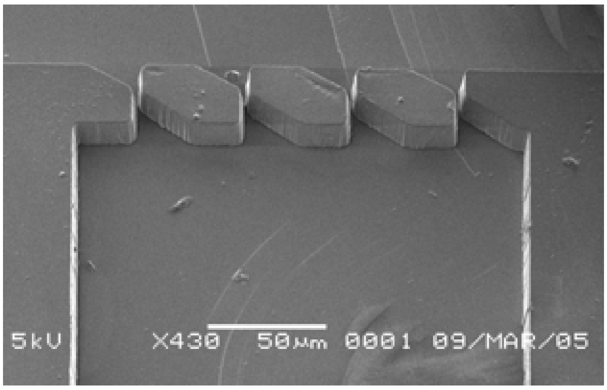

Fig.3. Microfabricated cell trap for time-lapse analysis of apoptosis induced in suspension cells.

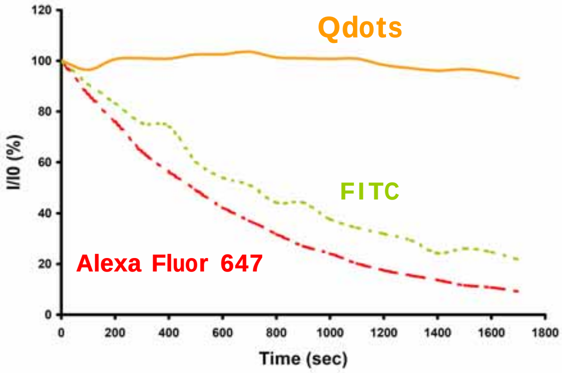

Fig. 4.Intensity vs. time curves for Qdot probes (orange) and two fluorescence probes.

ORAL CONTRIBUTIONS

STRUCTURAL AND ELECTRICAL PROPERTIES OF POLY(3-OCTYLTHIOPHENE) (P3OT) FILMS: A SCANNING PROBE MICROSCOPY STUDY.

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Poly-(3-octylthiophene) (P3OT) is one of the most promising materials for applications in organic opto-electronic devices like field-effect transistors, light-emitting diodes or solar cells [1-3]. In the present work we find that P3OT thin films (50-500 nm) present a very rich nanostructure which is studied by scanning force microscopy techniques. From a morphological point of view, self-assembled lamellar structures are formed on the surface of the films, theirs morphologies are very rich depending on the polymer films growth conditions (drop casting or spin coating).

Kelvin force microscopy is applied to study the electrical properties of the films under different working conditions, in particular under light illumination and while an electrical current is passing through the thin film. We find that, on the lamellar structures, different surface potential domains are clearly distinguished by Kelvin force microscopy.

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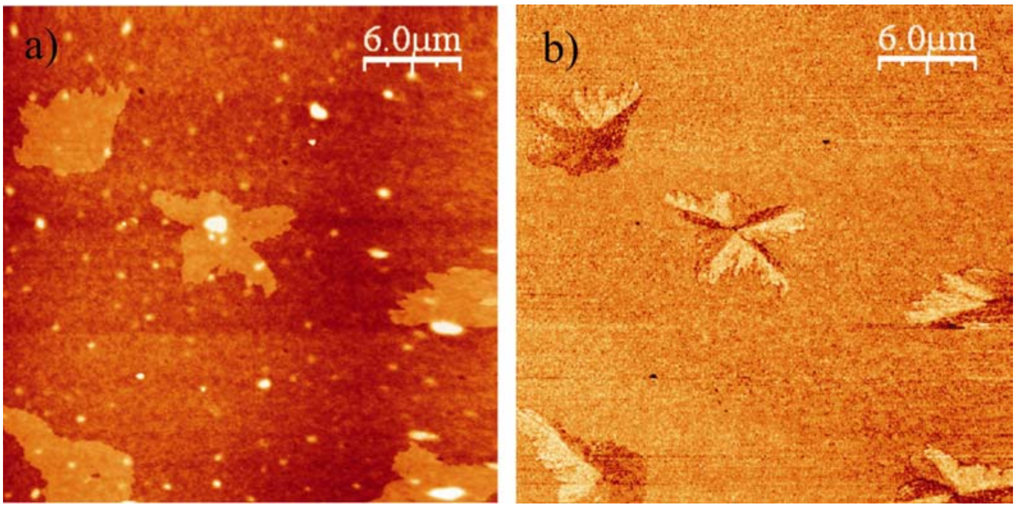

Figure: (a) Topographic and (b) KPM images of P3OT lamellar structures.

Fe_3O_4 NANOPARTICLES WITH BULK MAGNETIC PROPERTIES

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Magnetic nanoparticles [1] have attracted much research over the recent years due to their potential interest in a variety of biomedical applications [2]. Uniform magnetite Fe_3O_4 nanoparticles of 6, 10 and 17 nm in diameter were synthesised by thermal decomposition at high temperature of an iron organic precursor in an organic medium [3]. Oleic acid was used as surfactant in all cases and the organic solvent was chosen in each case so as to maximise size and shape uniformity. The particles, as revealed by transmission electron microscopy, are very uniform in size, with polydispersion below 20%, and x-ray patterns show that they consist of highly crystalline particles with an inverse spinel structure and lattice parameters similar to those of magnetite. Surprisingly enough, for all samples studied, saturation magnetization $M_s \approx 82$ emu/g almost reaches the expected value for bulk magnetite at low temperature, in contrast to results in small particle systems for which M_s is usually much smaller due to surface spin disorder (for example, $M_s \approx 50$ emu/g for 4 nm particles in [4]). The coercive field for the 6 nm particles is also in close agreement with that of bulk magnetite (175-210 Oe). Both results suggest that the oleic acid molecules covalently bonded to the nanoparticle surface yield a strong reduction in the surface spin disorder, such that the new O^{2-} surface ligands partially reconstruct the crystal field of the surface Fe cations, as suggested by x-ray photoelectron spectroscopy in the Fe 2p, 3p and 3s, and O 1s core levels. These findings may be of relevance in biomedical applications since they may reduce the strength of the magnetic field required to obtain a high value of the magnetisation and they open the question of whether M_s above the bulk value may be obtained by taking advantage of the orbital contribution to the magnetic moment, for example, due to the interplay of the surface cations in the particles and the ligands in the surfactant. XMCD experiments are currently in progress in order to ascertain the nature of the magnetic moments in the particles.

Work funded by Spanish NAN2004-08805-CO4-02 and NAN2004-08805-CO4-01, and CONSOLIDER CSD2006-12.

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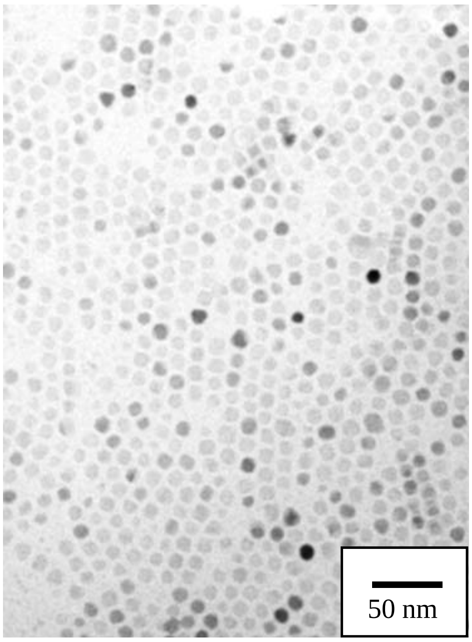

Figure 1. TEM micrograph of magnetite nanoparticles with an average diameter of 10.4±1.0nm.

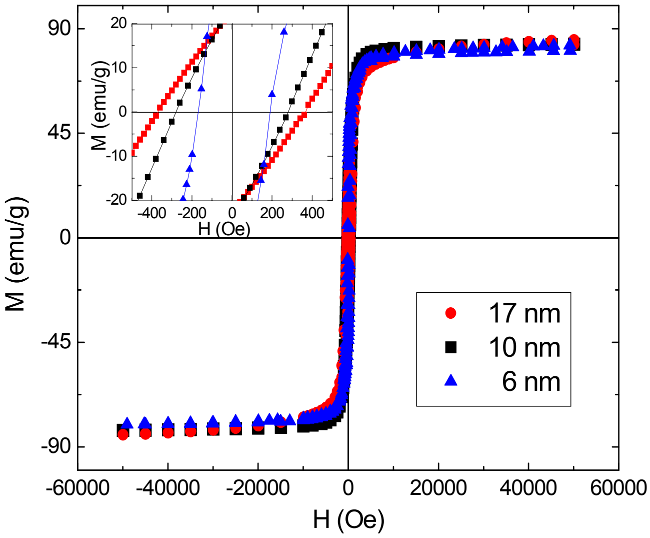

Figure 2. Hysteresis loops at T = 5 K for magnetite nanoparticles surfacted with oleic acid, as a function of the particle size. Inset: Low magnetic field region of the hysteresis loop.

ORGANIC MOLECULAR NANO-WIRES AND NANO-LADDERS

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Self-assembly of specific organic molecules deposited on metal and nanostructured metallic substrates by vapour deposition is nowadays a reliable method for investigating fundamental concepts in nanoscience and nanotechnology[1-2]. We have studied a spontaneous nanostructuration process of organic molecules on a surface to form 1D and 2D supra-molecular structures. Particularly, the use of well-controlled single crystal surfaces and the STM technique permits to gather chemical information about this process at a molecular level.

We have focused our study on PTCDA, 3,4,9,10-perylene-tetracarboxylic-dianhydride, deposited on Au(111) surfaces, both clean and partially covered by iron atoms. PTCDA molecules present a number of structural, electronic and optical properties[3] that make them interesting to serve as the basis for future electronic applications such as switches, optical sensors and data storage media.

The *PTCDA* molecules deposited on Fe/Au(111) substrates form several molecular arrangements (Figure 1) different for those found on the Au(111) surface. We present in this work a collection of different nanostructures and the influence in its formation on the experimental parameters. The interaction between diffusing Fe atoms and the deposited molecules become the key point for stabilizing new structural phases. By means of spectroscopic tunnelling images we obtain information about the modification of the molecular orbitals by the presence of either Fe atoms or clusters on the surface. Thus, We show how these systems combine the functional properties of the organic molecules with the low dimensionality of the 0D clusters (organic nanodots[4]), the 1D of the organic wires and the 2D character of the created ladder-like array (bidimensional crystal).

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Figures :

Figure 1 : Two kinds of structures obtained, (a) formation of elongated organic wires joined by iron ligand and (b) Ladder like organic structure joined by perpendicular PTCDA molecules, respectively.

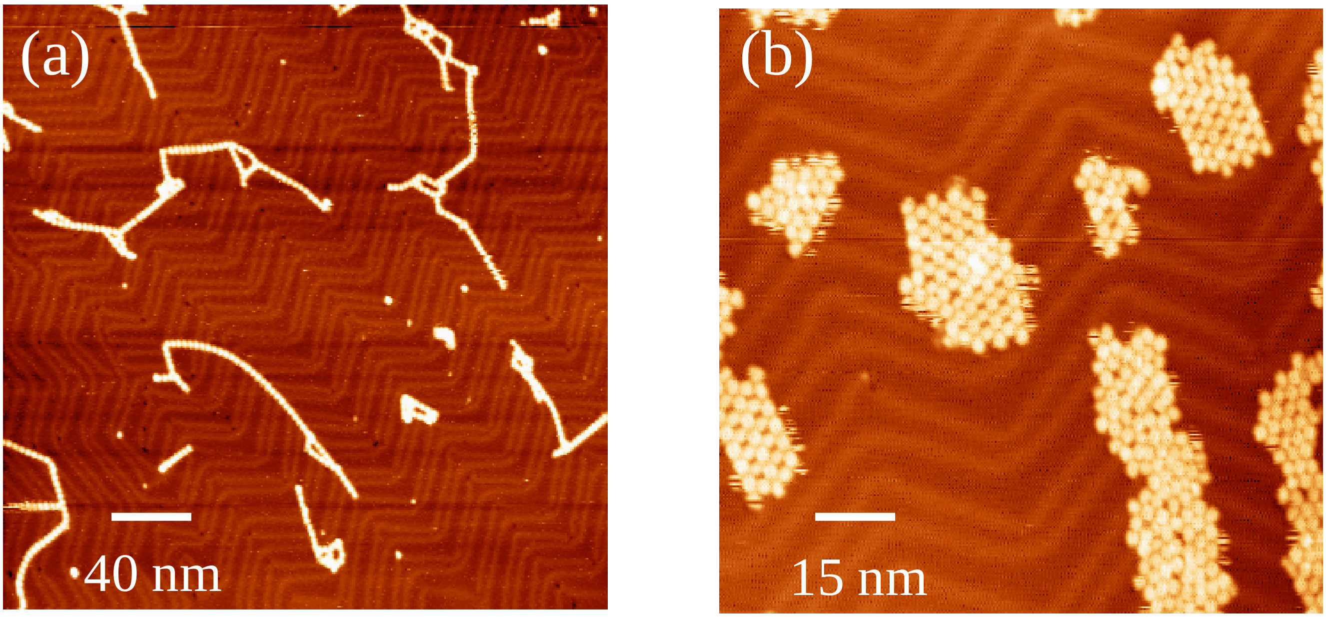
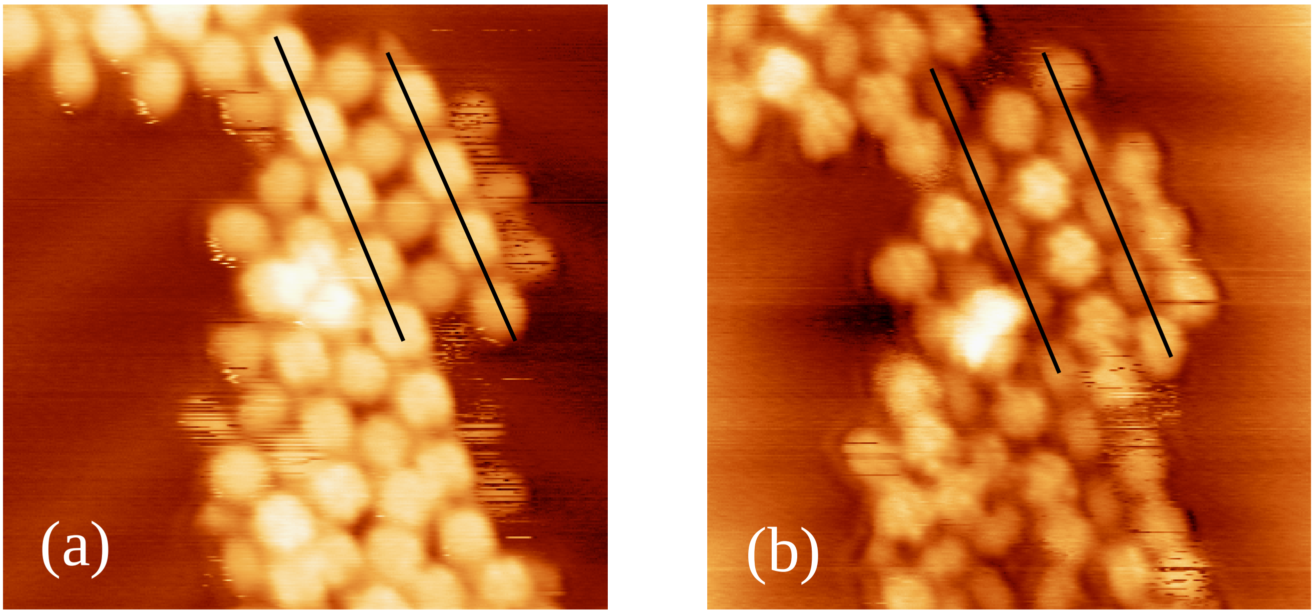


Figure 2 : STM images of 1ML PTCDA on Fe/Au(111) at RT obtained at V = +1.0 V (unoccupied, LUMO) and V = -1.8 V (occupied, HOMO), respectively.



COUNTING AND MANIPULATING SINGLE ELECTRONS IN A AU NANOPARTICLE USING A CARBON NANOTUBE TRANSISTOR

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We report on electric measurements of an individual Au nanoparticle with an ultra-high contact resistance of about 10^{19} ohms. The high-impedance measurements have been carried out by counting electrons going into the Au particle with a rate that corresponds to a current of about 10^{-21} A. For this, a carbon nanotube is used as the electrode for the supply of electrons but also as the detector of the charge transfer. The separation between the electron states in the Au nanoparticle is found to be about 4 meV, which is consistent with the charging energy of the particle. The measurement technique offers great promise for the study of electron transfer in high-resistive molecular systems.

DISCONTINUOUS TRANSITIONS IN NANOSTRUCTURED LIQUID/LIQUID INTERFACES: COMPUTER SIMULATION STUDIES

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Surfactants and nanoparticles have the ability to, under certain circumstances, adsorb onto liquid/liquid interfaces creating interfacial structures with characteristic order in the nanometer scale. In this way, liquid/liquid interfaces can be functionalised for specific applications. Nanostructured functional liquid/liquid interfaces are very important in Nature, being biological membranes the most prominent examples. In Materials Science, nanostructured liquid/liquid interfaces are also important in many applications including foams, thin films, biomimetic materials or magnetic soft nanocomposites assembled by nanoparticle adsorption, to mention only a few examples.

Discontinuous transitions in these soft interfacial systems are especially interesting both from the applied and theoretical point of view. In this work, we will discuss several examples of different discontinuous transitions including the NBF-CBF transition in thin films [1] and the orientational transition in interfaces containing adsorbed magnetic nanoparticles [2]. In both cases we will present computer simulation results which illustrate the underlying mechanisms driving the transitions. We will also discuss the applicability of classical thermodynamic concepts to these examples of these interfacial transitions arising at the nanoscale.

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CENTRE D'INVESTIGACIONS EN NANOCIÈNCIA I NANOTECNOLOGIA
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Nanoscience and nanotechnology (N&N) are new approaches to research and development that aim to control the fundamental structure and behaviour of matter at the level of atoms and molecules. These fields open up the possibility of understanding new phenomena and producing new properties that can be used at the micro- and macro-scale. The range of materials to be studied spans from the atomic scale, molecular or macromolecular compounds, to nanoparticles, nanowires and in general, nanostructured materials.

A comparative funding levels between EU, Japan, USA and other countries on a per-capita basis in 2003 (1€=1$) indicates that Spain shows the lowest mark, 0.04€ per capita.

The existence of a good number of groups in Spain working on techniques and methodologies related with N&N cannot hide the low support of the State to this important field of research. Just in the last two year a first call totally devoted to N&N has been proposed. Nevertheless, at present it is not clear the continuity of this call. In agreement with this specific action, a little increase in the funds per capita devoted to N&N has forcibly increased in 2005 although the percentage will remain unfortunately low.

The opportunity of the creation of a new Research Centre on N&N in Barcelona side is a crucial key action for the developing of N&N in our country. There are several reasons supporting this fact: a) the political support from the State (CSIC) and the Catalan Region b) the possibility to create a new and agile management of the Research Centre shared between those both actors; CIN2 will be a mix organism c) support of the Autonomous University of Barcelona (UAB) permitting and supporting actively the construction of the CIN2 building in his own Campus in Bellaterra by a cession of an adequate ground: this organism will be also included in the management of CIN2.

In this talk special attention will be paid with respect to the definition of selected research areas, the recruitment of personnel and internal structuring as well.

FERROMAGNETIC NANOWIRE ARRAYS: ENHANCED MAGNETO-OPTICS AND SIZE EFFECTS

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Localized surface plasmons are under intensive study since long ago because they play a very important role in the optical properties of metallic systems. In particular, they become especially relevant in the optical properties of nanostructures, such as tiny particles embedded in dielectric matrices. The intensity as well as the spectral position of these resonances strongly depends on a variety of parameters such as the size, the shape, the concentration of the metallic particles or the refractive index of the matrix.[1] The vast majority of the studies have been so far devoted to study noble metal particles since their free electron contribution to the optical properties in the infrared and visible spectral range is predominant, exhibiting also a low damping constant. In other metals such as palladium, platinum, cobalt, nickel or iron, the free electron contribution to the optical properties is smaller, and have a higher damping constant, therefore their surface plasmon resonances appear broader and less defined. On the other hand, some of these metals like Fe, Co and Ni, possess spontaneous magnetization which enables them to present magneto-optical properties, which are absent in noble metals. This characteristic can be used to design new kind of plasmonic structures. Moreover, different theoretical works have suggested that surface plasmon resonance of magnetic metallic nanoparticles could enhance the magneto-optical activity with respect to that of a continuous medium.[2] However, the size of the nanoparticles under consideration is always much smaller than the wavelength of the light and the interaction between the particles was rarely considered. But the particle size and the radiative coupling between nanoparticles strongly modify the optical properties of the system and, therefore, it may also modify its magneto-optical response. This is precisely the scope of this work, where we analyze the dependence of the magneto-optical properties on the size and on the dielectric environment of a system consisting on periodically arranged Ni nanowires embedded in a dielectric environment.[3] Such system has already shown to exhibit interesting effects, such as an enhancement of the magneto-optical Kerr rotation, whose origin will be pointed out here. We will show that the enhancement is due to a surface plasmon resonance of the Ni nanowires, its spectral position depending on the wire diameter.[4]

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Figures:

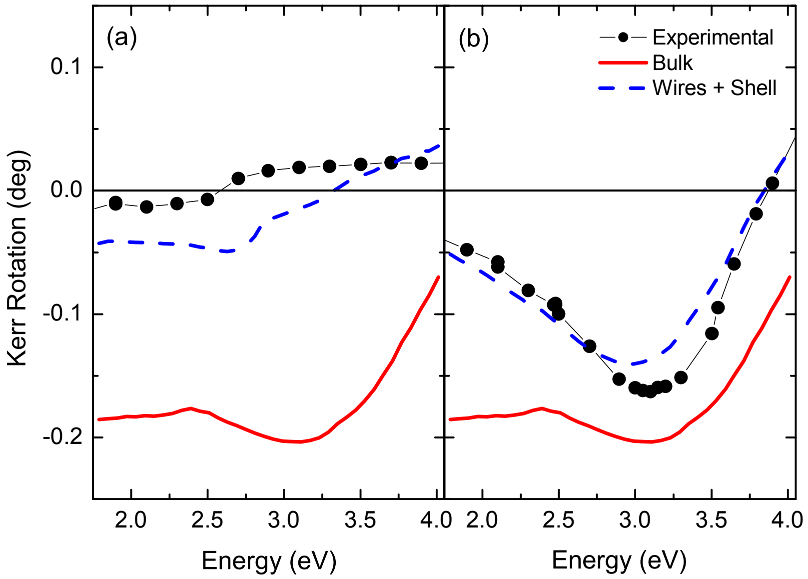

Figure: (a) Kerr rotation spectrum of an array of nanowires with d=40nm and a=105nm. The continuous line represents the Kerr rotation of nickel bulk. The enhancement of the rotation around 3eV is clearly visible. The dashed line is the theoretical result obtained using a Scattering Matrix Method. (b) The same as in (a) but the nanowire diameter is d=180 and the lattice constant a=500nm.

EFFECTS OF THE EXISTENCE OF VACANCIES IN THE ADSORPTION OF QUANTUM GASES IN THE INTERCHANNELS OF A BUNDLE OF CARBON NANOTUBES

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Since their discovery, carbon nanotubes and their bundles have been the object of a lot of interest because, among others, their purported capacity as gas adsorbents. This could be very interesting from the technological point of view, since these systems were proposed as hydrogen reservoirs in fuel cells. In principle, the possible adsorption sites are the outside surface of the bundle, the interchannels (IC's) existing in between every three (or more, if the bundle is irregular), tubes located parallel to each other and the inside of the cylinders themselves. However, this option is only feasible when the nanotubes are open in the ends, something to be done chemically after their synthesis. This means that, the issue of how much adsorbate can enter the IC's could be of importance to assess the real gas uptake in these systems.

In principle, the only species small enough to enter the IC's are H_2, He and Ne, as indicated by different sets of quantum calculations [1,2], other gases are simply too big. However, there are experimental indications against the adsorption of even the lightest gases. To try to explain the discrepancies, we presented here some Diffusion Monte Carlo (DMC) calculations on the systems under consideration. To do so, we considered the adsorption of ^{4}He, H_2 and Ne inside IC's formed by three perfectly parallel (10,10) tubes with no defects, separated of each other by a distance of 17 Å. High binding energies in al cases and the fact that all the species considered roam freely all the length of the simulation cell makes us believe that the size of the IC is not the key issue to prevent adsorption.

We found that the only influence that certainly could impede the smallest quantum species to enter the IC is the presence of carbon vacancies in the nanotubes [2]. The hole created by a single missing carbon (an 5-1DB defect) is enough to stop any of the considered species to move beyond it. This means that, if one of this vacancies is at the beginning of the IC, the adsorption cannot progress further, making the entire interchannel an empty space. Since even the purest nanotubes are though to have a certain measure of defects, this can be the mechanism that could explain the experimental lack of adsorption.

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MAGNETICALLY-CHARGED DENDRITIC CELLS AS VECTORS FOR MAGNETIC HYPERTHERMIA THERAPY.

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We present here a study on the internalization of magnetic Fe-containing nanoparticles into dendritic cells (DCs) in order to assess the potential for this tumor targeting strategy for magnetic hyperthermia. DCs are the principal antigen presenting cells to naive T-cells, triggering antigen-specific immune responses. DCs obtained from myelomonocytic progenitors (MCDs) and maturated with tumor antigens have showed antitumoral activity in animal models (Mayordomo et al) and humans [1]. Recently the induction of endothelial cell features in MCDs cultivated with angiogenic factors like VEGF has been demonstrated [2] and similar cells have been isolated from human tumor vessels [3], opening the possibility of targeting MCDs with incorporated magnetic nanoparticles to tumoral sites and use them to visualize tumors (MRI) or in oncologic therapy. Magnetic inductive hyperthermia (MIH) is a therapeutic application that uses capacity of MNPs to absorb power from an oscillating magnetic field to heat and destroy malignant cancer cells. For this biomedical application, the granular materials must have a high saturation moment in order to minimize the required clinical doses due to toxicity effects. Previously synthesized Fe-C nanoparticles showed to be promising materials because of its low toxicity, high Curie temperature (T_C) and saturation magnetic moment (M_S ~211 emu/g). [4]

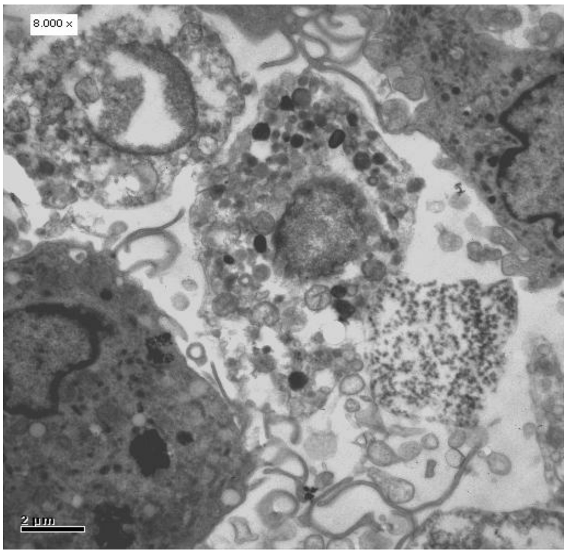

Figure 1: TEM image of DCs with Fe-C NPs. Intralysosomal NPs aggregates can be observed as metal shavings inside lysosomes.

Although great achievements have been reported on the use of magnetic NPs as cell markers, the fundamental mechanisms by which a given cell type recognizes and incorporates inorganic NPs is not completely understood. We have studied both the viability of the cellular culture and final location of the magnetic NPs, verifying the incorporation of the NPs and finding no toxic effects on the DCs regarding their viability. The incorporation of NPs onto CDs was assessed by electron microscopy, finding that the NPs are visible as aggregates in lysosomes (Figure1).We found that mature DCs are able to incorporate magnetic nanoparticles in a range of size from few nanometers to ca. 200 nm, after 24 h of culture.

Dendritic cells were cultured in a 12-well plates and NPs incorporated along the process. Cells were recollected from different plates on days 7,8,9,10 and 11 and viability of the DCs was assessed with tripan blue. The fraction of viable cells on days 0,1,2,3 and 4 after NPs incorporation was not significantly affected by the incorporation of carbon NPs. As shown in Figure 3, cell viability was 80% on day 0 after incorporation of NPs and decreased slowly so that it remained above 75% for 4 days.

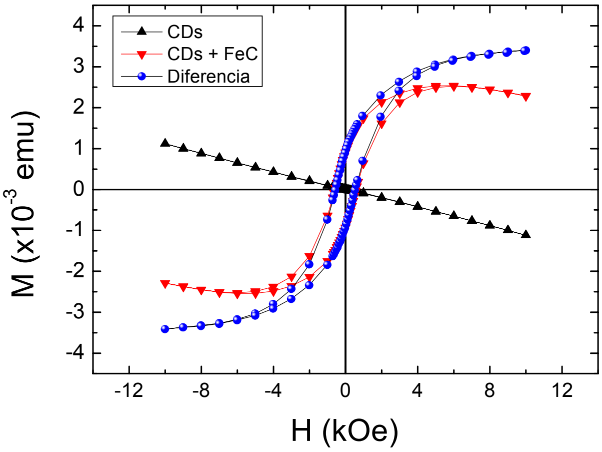

Figure 1: Magnetization curves for a) Dendritic cells (up triangles) b) NP-charged DCs (down triangles) and c) the difference between the two samples, showing the same hysteresis loop than the original ferrofluid

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The method for separating NP-loaded DCs by density discontinuity and analyze the results through magnetic techniques showed great efficiency regarding the detection of charged cells on in vitro samples. The separation sequence used for our DCs samples allows us to assume that, after centrifugation of charged cells in a density gradient, all the magnetic particles not included into the DCs are located in the pellet. On the other hand, the floating band is composed of charged CDs with MNPs, with eventual small fractions of uncharged cells. Finally, our first studies on the effect of alternating magnetic fields for in-vitro hyperthermia showed that the effect of a 30-minutes application was to decrease the viability of cells. We will discuss the results based on current strategies for tumor targeting.

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NANOSCALE ELECTRONICS AND SENSORS BUILT ON SEMICONDUCTING NANOWIRES

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Various nanowires, such as ZnO, Fe_2O_3, Ga_2O_3, have been synthesized and their structures and properties are characterized by TEM, SEM, XRD, AFM, photoluminescence, photoconductance, scanning surface potential microscopy, and electrical transport measurement. By integrating bottom-up technique with top-down lithographic technique, these nanostructures are used to fabricate a range of electronic and chemical sensing devices.

As an example, zinc oxide (ZnO) nanowires have attracted tremendous interest due to their remarkable physical properties and versatile applications in electronic devices, such as logic circuit, UV emitter and photodetector, as well as chemical sensor. In the previous research report, ZnO nanowire configured as field effect transistor (FET) shows an electron mobility ranging from 3 to 80 $cm^2/V{\cdot}s$ without surface treatments [1-4]. In order to optimize the performance of devices based on these nanowires, it is crucial to improve the carrier transconductance and mobility in the nanochannel. In this work, single-crystalline ZnO nanowires were synthesized via a catalyst-assisted chemical vapor deposition method. Temperature dependent photoluminescence measurements demonstrate the evolution of peak intensities resulted from different radiative mechanisms. The sharp peak with its full-width half maximum of 3.6 meV at 12 K (as shown in Figure 1) and the absence of other bound-exciton lines indicate that the as-grown nanowires are of high crystal and optical qualities. Following CMOS compatible procedures to passivate surface defect states and also to reduce chemisorption processes, the nanowire FETs exhibit orders of magnitude improvement in the on/off ratio, sub-threshold swing and field effect mobility. Figure 2 depicts the gate modulated current of a sample at different drain-source bias voltages, divided into three regions: off state, linear region, and saturation region. Remarkable mobility exceeding 4000 $cm^2/ V{\cdot}s$ was obtained. [5]

In addition, individual single-crystalline ZnO nanowires are configured as *n*-channel FETs and implemented as highly sensitive chemical sensors for detection of NO_2, NH_3, CO toxic gases. Due to a Debye screening length comparable to the nanowire diameter, the electric field applied over the back gate electrode is found to significantly affect the sensitivity. Applying a strong negative field at the gate electrode is able to efficiently refresh the sensors by an electro-desorption mechanism.[6-7] Furthermore, different chemisorbed species could be distinguished from the “refresh” threshold voltage and the temporal response of the conductance. These results demonstrate a refreshable field effect sensor with a potential gas identification function.

Furthermore, high density vertical zinc oxide nanowire arrays were synthesized using highly ordered channels in anodic alumina membranes via chemical vapor deposition assisted by electrochemical deposition methods. An anomalous negative photoconductivity was first observed as a result of electron trapping in the alumina membrane.[8] In contrast, positive photoconductivity was observed using a thermally annealed anodic alumina membrane as the nanowire growth template. Such vertical alignment fully utilizes the scaling advantage of nanowire’s unique anisotropy geometry, demonstrating an efficient strategy to construct highly integrated nanowire based electronic and optoelectronic circuits, such as logic gates, light emitting diodes, and high resolution imaging sensors.

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Figures:

Figure 1: The high-resolution photoluminescence at the band-edge, measured at 12 K, shows the sharp donor bound exciton emission as well as the surface bound exciton (SX).

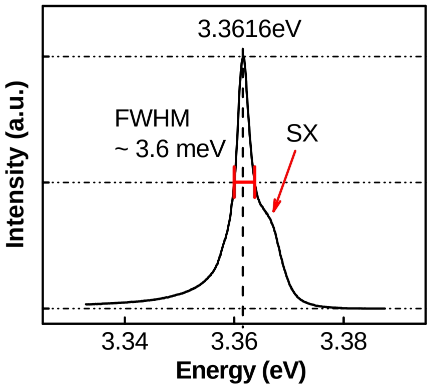
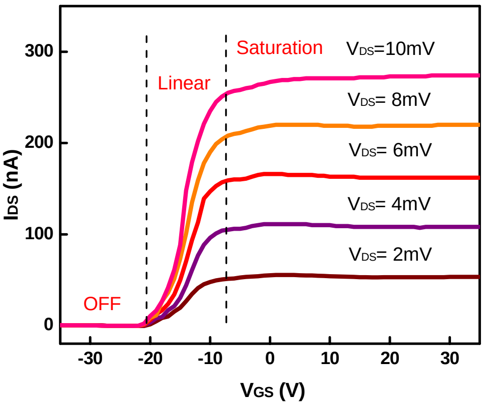


Figure 2: I_{DS}-V_{GS} of a surface treated nanowire FET exhibits significantly enhanced on/off ratio and transconductance.



APPLICATIONS OF FUNCTIONAL AND POLYMERIC IONIC LIQUIDS IN NANOTECHNOLOGY

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Ionic Liquids (ILs) are essentially salts that are liquid at room temperature, chemically composed by an organic asymmetric cation and an inorganic anion. Due to their organic/inorganic character ILs present a low melting point (<100 ºC), negligible vapour pressure, high chemical stability, low flammability, high ionic conductivity and wide electrochemical window. Significantly, the use of ILs in nanoscience and nanotechnology (N&N) is having an exponential increase in the last years as illustrated in Figure 1, which shows the number of scientific publications in the last years [1]. Contemporary research topics include the use of ILs in the synthesis of metallic nanoparticles (NPs) [2], the self-organization of inorganic nanostructures and the functionalization and dispersion of carbon nanotubes (CNTs). For example, Aida et al. [3] discovered that ILs with SWNTs formed physical gels named “bucky gels” in which CNTs were untangled. As an interesting application, ILs have also been used to develop new phase transfer methods for NPs between water and organic solvents [4].

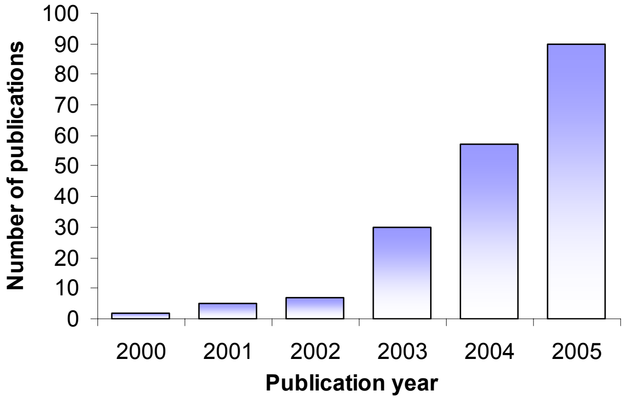

Figure 1: Number of scientific publications related to Ionic Liquids and the term “Nano” during the period from 2000 to 2005. Source: ISI Web of Science

In this oral communication, we will introduce some of our new results on the original applications of functional ionic liquids in nanotechnology. For instance, an original strategy that allows for a quantitative and completely reversible phase transfer of nano-objects between water and organic solvents will be presented [5]. The method is based on the application of the chemistry of ionic liquids to the phase transfer of nano-objects. Using polymeric ionic liquids (PILs) our group has recently developed a fully reversible method for the phase transfer of nano-objects (CNTs, silver NPs and gold nanorods) from water to organics and vice-versa (Figure 2). We found that PILs are able to trap several nano-objects during its anion exchange-induced precipitation in water and in organic solvents. Interestingly, this process provides a PIL/nano-object composite that is fully re-dispersible in organic solvents after separation of the aqueous medium or fully re-dispersible in water after separation from the organic medium. This versatile methodology provided dispersions (acetone, THF, DMF, $CHCl_3$, water) extremely stable in time.

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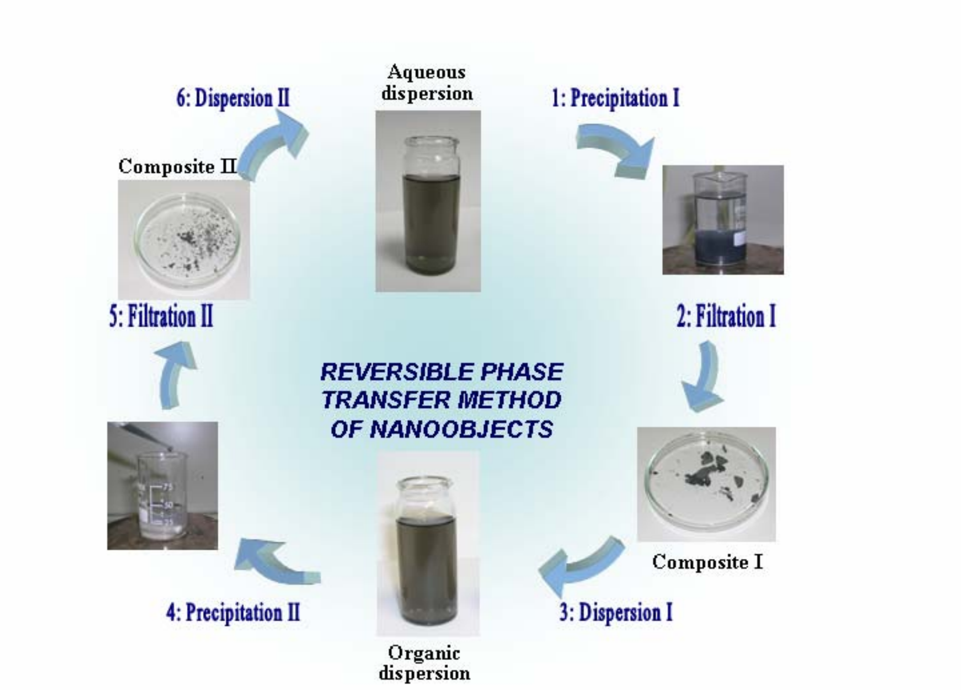

Figure 2. Method for the reversible transfer method of nano-objects between aqueous and organic phases using polymeric ionic liquids

To conclude, we will discuss our recent research activities on the development of anion sensors based on gold nanoparticles. For this purpose, new amine ILs have been synthesized and used to surface functionalize gold nanoparticles. This system behaves as an optical anion sensor due to the sensitivity of ILs to different anions and the corresponding change in the surface plasmon resonance associated to the aggregation of the nanoparticles. Finally, some results about the dispersion of carbon nanotubes using ILs will be presented.

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DETECTION OF SALMONELLA WITH CARBON NANOTUBE FIELD EFFECT TRANSISTORS

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Salmonella is a common source of foodborne diseases. To reduce the cause of this food-related illnesses and death, there is a need for fast, sensitive and reliable methods to identify contaminated foods. Conventional culturing methods are reliable but very time consuming (i.e. typically requiring 3-7 days) and other methods such as the polymerase chain reaction (PCR) or the enzyme-linked immunosorbant assays (ELISA) requires between 8-48h. Some biosensors have been developed for the real-time and label-free detection of pathogens. However these biosensors have quite high limits of detection (LODs), i.e. about 10^3 cfu/ml. To improve these LODs, we have used carbon nanotubes to develop a biosensor for the detection of Salmonella.

Single-Walled Carbon Nanotubes (SWCNTs) have outstanding mechanical and electrical properties. Their electrical conductivity is very sensitive to their chemical environment and, as a result, they have been successfully applied as sensitive and selective biosensors for the detection of proteins [1] and oligonucleotides [2]. These biosensors are based on integrating SWCNTs as the conducting channel of field effect transistors (FETs). So far these biosensors have not been applied for the detection of bacteria or higher organisms.

We have developed a FET biosensor based on a network of SWCNTs for the selective detection of Salmonella. A polyclonal antibody to Salmonella was adsorbed on the SWCNTs and subsequently the SWCNTs were protected with Tween 20 to avoid the non specific binding of other bacteria or proteins. Therefore, SWCNTs have been used as the transducer part of the sensor to decrease the LODs of current biosensors. The recognition element of the FET is the antibody. Since the antibody is selective to Salmonella, we can ensure the selectivity of our biosensor against other bacteria. Our FET devices were submerged in solutions of Salmonella and were able to detect 100 cfu/ml after one hour. Figure 1 shows a SEM image of a typical SWCNT network of a FET device after being submerged with a solution of Salmonella. We can see that the SWCNTs are decorated with the antibodies and that Salmonella is linked to the SWCNTs.

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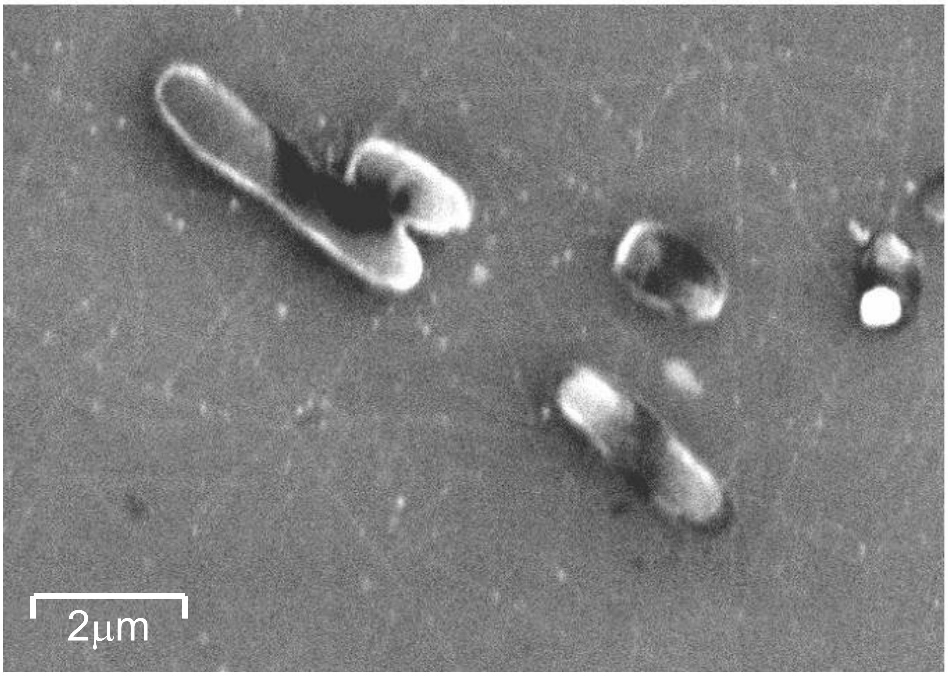
Figure 1.



PRODUCTION OF FUNCTIONALISED MICRO AND NANOSTRUCTURED POLYMER SURFACES TO TRIGGER MESENCHYMAL STEM CELL DIFFERENTIATION

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In vivo, mammalian cells interact with one another triggering diverse intracellular processes that control cell development. Similarly, the surrounding environment, constituting the extra-cellular matrix (ECM) and soluble factors, causes cells to adapt, reprogramming their intracellular apparatus. Cells can sense topological, chemical and physical cues within the surrounding milieu. Indeed, mammalian cells respond to nano/microscale features on artificial surfaces [1-3]. Hence, artificial bio-functionalised substrates with nano and micropatterns might make cells develop through different pathways, depending on the substrate design, in a non-invasive approach; specifically controlling processes such as cell adhesion, survival, proliferation, migration and differentiation. The principle relies on genetic reprogramming via intracellular signalling pathways, due to specific reactions through customized nanostructured surfaces in contact with cell surface receptors. The “CellPROM” European integrated project, involving 27 collaborating partners (both industrial and academic) from 12 European countries, entails the production of these nanostructured surfaces for controlling cellular characteristics. Substrate topology and biochemistry can be highly controllable factors. An understanding of these aspects will help in creating functional engineered tissues, as well as in the design of many implantable medical devices. It is not hard to envisage nanoscale devices with the ability to stimulate stem cells to produce partially or completely differentiated cells for regenerative therapies.

The main objective of our work is to apply novel micro and nanofabrication techniques and surface modification strategies to generate well-defined topographical and biochemical cues for cell culture. To achieve this goal, nanoembossing has been used to impart micro and nanostructures into polymer substrates, and their surface properties modified by micro-contact printing, nanoplotting and dip-pen nanolithography of ECM proteins, which are attached covalently to the surface. The modified surfaces are then used to study their influence on cell adhesion, morphology, proliferation and differentiation.

Nanoembossing is achieved using nanoimprint lithography apparatus in biocompatible polymers such as poly(methyl methacrylate) (PMMA) [4]. Moulds for the nanoembossing are produced using conventional photolithography techniques combined with dry etching processes (micro) and focussed ion beam lithography or e-beam lithography (nano). Micro/nanopatterning of biochemical factors has been undertaken by a variety of techniques, including micro-contact printing using PDMS stamps, nanolitre drop delivery (nanoplotter) and dip pen nanolithography, performed using a dedicated AFM instrument.

Results show that surface functionalisation with adhesion proteins such as fibronectin can be used to selectively attach and confine cells at specific surface locations (Fig. 1). When micro and nanopatterned, fibronectin can also alter cell morphology, cytoskeletal organisation and stress level (Fig. 2). Surface topography is instrumental in cell guidance and alignment processes, but it also greatly affects cell morphology. The study of both topographical and biochemical patterns is therefore particularly relevant when examining cell differentiation.

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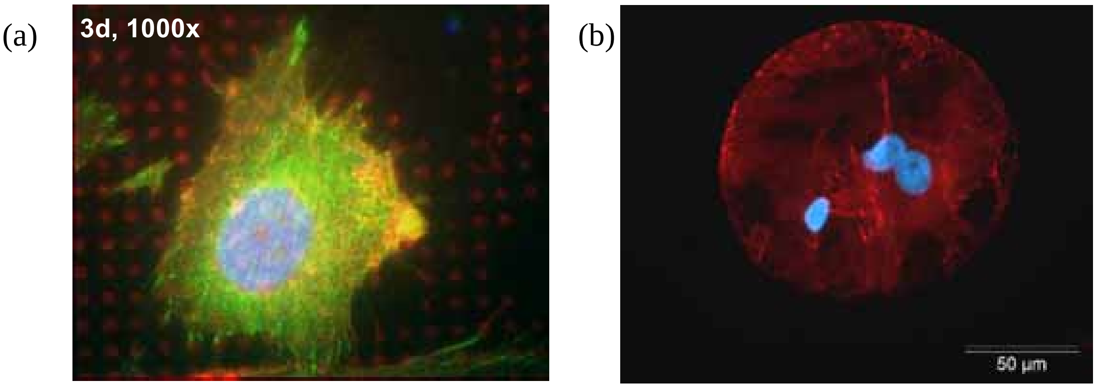

Figure 1. (a) Fluorescence microscopy pictures showing cells growing on micropatterned fibronectin layers (pattern size 2.5 µm). (b) MSC cells confined to selective areas of fibronectin functionalised PMMA substrates In each image, nuclei are stained blue, fibronectin is stained red, and focal contacts are green.

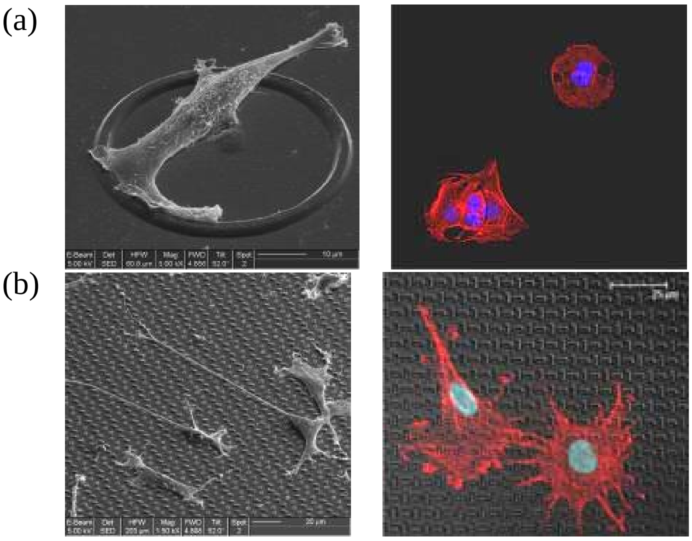

Figure 2. SEM and confocal microscopy images of MSC cells cultured on PMMA with (a) 50 micron diameter donut structures and (b) irregular structures: both sets of structures are 1 µm tall. Nuclei are stained in blue and actin filaments in red

This work has been generated in the context of the CellPROM project, funded by the EC (contract No. NMP4-CT-2004-500039) and it reflects only the authors’ views. The authors thank Drs. C. Moormann and T. Wahlbrink of AMO Gmb (Germany) for providing the moulds used for nanoembossing, and M. Funes of the Barcelona Science Park (Spain) for cell culturing.

A NEW WAY OF MANUFACTURING HIGH RESOLUTION OPTICAL ENCODERS BY NANOIMPRINT LITHOGRAPHY

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Key words : optical encoders, Nanoimprint Lithography

Optical encoders have been used for decades as displacement measuring devices. An encoder consists of a scale and a scanning device that reads off the scale. Optical encoder scales are rigidly attached to a metrology frame and consist of grating or grid plates, and the read head which senses displacement relative to the grating scale (Fig. 1a). Highest resolution (a small fraction of the grating period) is achieved with a variety of diffraction based schemes [1,2]. The main advantages of optical encoders are the short and constant beam path lengths between gratings and sensors, reducing the effects of the atmosphere compared to laser interferometers. However, the main problem with encoders today is that commercially available encoder plates are limited in accuracy to worse than 100 nm. Since the encoder can only be as accurate as the grating scale, advance in this area crucially depends on the availability of encoder plates with sub-nanometer accuracy over macroscopic distances.

Grating scales are typically manufactured in two ways. They are either mechanically ruled with a diamond tip, which is a very low, expensive, and difficult to control process, or the grating pattern is defined lithographically, typically by interference lithography or electron beam lithography. Interference lithography is fast, but prone to hyperbolic distortions [3], while e-beam lithography patterns suffer from stitching errors and take considerable time to write. We propose to produce linear and angular encoders by Nanoimprint Lithography (NIL) looking for better resolution [4]. The possibility of manufacturing high resolution linear encoders by NIL gives the technology needed to mass-produced encoders, and provided the process is accurate enough, high accuracy encoders may be manufactured in a low cost.

An optical encoder with 250 nm line resolution and 20 mm in length was designed (fig.1b) and protected by surrounded rectangles to ensure a right pattern transfer. Encoders arrays distributed through 8” silicon wafers were manufactured at LETI by an ASM PAS 5000/300 optical stepper and RIE (fig.2a). These stamps were cut and imprinted on silicon and glass. A 300 nm of mr-I7030 on silicon (monolayer NIL) and 60 nm of Microposit LOL1000 and different thickness of mr-I7030 (bilayer NIL) on silicon and pyrex were used to ensure a right pattern transfer by lift-off of chromium on glass as well as by etching on silicon (fig 2b, 2c, 3a, 3b, 3c, 3d). The right pattern transfer on this large scale is discussed in function of the substrate size to avoid stamp bending and mr-I7030 thickness. The minimization of residual layer thickness is studied as a function of the original thermoplastic thickness and force applied during imprinting in order to get a good enough duty (ratio: line/space in a grating) transfer between stamp and final glass and silicon components. The bilayer NIL process is accurate defined in function of Microposit LOL1000 thickness and developer rate so as to ensure the successful lift-off. The duty and roughness of the stamp are compared with the values on the glass and silicon final components, which shows its suitability for being used as optical encoders. Following this procedure, a 500 nm pitch and 20 mm length encoder was fabricated on glass and silicon (fig. 4). The glass can be used as a read head and the silicon as a phase scale in a classical encoder design, which may open the possibility to fabricate these components on a large scale.

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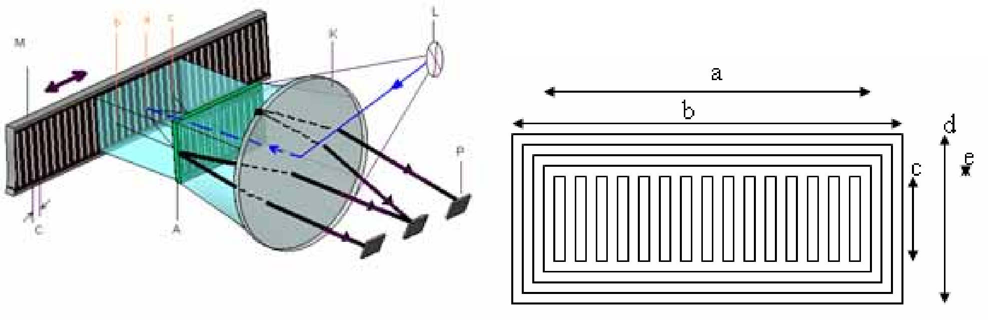
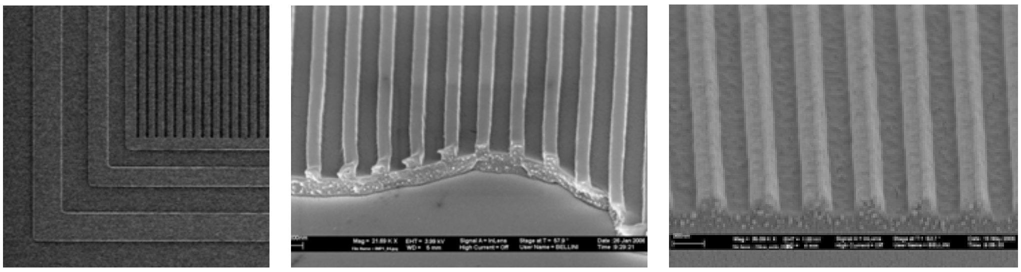
A new way of manufacturing high resolution optical encoders by nanoimprint lithography



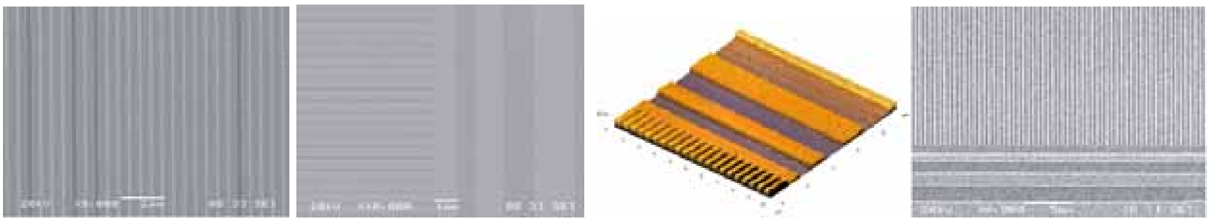
a) b)

Figure 1. a)Classical interferencial measuring principle. M=scale with phase grating, C=grating period, A=read head, L=semiconductor light source, K=condenser lens, P=photodiodes. a, b and c light beams that leave the scanning reticle in the 0, 1 and -1 orders of diffraction to strike the scale. b) Encoder design manufactured. a=20 mm, b=21.7 mm, c=1 mm, d=3.5 mm, e=500 nm.



a) b) c)

Figure 2. a) SEM picture of the silicon stamp with 200 nm depth, in which can be seen the 500 nm pitch and the rectangles used to keep the fill factor constant during imprinting. b) 300 nm of mr-I7030 imprinted with a residual layer thickness around 200 nm. c) 210 nm of mr-I7030 imprinted with a residual layer thickness around 120 nm.



a) b) c) d)

Figure 3. a) Glass sample after lift-off with chromium using a monolayer NIL process with 300 nm thickness of mr-I7030, in which some lines (dark lines) has been released and others remain the mr-I7030 (light lines). b) Glass sample after a bilayer NIL process with 210 nm thickness of mr-I7030 and lift-off with chromium. c) AFM topography of sample b). d) Pattern transfer on silicon from 210 nm of mr-I7030.

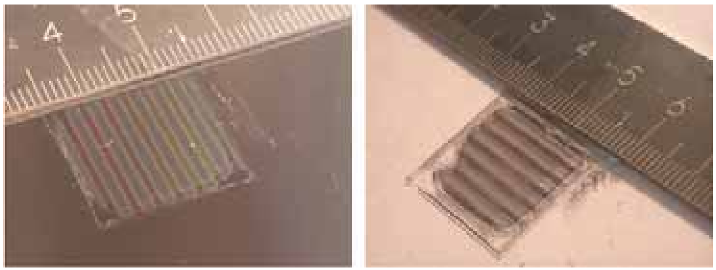


Figure 4. Final scales manufactured on silicon and glass, in which a comparison with reference marks in centimeters is showed.

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QUANTUM SIZE EFFECTS IN METALLIC NANOSTRUCTURES

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The confinement of electrons in nanostructures originates a set of new quantum states: the Quantum Well States, which influence and, in many instances, determine most of their properties. We report here the oscillatory behaviour of stable ("magic") heights of Pb nanodots grown on Cu(111) [1], thermal stability, roughening (or dewetting) temperatures [2], apparent step heights [3], phonon frequencies [4] and superconducting temperatures of Pb nanofilms grown on Cu(111). All these properties oscillate with the thickness of the film or the height of the islands with a periodicity that is given by the size of the Fermi surface of Pb. A simple model is used to fit the data and compared with first principles calculations. The QWS close to the Fermi level determine the electronic energy, which, in turn, might be in many cases decide the energetic balance.

The left part of the figure below shows: a) an STM image of a 8 ML thick Pb film deposited and kept at 90 K on Cu(111) under UHV conditions; b) Tunneling Spectra recorded locally on top of areas of consecutive layers, showing the QWS close to the Fermi energy and c) the roughening temperature and the total energy of the films as function of the thickness.

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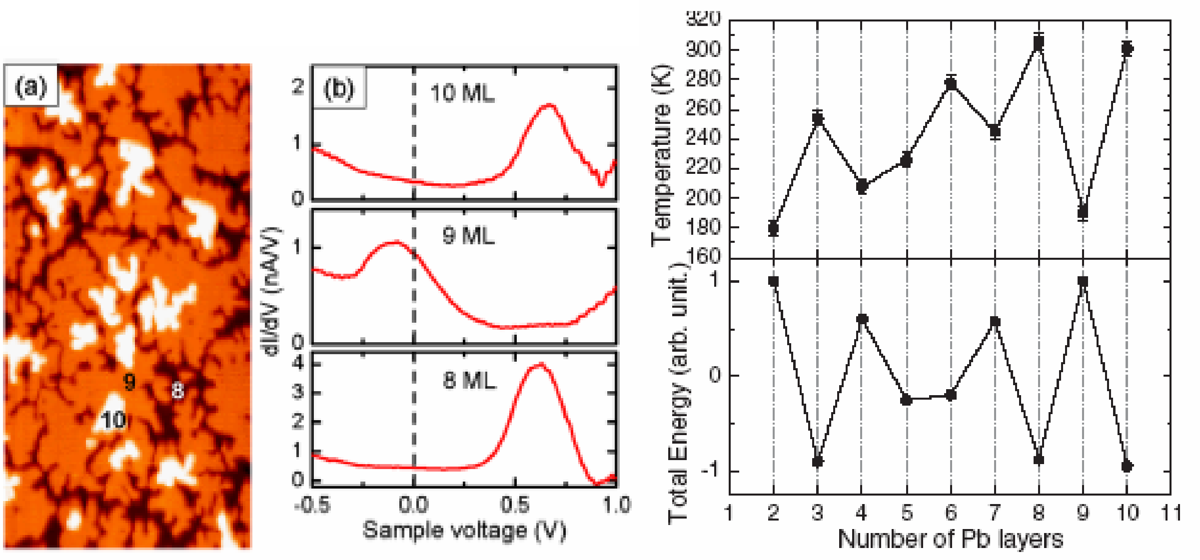

IMDEA-NANO: A NEW INSTITUTE DEVOTED TO RESEARCH IN NANOSCIENCE AND NANOTECHNOLOGY IN MADRID

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The Madrid Institute of Advanced Studies in Nanoscience (IMDEA-Nano) has been recently created as an initiative of the regional government (Comunidad de Madrid), joined by the spanish Ministerio de Educación y Ciencia. The IMDEA-Nano Foundation has been stablished to run the Institute. The Foundation is governed by a Patronate, which contains representatives of the Administration, the Academic Institutions involved (UCM, UAM, UPM, CSIC), industries, members of the Scientific Advisory Council, and experts in societal implications and technology transfer. A description will be presented of the location, building, organization, management, scientific lines and personnel recruitment issues.

MULTIFUNCTIONAL CARBON NANOTUBE/POLYMER COMPOSITE FIBERS

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Jonathan N. Coleman,[4] Bog G. Kim,[5] Dong-Seok Suh,[2] Von Howard Ebron,[2] Miles Selvidge,[2]
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Continuous single-walled carbon nanotube (SWNT)/polyvinyl alcohol (PVA) composite fibers having record energy-to-break (toughness) were fabricated by coagulation [1] of aqueous surfactant-assisted SWNT dispersions upon injection in PVA solutions. These SWNT/PVA fibers have been employed in the fabrication of lightweight fiber supercapacitors, which can be woven or sewn into fabrics and, therefore, be potentially considered as components for smart textiles. Moreover, these fibers provided remarkable electromechanical actuator capabilities. [2-4]

SWNT/polyethylenimine (SWNT/PEI) composite fibers are also here reported. The resulting SWNT/PEI composite fibers have useful mechanical properties and over a hundred times the electrical conductivity of super tough SWNT/PVA composite fibers. The efficient interfacial interaction between the polymer and the nanotubes enables the fabrication of stable gel fibers and solid fibers from PEI, which is a liquid polymer at room temperature.[5]

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SYNTHESIS AND ELECTROCHEMICAL CHARACTERIZATION OF CATALYTIC ACTIVITY OF POLYMER STABILIZED PT AND PT@CU CORE-SHELL NANOPARTICLES

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The use of platinum-group metal PGM) nanoparticles (MNPs) in various catalytic and electrocatalytic applications (such as, for example hydrogen and methanol fuel cells, sensors, biosensors, etc.) is permanently growing. In many instances application of MNPs is based on the use of their unique properties (electrical, magnetic, optical, ionization potentials, etc.), which are distinct from those of the bulk metal and isolated atoms. On the other hand, they require stabilization to prevent coalescence and aggregation, and hence to save their special size and properties. The development of Polymer-Stabilized MNPs (PSMNPs) is one of the most promising solutions to the MNPs stability problem [1-3]. Another important problem concerning the use of noble metal nanocatalysts is the decrease of PGM loading without dramatic change of their catalytic properties. One of the possible solutions of this problem is the use of core-shell PSMNPs, which are composed of a cheap metal core coated with a thin PGM shell [4].

In this presentation we report the results obtained in a comparative study of electrocatalytic properties of Pt (monometallic) and Pt@Cu (core-shell bimetallic) PSMNPs, which have been synthesized under identical conditions by using the polymeric membranes as a nanoreactor. The intermatrix synthesis of MNPs was carried out by sequential loading of the functional groups of sulfonated poly(etherether ketone) (SPEEK) with desired metal ions followed by their reduction inside the membrane (intermatrix synthesis stage), what resulted in formation of PSMNPs of required composition and structure. PSMNPs-containing membranes were characterized by SEM, AFM and TEM techniques to evaluate the morphological changes of their structure and to estimate the MNPs size. Typical TEM images of the Pt- and Pt@Cu-MNPs are shown in Figs. 1 and 2, respectively. As it is seen, the shape and size of monometallic Pt-MNPs differs dramatically from those of Pt@Cu nanoparticles, although the value of platinum loading in both cases is the same. Indeed, Pt-MNPs are characterized by a far larger size and absolutely irregular shape, what makes practically impossible to estimate their diameters, while the majority of Pt@Cu-MNPs have close to spherical shape with diameters of 3-6 nm. As the result, the surface area of Pt@Cu-MNPs appears to be far higher than that of Pt-MNPs.

The MNP-loaded membranes were also dissolved in DMF followed by deposition of the PSMNP-inks on the surface of graphite-epoxy composite electrodes to study the electrochemical properties of polymer-PSMNP nanocomposites and to evaluate their electrocatalytic activity. The results of these experiments are demonstrated in Fig. 3, where the calibration curves of amperometric detection of H_2O_2 are shown. As it is seen, the sensitivity of sensors based on the use of Pt- and Pt@Cu-MNPs synthesized by using the same value of platinum loading differs dramatically from each other. Indeed, the amperometric response of the later exceeds by almost two orders of magnitude that of the former at the same concentration of hydrogen peroxide. One of the possible reasons for this difference is quite different values of surface areas of Pt@Cu- and Pt-MNPs. Another reason can be the influence of the core-metal on the catalytic activity of the shell. However, this point requires additional clarification and we continue our research in this direction.

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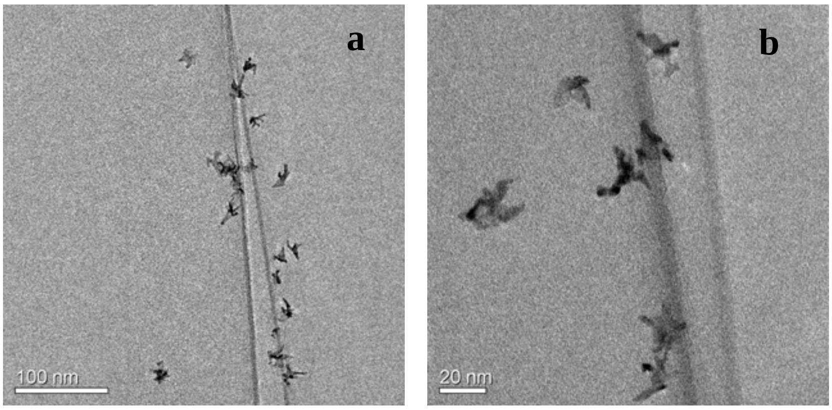

Figure 1. (a) Typical TEM images of Pt- PSMNPs immobilized in SPEEK matrix; (b) HRTEM of group of Pt nanoparticles. Particles are characterized by irregular form.

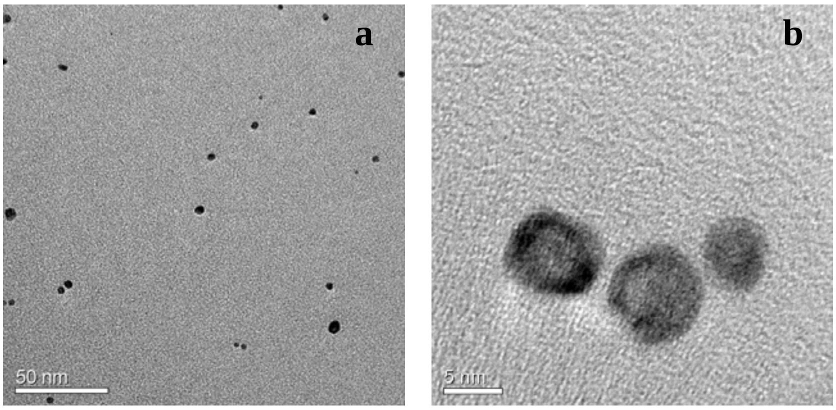

Figure 2. (a) Typical TEM images of Pt@Cu-PSMNPs immobilized in SPEEK matrix; (b) HRTEM of group of few Pt@Cu nanoparticles. Particles are characterized by regular spherical form.

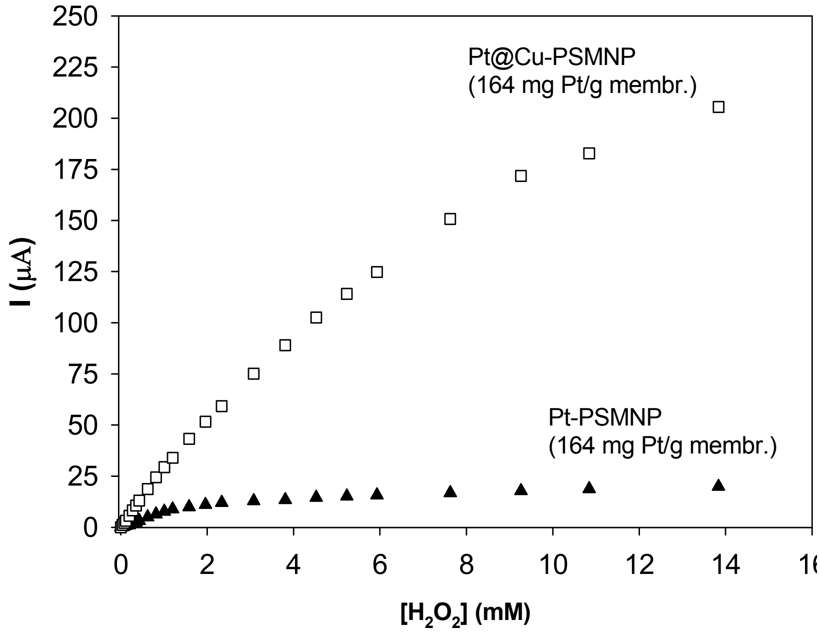

Figure 3. Calibration curves of amperometric sensors prepared by modification of graphite-epoxy composite electrodes with Pt-(black triangles) and Pt@Cu-PSMNP-SPEEK membranes(white squares) at identical values of platinum loading. Conditions: potential: -250 mV; 0.1 M KCl in 0.1 M acetate buffer, pH = 7.0.

ORGANIC DONOR/ACCEPTOR MIXED THIN FILMS SEGREGATE INTO NANOSCALE INTERDIGITATED AREAS ON Au(111): TOWARDS AN OPTIMUM SOLAR CELL HETEROJUNCTION MORPHOLOGY.

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Photon absorption by organic molecules with adequate HOMO-LUMO gap excites metastable electron-hole pairs, whose energy can be converted into electrical power by driving the photogenerated electrons and holes to the different electrodes of a solar cell [1]. Facile processing, mechanical flexibility and low cost are some of the advantages of these “plastic” solar cells [2], which have already reached energy conversion efficiencies higher than 5%. Achieving higher efficiencies is however limited by the fact that, instead of free electron-hole pairs, photon absorption usually leads to the formation of tightly bound excitons (bound states of an electron-hole pair) which can diffuse only for a characteristic length of about 10 nm before radiative recombination occurs [3]. The hitherto most successful approach to promote the dissociation of the photogenerated excitons is to use blends of phase-segregated electron-donor/electron-acceptor molecules – the so-called bulk heterojunction concept [1]. At the interface between electron-donor and electron-acceptor areas, the difference in electron affinities drives the exciton dissociation by injecting free electrons (holes) into the electron-acceptor (electron-donor) areas. Provided that continuously connected paths between the interfaces and the electrodes exist, the free electrons and holes will be collected therein. From these considerations a number of morphological criteria can be extracted for optimum solar cell performance: first, the segregated electron-donor and acceptor domains must have a typical size of the order of the exciton diffusion length, in order to avoid wasteful radiative recombination events; second, the interface area between donor and acceptor domains, where exciton dissociation takes place, must be maximized; and, finally, donor (acceptor) domains must be continuously connected to the cathode (anode) to favour efficient charge transport. A schematic representation of a morphology that would satisfy these three criteria is shown in panel d) of the Figure: interdigitated donor-acceptor domains and elongated structures (to maximize interface area) with typical diameters of no more than 10-20 nm (to suppress exciton radiative recombination events) connected to the electrodes [4].

In this work we describe variable-temperature Scanning Tunneling Microscopy (STM) experiments that show how monolayer-thick blends of the electron donor molecule 2-[9-(1,3-dithiol-2-ylidene)anthracen-10(9H)-ylidene]-1,3-dithiole (exTTF, see Figure a) [5] with the electron acceptor [6,6]-phenyl C_{61} butyric acid methyl ester (PCBM, see Figure b) [6] on a reconstructed $22\times\sqrt{3}$ Au(111) surface, segregates laterally into “nanostripes” whose width is of the order of the exciton diffusion length (Figure c); it thus corresponds closely with the morphology for optimum solar cell performance described in Figure d. The reason for such a peculiar nano-scale morphology can be traced back to the different interactions between the two molecular species and the herringbone reconstruction of Au(111). Our results demonstrate the potential of atomistic studies about the growth of organic semiconductors to open new directions for the design and construction of highly-efficient organic electronic devices.

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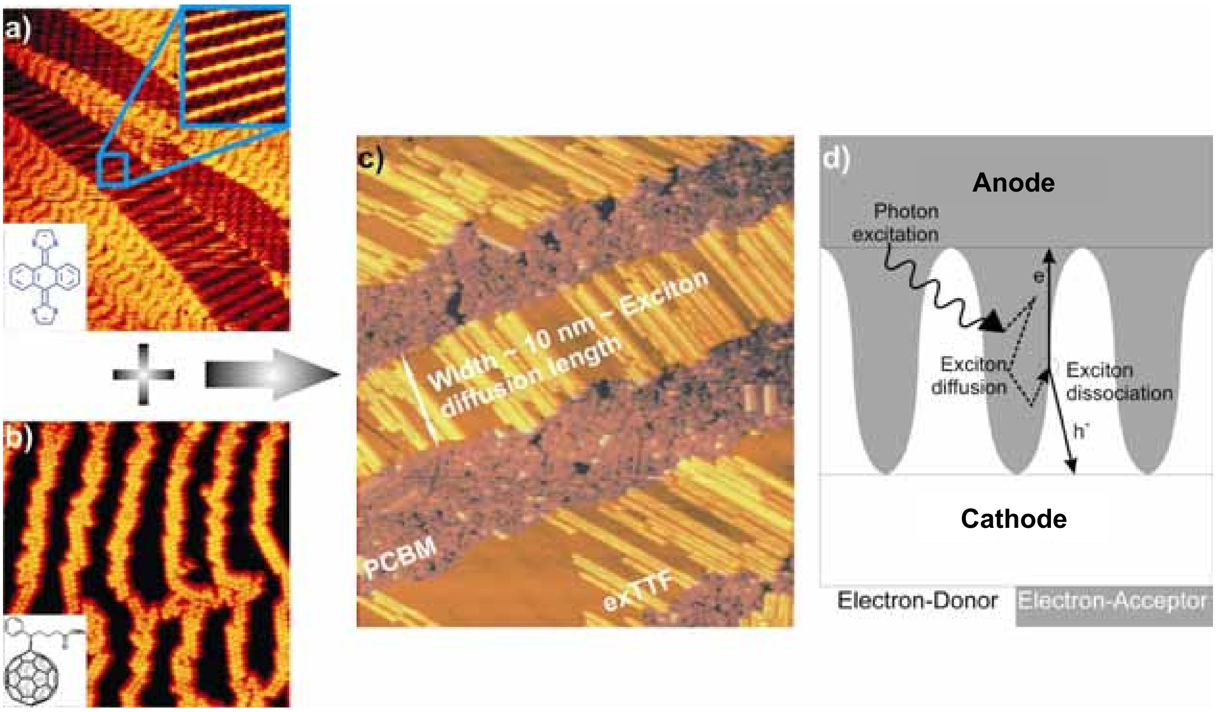

Figure caption. a) exTTF striped islands on Au(111) (176 × 198 nm^2 STM image). b) PCBM selective growth on FCC areas of the $22\times\sqrt{3}$ herringbone Au(111) reconstruction (59 × 60 nm^2 STM image recorded at 150 K). c) Lateral segregation into nanoscale "fingers" whose width is about 10 nm, which is comparable to the exciton diffusion length (118 × 132 nm^2). d) Schematic representation of a hypothetical morphology for optimal solar cell efficiency.

CIC nanoGUNE Consolider

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The CIC nanoGUNE Consolider is a newly established Center created with the mission of addressing basic and applied world-class research in nanoscience and nanotechnology, fostering high-standard training and education of researchers in this field, and promoting the cooperation among the different agents in the Basque Science, Technology, and Innovation Network (Universities and Technological Centers) and between these agents and the industrial sector. nanoGUNE will develop the Cooperative Research Center (CIC) concept which has been successfully implemented in various cases in the Basque Country. Besides, nanoGUNE has been awarded as a Consolider Center by the Spanish Education and Science Council.

CIC nanoGUNE has been designed to address a wide range of activities, including excellence research, technology transfer and innovation related activities, high-level training, international cooperation, and education and outreach.

CIC nanoGUNE focuses its research activities on the following four major strategic areas:

- Physics of low-dimensional structures, nanostructures and nanoscale structured complex systems.
- Synthesis, assembling, and nanofabrication of nanomaterials (nanoparticles, nanotubes, thin films, nanocomposites) and nanostructured materials.
- Development of nanodevices and its impact on molecular electronics, spintronics, nanomagnetism, and nanophotonics.
- Biofunctional nanoparticles and nanobiotechnology.

In this talk, an overview and the current status of the CIC nanoGUNE will be presented.

MAGNETIC RELAXATION OF γ-Fe_2O_3 DISPERSIONS AND ELECTRONIC PHASE-SEGREGATED SYSTEMS

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The technological demand for higher density storage capacity has stimulated the development of methods to fabricate and assemble ultrafine magnetic particles.[1] When synthesized below the critical size for domain-wall formation (commonly in the nanometer range), magnetic nanoparticles (MNPs) exhibit a number of properties different from the bulk. Below a certain size, thermal energy can overcome the energy barrier for magnetization relaxation and make the whole magnetic moment of the particle to fluctuate above a characteristic temperature, T_B, called blocking temperature. This behaviour is called superparamagnetism and poses an important technical limit for the development of high-density magnetic storage devices.[2] On the other hand, below T_B, interparticle interactions can establish collective modes of relaxation, and introduce aging, thermal and field memory, and other complex relaxation phenomena. A still unsolved question concerning these systems is the analysis of the conditions under which dipolar interactions among dispersed MNPs can produce collective states that constitute true spin-glasses (superspin-glass). Although important advances in the comprehension of this problem have been made[1-3] several experimental difficulties associated to unavoidable shape and size distributions have hampered a definitive testing of theoretical models.

In this work we present a combined approach to test the most relevant predictions of the theoretical models for relaxation in assemblies of magnetic particles. On one side, high quality MNPs of γ-Fe_2O_3 have been synthesized by a microemulsion method[4] and dispersed in a polymeric matrix at different concentrations, to modify interparticle interactions. On the other side, the spontaneous phase segregation of FM “particles” into a non-FM matrix that takes place in some strongly electronic correlated materials has been used to study the problem of the phase-transition towards the superspin-glass phase.

DC magnetization of PVB based-magnetic nanocomposites with different wt% of γ-Fe_2O_3 NPs was measured as a function of temperature. For the lowest concentrations of MNPs the ZFC curves show a narrow maximum located at $T_B \approx 5K$. The magnetization in FC conditions increased with decreasing temperature and both curves ZFC and FC split from slightly above T_B. Increasing the concentration, the peak broadens and T_B shifts to higher temperatures, in agreement with a progressive increase in the magnetic dipolar interactions.

The variation of the magnetization relaxation rate, W(t), was also measured as a function of time for dispersions with different concentrations of MNPs. The behavior of different samples was compared with the model proposed by Ulrich et al.[5] in which, by analyzing the values of n (the slope of the W(t) vs t curve), three basic regimes can be distinguished: non interacting systems, corresponding to $n=0$; weakly to medium interacting systems, with $0<n<1$ and strongly interacting systems, having $n\geq1$ (reminiscent of spin-glass relaxation behavior). Our results showed that by increasing the concentration of MNPs in the composite, an appreciable increase in the n value is produced, reaching a value of $n\approx1$ for the most concentrated assembly proved in this work (48.3%Wt, figure 1a, inset). Although the dispersion of the data is small enough to get reliable values of n, is very difficult to extract a definitive, irrefutable conclusion about the formation of a canonical spin-glass with the present data. Higher concentrations of particles should be proved to increase the interactions and test this hypothesis. However, the surfactant that coats the particles sets an upper limit for the maximum concentration that can be attained around 50 Wt% (near 0.17 as volumetric fraction).This experimental drawback can be avoided following a completely different approach, which implies the use of certain materials that undergo spontaneous magnetic phase segregation. In these systems, it should be possible to find a situation in which metallic-FM droplets segregate into a localized-AF matrix. We have studied the relaxation behavior of a prototypical system: $(La_{0.25}Nd_{0.75})_{0.7}Ca_{0.3}MnO_3$. As can be seen in figure 1b, although the system remains insulating in all the temperature range, the magnetization increases rapidly bellow ≈120K, indicating an increase in the FM correlation length. However, below a certain temperature, T*≈90, both ZFC and FC curves split, and while the ZFC magnetization shows a strong temperature dependence, the FC curve flattens and remains almost constant down to the lowest temperature proved (Figure 1b). This behavior is suggestive of a non-homogeneous magnetic system, in which magnetic order remains short-ranged (cluster-glass).[6] Below T*, which can be considered as a blocking temperature of an assembly of FM particles in an AF matrix (compare with figure 1a), logarithmic relaxation of the thermoremanent magnetization was probed. The value of n was clearly in the regime suggested by Ulrich et al.[5] for a true (super) spin-glass (Figure 1b, inset). However, to definitively confirm the existence of a true spin-glass we studied the critical behavior of the spin-glass order parameter susceptibility and checked the critical exponents through scaling. The results obtained from this analysis showed that the spin-glass state can be achieved in this system and there are plausible evidences about the frustrated interparticle interaction of this collective state.

In summary, our results point towards the formation of some sort of collective or glassy state in concentrated MNPs dispersions, although a definitive confirmation of the existence of a true spin-glass remains elusive. On the other hand, we have proposed that certain inhomogeneous magnetic phases that occur in strongly-correlated materials can be considered as a "self generated colloid" of FM particles in an AF matrix. Magnetic interaction among these particles introduces a true spin-glass state in this case, and opens this possibility for sufficiently concentrated assemblies of classical MNPs.

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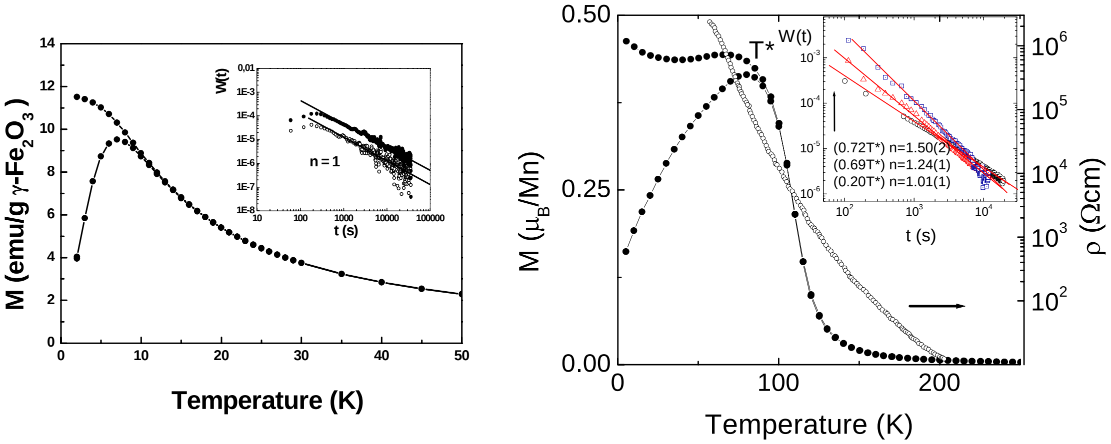

(a) (b)

Figure 1. (a) Zero-field-cooled (ZFC) and field-cooled (FC) magnetization curves for (a) a powdered sample containing 48.3 Wt% of MNPs at H = 100 Oe and (b) $(La_{0.25}Nd_{0.75})_{0.7}Ca_{0.3}MnO_3$, at H=250 Oe (The resistivity is also shown (open circles, left axis)) Insets: Relaxation rates at different temperatures below T_B (a) and T* (b).

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THE INTERNATIONAL IBERIAN NANOTECHNOLOGY LABORATORY (INL)

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INL - Braga

The decision to create in Braga a Portugal-Spain International Research Laboratory was announced on November 19th, 2005 by the heads of Government of both countries at the XXI Portugal-Spain Summit. At the end of November 2006, both Governments approved the legal statutes of the International Iberian Nanotecnology Laboratory (INL). The purpose of this presentation is to show the future of the research and social influence of the INL in the initial stages.

The INL shall provide a basis for scientific and technological co-operation, especially in nanotechnology by carrying out both fundamental and applied research as well as research essentially related thereto. Among others, the Laboratory's activities shall aim at developing collaboration between universities and industries, as well as between public and private sectors, training researchers, and contributing to the development of a skilled work force for the nanotechnology industry.

In this talk special attention will be paid to two major points: the definition of initially selected research areas as well as the recruitment of personnel, on the basis of internationally recognized scientific and technical excellence.

CHARACTERIZATION OF FUNCTIONALIZED Si SURFACES FOR BIOSENSOR APPLICATIONS.

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Biochips, devices with biological macromolecules located in spatially-defined areas, play an increasingly important role in the molecular and medical biosciences. Fluorescence is the dominant method for array interrogation but requires a label to be added to one of the components, bulky and expensive instrumentation and sophisticated software for data interpretation. Recently attention has been focused on electronic and electrochemical sensors based on self-assembled molecules on surfaces, because they present the sensitivity of fluorescence-based systems but are cheaper and more compact, potentially allowing near instant diagnostics at the point of use[1]. One of the most studied systems as biosensor is the self-assembled monolayer of alkanethiols on gold[2]. It is clear, however, that deserve importance to construct ordered molecular layers on semiconductor surfaces, mainly on Si, because the wide range of possible applications in conjunction with the advanced silicon technology.

There has been increasing interest in the molecular functionalization of hydrogen-terminated silicon surfaces[3]. Our work, based on the reaction of Si-H surfaces with alkene chains by thermal alkylation reaction, is focused on the functionalization using mixed monolayers. The thermal alkylation reaction produces a uniform monolayer where both components are well mixed, despite being of different chain length and tail-group.

The reaction is irreversible, via the stable Si-C bond[4], and it is not influenced by the functional groups at the other end of the molecule, by a simple dilution method we are able to control the mean spacing between reactive groups on the surface and this is a useful method for nanoscale surface design: chosen the appropriate terminated groups for these chains, the Si surfaces are suitable for the attachment of different nano-objects[5] (nucleic-acids, enzymes, proteins, nanoparticles…)

In our work we have combined different silicon surfaces, porous Si and Si(111) single crystal with different molecules to mixed, octyl (C8), undecyl (C11), undecenyl aldehyde (C10CHO), and undecanol (C11OH). By the combination of different experimental techniques we have fully characterized these mixed monolayers.

The combination of Fourier transform infrared and Synchrotron Radiation X-ray photoelectron spectroscopies reveals that the resulting molecular films present a composition that is representative of the composition of the solution.

On the other hand atomic force microscopy gives us information about the structure and resistance for the layers prepared in every stage of the immobilization process. AFM images show that lateral diffusion and/or desorption-readsorption of the adsorbate is very small.

Finally, the experiments also show that we have achieved our aim of covalently locating biomoléculas (proteins or PNA) to specific areas of the silicon surface.

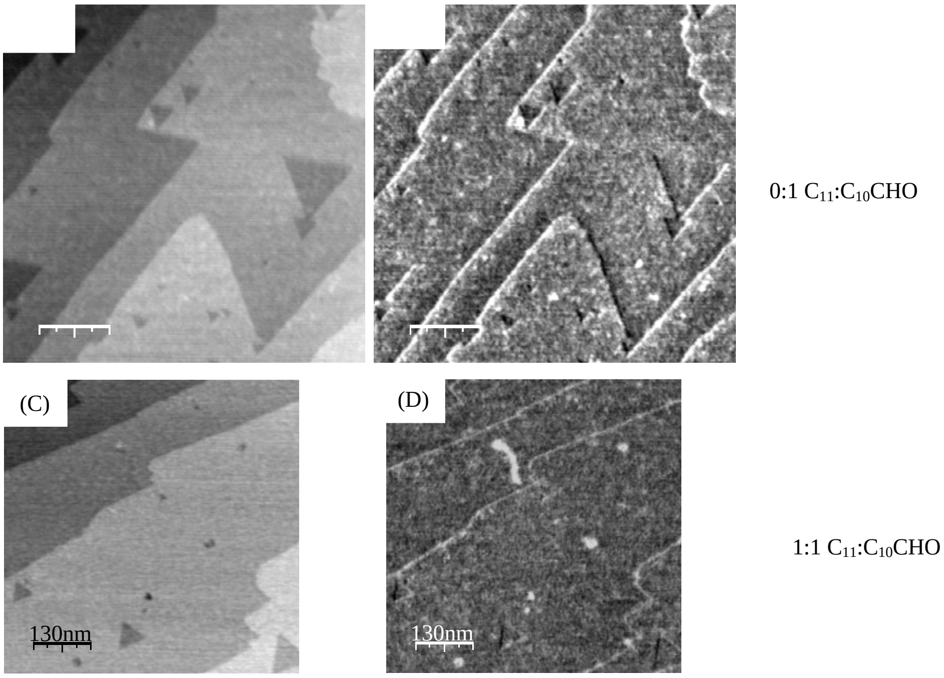

Figure 1: Topographic (left) and friction (right) AFM images of a one component C_{10}CHO monolayer (A,B) and a mixed monolayers, 1:1 C_{11}/C_{10}CHO, on Si(111) (C,D). The mixed monolayer images exhibit the same features as the single component monolayers and do not show patches or islands due to the phase separation.

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ELECTRONIC TRANSPORT AND MECHANICAL PROPERTIES OF SUSPENDED ATOMIC CHAINS OF GOLD

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Freely suspended nanowires of single atoms are the ultimate metallic conductors, they form spontaneously in the process of breaking of a metallic contact of certain metals (Au, Pt and Ir) . Atomic nanowires of gold have a zero bias conductance close to one quantum of conductance $G_0 = 2\ e^2/h$ (where e is the charge of the electron and h is Planck's constant), independently of their length, because electron transport proceeds through one single quantum conductance channel which is almost completely open. Gold atomic chains are very stable at low temperatures and offer the possibility of studying the mechanical behavior of a small number of atoms in a well-defined configuration [1][2]. We use the force measurement and vibrational spectroscopy to probe the mechanical properties of the atomic chains [3] and gain insight into the dynamical processes during chain formation.

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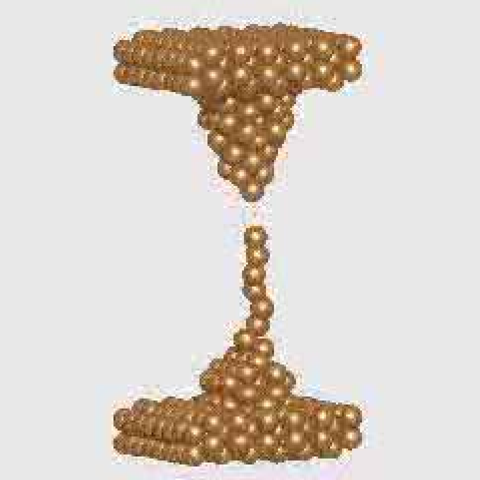

SURFACE PLASMON PHOTONICS ON METALLIC NANOSTRUCTURES: SERS SUBSTRATES AND NANO-ANTENNAS

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We investigate theoretically and numerically the interaction of light with metallic nanostructures supporting surface plasmons (SP). The rich phenomenology associated with such interaction is explored in relevant configurations. Collective electromagnetic processes stemming from molecular emission close to complex nanostructured metal surfaces pumped at/near surface-plasmon resonances are investigated. We present a theoretical model for the classical electromagnetic radiation from a molecular layer on a nanostructured metal surface, assuming that the emission process is concentrated on the surface [1]. The resulting inelastic polarization can be incorporated in any scattering formulation; in particular, we have worked out the corresponding expressions for the (formally exact) Green's theorem surface integral equations. With this model we are able to calculate the surface field, near field, and far field at the (inelastic) Raman-shifted frequency, separately of the electromagnetic field at pump frequency. In this manner, we explore both collective spontaneous emission near metallic nano-antennas and surface-enhanced Raman scattering from Langmuir-Blodgett films (molecular monolayers) on disordered, nanostructured metal surfaces.

On the one hand, the excitation of localized SP leads to large enhancements of the surface electromagnetic (EM) field, crucial to the EM mechanism of surface-enhanced Raman scattering (SERS), and to a large extent responsible for the phenomenon of SERS single-molecule detection [2]. A rigorous calculation of the scattered electromagnetic field has been carried out for random metal surfaces with similar properties to those exhibited by nanostructured metal substrates used in SERS. Numerical results are presented for near-field enhancements for single realizations [3], as shown in Fig. 1. Mean values of the SERS enhancement factor averaged over an ensemble of realizations [3].

On the other hand, the resulting formulation is also exploited to explore surface molecular emission close to metal nanoparticles of complex shape, pumped at/near SP resonances, such as spontaneous emission processes near metallic nano-antennas (e.g. rectangular dimers as in [4,5]), for which near-field and far-field maps are obtained at both pump and emission frequencies (see Fig. 2).

We acknowledge support from the Spanish MEC (FIS2004-0108, FIS2006-07894) and CAM (MICROSERES Network, S-0505/TIC-0191).

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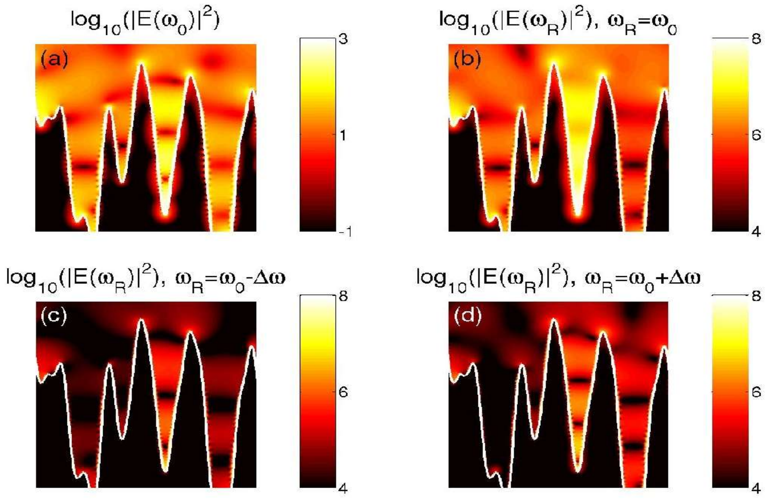

FIG. 1: Near electric field intensity maps in a $\log_{10}$ scale, from a rough Ag surface with RMS 255 nm and correlation length 51. 5 nm, for normal incidence and 603 nm wavelength in an area 0.9x0.9 μm^2 . (a) Pump field. (b)–(d) SERS field at (b) negligible Raman shift, (c) Stokes emission at 670 nm, and (d) Anti-Stokes emission at 548. 2 nm.

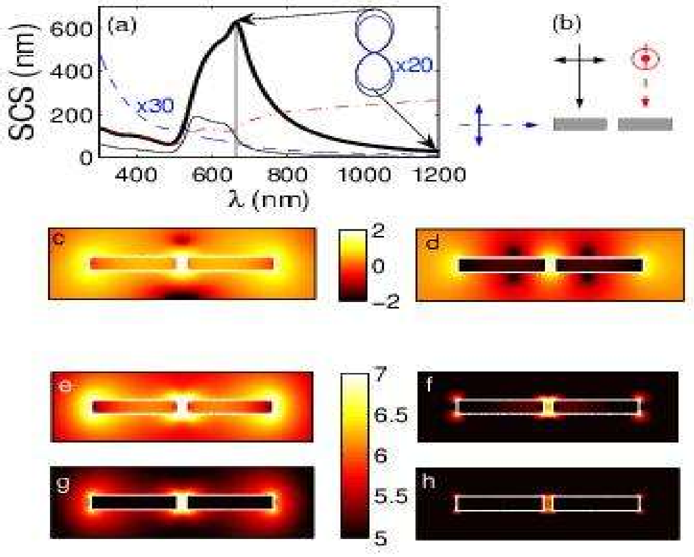

FIG. 2: (a) Scattering cross sections for a dimer consisting of rectangular gold nanowires of 100 nm length and 20 nm width with a 10-nm-wide gap; incident angles and polarizations as shown in (b), the thin black curve being as the thick one but for a single nanowire. (c–d) Near field intensity (log10–scale, normalized to the incident field) at the pump frequency for incident direction/polarization perpendicular/parallel to the dimer axis: (c) on resonance (665 nm) and (c) off resonance (1.2 µm); corresponding far-field patterns shown in the inset in (a). (e–h) Near field intensity (log10–scale, a.u.) at the emission frequency for various pump/emission frequencies: (e) on/on; (f) on/off; (g) off/on; and (h) off/off.

ORAL CONTRIBUTIONS (PARALLEL SESSIONS)

THE IMPORTANCE OF THE SPIN-OFFS ON SPANISH UNIVERSITIES

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Nanogap is a spin-off from the University of Santiago de Compostela. The following lines schematize the steps of its creation and growth from the very beginning up to today.

- Where did the idea come from?
    - The Spanish universities knowledge: Realizing the true potential of the Spanish universities.
- Creating the enterprise: USC entrepreneurship support structures
    - Empresa concepto: Development of the business plan and economical viability.
    - Credits, Funds and economic aids: Money search
    - Investors: Business angel or venture capital society external funds.
- Difficulties
    - Technology transference
    - Science men in business world
    - From the pure knowledge to the final application
- Keeping an eye on the money
    - Business focus
    - Industry approach
    - Hitting the road

MECHANICAL DETECTION OF CARBON NANOTUBE RESONATOR VIBRATIONS

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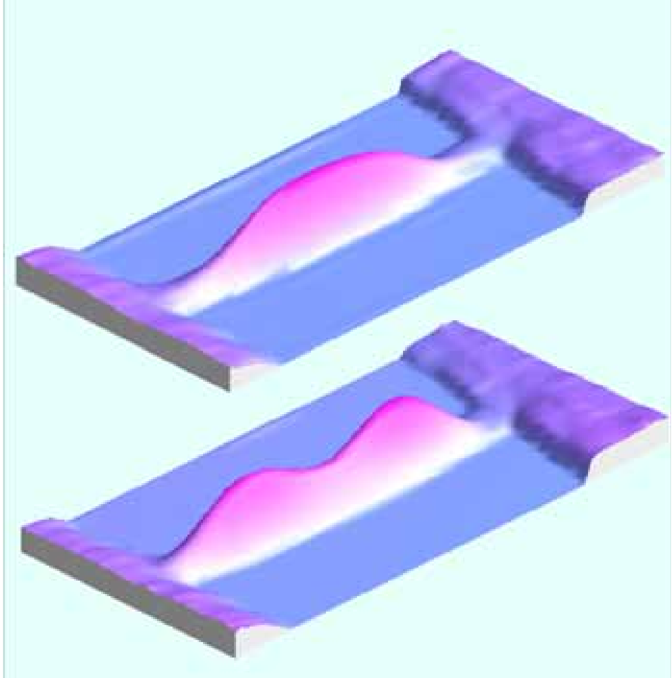
Carbon nanotubes are often recognized as the ultimate material for high-frequency mechanical resonators. Single-wall nanotube (SWNT) resonators are ultra light, which offers great promise for the sensing of molecular masses. In addition, nanotubes are exceptionally stiff, making the resonance frequency very high, which is suitable for experiments that manipulates and entangles mechanical quantum states. However, the detection of vibrations of nanotube resonator devices remains very challenging. The detection, which is so far based on capacitive measurements, can often not assign the measured resonance peaks to their eigenmodes. Another difficulty is to discern actual resonance peaks from artefacts of the electrical circuit. Here, we demonstrate a novel characterization method of nanotube resonator devices, which is based on mechanical detection by scanning force microscopy (SFM). This method enables the detection of the resonance frequency up to 3.1 GHz in air at atmospheric pressure and the imaging of the mode-shape for the first three eigenmodes. SWNT resonators are shown to be ultra sensitive to stress, slack or contamination. On the other hand, the resonance frequencies of multi-wall nanotubes are found to be consistent with elastic beam theory for a doubly clamped beam. We anticipate that SFM detection will be very useful to study NEMS devices made of other materials.

The collaborators of this project are D. Garcia-Sanchez, A. San Paulo, M.J. Esplandiu, F. Perez-Murano, L. Forró, and A. Aguasca.



THREE DIMENSIONAL POLIMERIC PHOTONIC CRYSTALS

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Here we present our latest results regarding the fabrication and characterization of three dimensional photonic structures starting from polymeric templates. Polymeric photonic matrices (polystyrene or pmma) have some advantages versus their inorganic counterparts (i.e. silica) when used as templates. Submicron polymeric spheres can be arranged in 3D and used to fabricate photonic nanostructures in different materials (ZnO, Silicon, SiO_2, etc.), enhancing or tailoring their properties.

NOVEL APPROACH TO THE FABRICATION OF ORDERED ARRAYS OF QUANTUM WIRES

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We propose a novel method for the engineering of one-dimensional nanostructure fabrication with no need of catalyst agents. The method is based on a lithography design of a pattern of channels onto a conveniently cleaved semiconductor surface, as illustrated in Fig.1. We believe that this method opens a range of possibilities for optoelectronic nanodevices with improved efficiencies.

We demonstrate by means of first-principles electronic structure calculations that when the channel diameter is sufficiently larger than the interstitial space, the resulting pillars constitute an ordered array of electronically independent, though mechanically interconnected nanowires. We also show that a controlled coupling of the nanowires can be achieved, as long as one is capable to tune, at fabrication time, the thickness of the interconnections, which are ultimately responsible of the efficiency of the quantum confinement. This method, being based on a top-down approach, would yield an ensemble of identical nanowires, grown along the same crystallographic orientation and with similar properties concerning the length and the diameter.

We present density-functional calculations [1] of different templates, where the channels – and consequently the nanowires – are distributed according to a square or a hexagonal network, discussing the case of silicon and gallium arsenide. The hexagonal distribution of channels proved to offer the best confining properties, while there is no clear evidence that any of these two materials should be clearly superior to the other for what concerns the confinement properties. Calculations have been performed with the Siesta ab-initio package [2]. For a silicon substrate, holes in a square disposition, wire size of 23.3Å and interconnects 22.0Å long and 5.5Å, we observe that states remain in the wire section. However, widening the interconnect to 11.0Å, we observe the appearance of laterally propagating states (see Figure 2). The dispersive behaviour is conclusively determined from the observation of the band width for the bands of interest (cf. Figure 3).

We also present results for structures with less demanding (i.e. bigger) feature sizes. Figures 2.d) and 2.e) show the charge density associated to the minimum of the conduction band for a GaAs substrate with different channel radii. These results are obtained with the Effective Bond Orbital Model (EBOM), and display d) purely 1D or e) two-dimensional superlattice behaviour.

The use of such structures could be easily extended to quantum well or superlattice substrates, e.g. GaAs/InGaAs or GaAs/GaAsP, leading to the fabrication of one-dimensional heterostructures or quantum dots with potential applications as light emitting devices.

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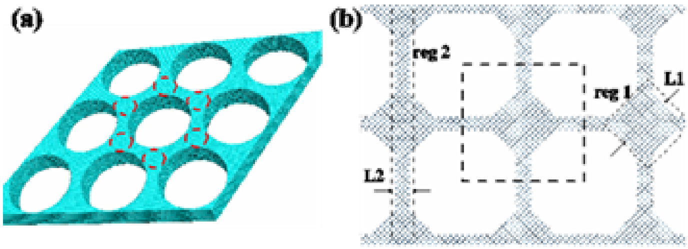

Figure 1 (a) Schematic of the proposed approach and (b) unit cell for the square topology.

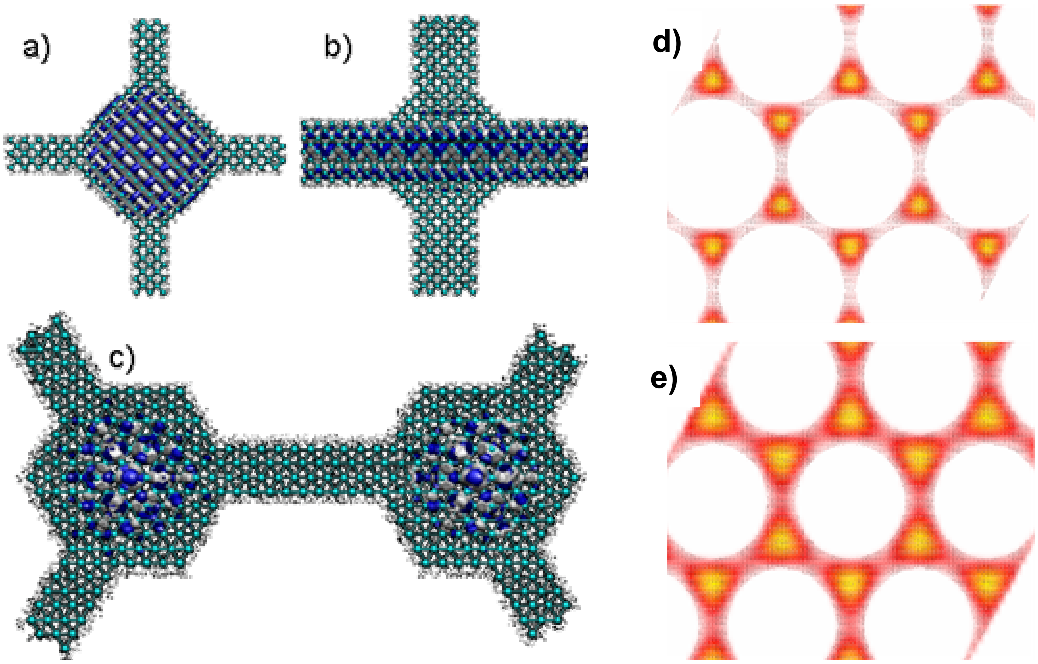

Figure 2 Wave-function of the lower state of the conduction band in the case of square [a) and b)] and hexagonal [c)] arrays of channels in silicon (unit cell shown). The confined character of the state sustaining the electron carriers is evident in a) and c), while b) is obviously propagating. Hole carriers are hosted by states with similar features (not shown here). d) [e)] shows isolated (interacting) NW behavior in GaAs, with a distance of 40 nm between hole centers.

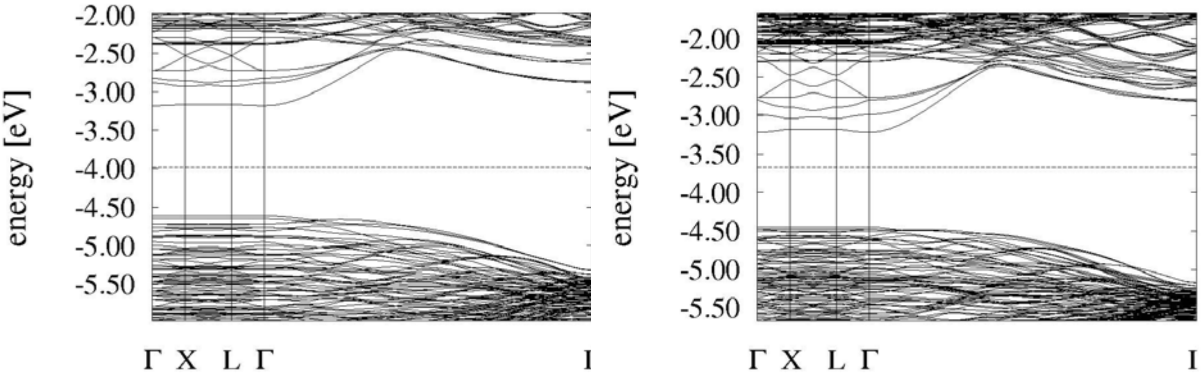

Figure 3 Band structure diagrams in the case of a square arrangement of channels in GaAs. The interconnections between neighboring pillars have a thickness of 0.6 nm (left panel) and 1.2 nm (right panel). With the thinner interconnections the bands disperse essentially only along k_z direction, indicating an efficient confinement; coupling between neighboring pillars starts to appear for the thicker interconnections.

BIASED GRAPHENE BILAYER: A TUNABLE GAP SEMICONDUCTOR

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The two-dimensional (2D) arrangement of carbon atoms forming a honeycomb lattice structure is called *graphene*. It can be viewed as the fundamental unit of several carbon allotropes: three-dimensional graphite is obtained upon stacking; rolling it up gives a one-dimensional nanotube; and it can be wrapped up to form zero-dimensional fullerenes. However, it was not until very recently that graphene, the 2D allotrope of carbon, was experimentally realized [1, 2].

Graphene has immediately attracted great deal of attention. Low energy quasi-particles in graphene have a linear dispersion relation, behaving as massless relativistic particles. This property is responsible for quite unusual (and interesting) solid state physics in graphene; the unconventional integer quantum Hall effect (QHE) being a paradigmatic example [3-6]. Moreover, the surprising stability of this new 2D material and the observed ballistic transport makes graphene a promising candidate for future carbon-based electronics [7].

The technics that made possible the production of single layer graphene were successfully applied to produce *bilayer graphene* – two coupled single layers. The bilayer turned out to have interesting properties on its own. A third kind of integer QHE was recently observed [8], and the possibility of externally control the bilayer band structure [9] makes this system even more promising for some electronic devices.

A graphene bilayer with an electrostatic potential difference between layers – *biased bilayer* – has been experimentally realized recently [10]. Using a tight binding description we have demonstrated that the externally applied gate bias effectively controls the electronic gap between the valence and the conduction bands of bilayer graphene.

Applying the theory to the description of magneto-transport data (Shubnikov-de Haas measurements of the cyclotron mass) we have extracted the value of the gap as a function of the electronic density. It was shown that the gap can be tuned between zero and mid-infrared energies using fields still below the electric breakdown of SiO_2.

The opening of a gap is clearly seen in the quantum Hall regime, where the zero-energy double step characteristic to the anomalous QHE in unbiased bilayer graphene, splits into two, giving rise to an additional plateau at zero Hall conductivity, besides the standard quantum Hall sequence.

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Abstract not available

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GLYCONANOTECHNOLOGY: A METHODOLOGY TO PREPARE BIOFUNCTIONAL NANOPARTICLES WITH APPLICATION IN NANOMEDICINE

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During the last years our laboratory in Seville has developed a new technology (Glyconanotechnology) for tailoring - in a simple and versatile way – bio-functional gold nanoclusters (glyconanoparticles, GPNs). [1,2,3] The GNPs present some advantages over other previously prepared colloids as: 1) easy preparation and purification; 2) exceptional small core size and narrow distribution sizes; 3) control over ligands number and nanoparticles size; 4) water solubility; 5) high storage stability without flocculation; and 6) singular physical properties.[4]

The manipulation of the metallic cluster to obtain luminescent *glyco*-quantum dots (semiconductors) [5] and magnetic nanoparticles for application in cellular labelling and imaging by magnetic resonance (MRI), is comprised within the potential of this novel technology. Furthermore, the introduction of additional ligands can be used to guide the assembly of the nanoclusters creating a wealth of different nanostructures. [6]

GNPs with biological significant carbohydrates (antigens) and with differing carbohydrate density have also been prepared to study biological mechanisms [1,7,8] and to intervene in cell adhesion processes.[9] The methodology includes the preparation of *hybrid* GNPs incorporating carbohydrates and other molecules such as fluorescent probes, biotin as well as biological molecules such as peptides, DNA and RNA etc.

The biofunctional nanoclusters presented here has the potential to integrate all the current knowledge and applications on processes that involve both Nanomaterial Science and Biology and to complement the current gene oriented Nanobiotechnology. [10]

The design and preparation of complex bio-functional glyconanoparticles (GNPs) and their application as polyvalent tools to study and intervene in carbohydrate mediated biological interactions will be highlighted. As examples of application in Nanomedicine, the preparation and study of GNPs as anti-adhesion agents in inhibition of metastasis, as potential microbicides for blocking HIV-1 infection, or as anti-cancer vaccines will be discussed. In addition, magnetic glyconanoparticles for application in cellular labeling and magnetic resonance imaging (MRI) will also be reviewed.

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Figure 1. Synthesis of GNPs.

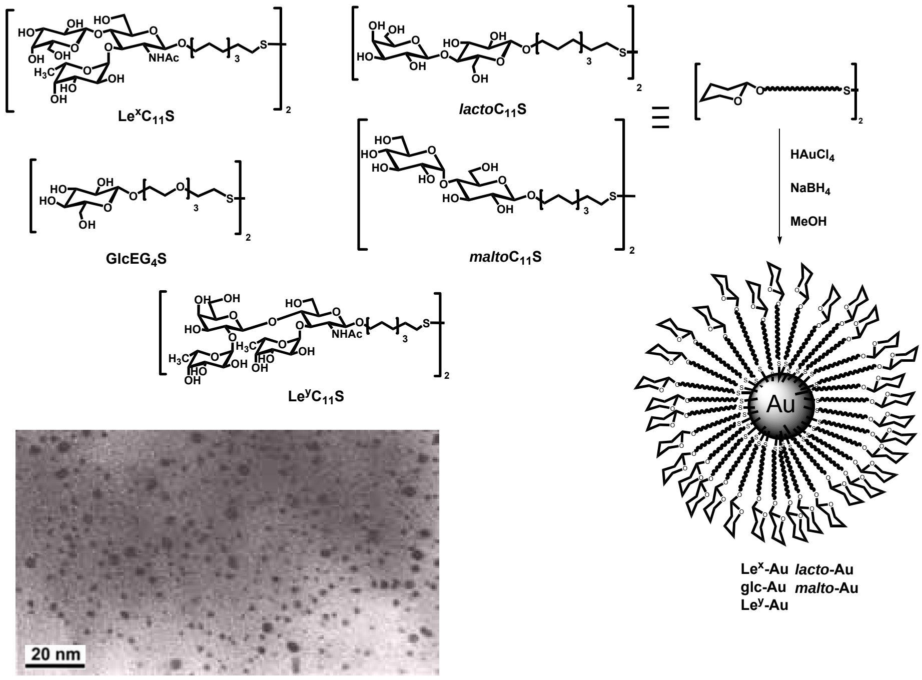
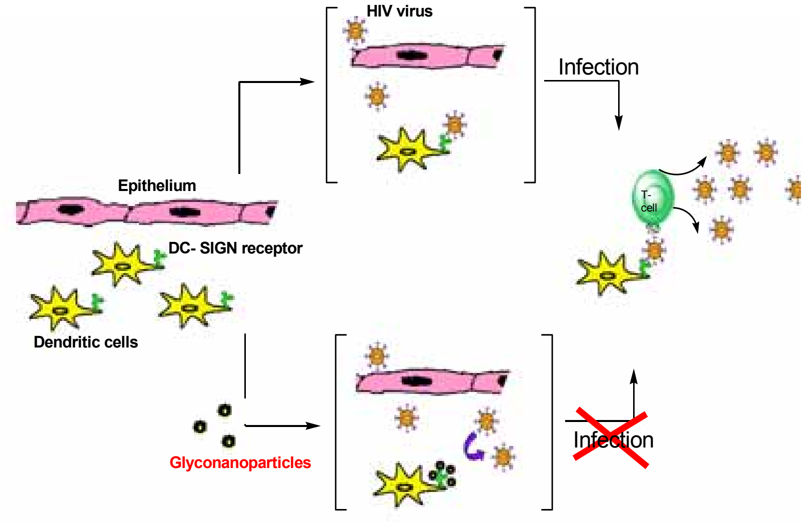


Figure 2. Possible action of mannose GNPs against HIV infection.



ULTRAFAST DYNAMICS WITHIN NANOCAVITIES AND NANOCHANNELS

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Within recent years, we have reported on fast and ultra fast events in chemical and biological nanocavities.[1-6] As expected,[7] the results obtained demonstrated that confinement may affect both spectral (color) and time domains. In this talk, we will show and discuss the results of our efforts in studying ultrafast dynamics in confined systems by reporting on picosecond and femtosecond dynamics of selected molecules – undergoing proton transfer reaction and twisting motion- within nanocavities and nanochannels of zeolites in water and organics solutions. We found a rich dynamics with times ranging from 50 fs to 100´s of ps, and explain the results in terms of different nanoreactivity, confinement and restriction to free motions within the nanospace.

We believe that these results might be important for a better understanding of nanocavities and nanochannels confinement of organic molecules undergoing proton and twisting motions.

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CREATION OF TECHNOLOGY-BASED START UPS

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Creation and growth of technology based start ups normally requires a deep involvement of those researchers involved in the technology development and also of those owning technologies' Intellectual property Rights (most of the times not the researchers themselves). Moreover, it does require an entrepreneurial attitude and business skills, which are not easy to find within research groups. Because of this lack of business skills, researchers do often have difficulties in translating their ideas and results into businesses.

This presentation will introduce the phases that an entrepreneur would go through when creating a technology-based start up, from the initial idea (and initial research results) until the creation of the start up and its development into an established company.

For every phase, key issues to be addressed will be presented, giving special emphasis to issues researchers are less familiar with, the common challenges they face and how they could be solved.

NEUTRON SPIN-ECHO EVIDENCE OF INTER-PARTICLE SPIN CORRELATIONS OF FE(CU) NANOPARTICLES IN A AG MATRIX

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Giant magnetoresistance (GMR) alloys of technological interest are often produced in the form of a collection of nanometric magnetic particles randomly embedded in a metallic matrix. This leads to the existence of intrinsic *magnetic relaxation* phenomena of the nanoparticles, which naturally affect the GMR behavior. Usually, this magnetic relaxation is governed by the competition between the anisotropy and the thermal energies, and the outcome is particles with their atomic spins blocked or in which the net magnetization is flipping around the easy magnetic axis (*superparamagnetic regime*). This ideal situation is modified when the interparticle distance is reduced to a few nanometers; in such an arrangement, extra magnetic interactions are triggered and the relaxation behavior tends to be more collective [1]. Many examples have been given thanks to the interpretation of macroscopic magnetic data (AC-susceptibility, DC-magnetization, aging, etc.), but the *direct* observation of the relaxation phenomena is limited to a small number of microscopic techniques, as Mössbauer and muon spin relaxation, anyhow both presenting a limited spatial coherence.

Neutron spin-echo is a *unique* powerful technique to detect spin-spin correlations with spatial resolution through the measurement of the correlation function $S(q, t)$. In addition the intrinsic relaxation time of neutrons ($\approx 10^{-12}$ s) allows the fastest sampling time to detect spin coupling. We report here the results (0.034 Å$^{-1} \leq q \leq 0.156$ Å^{-1}, 20 K $\leq T \leq$ 300 K) and analysis the *first experiment* using NSE on a metallic fine-particle system.

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CONDUCTANCE, SURFACE TRAPSA ND PASSIVATION IN DOPED SILICON NANOWIRES

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By means of *ab initio* total energy and conductance calculations within the Landauer Formalism we investigate the structural, electronic and transport properties of doped silicon nanowires (SiNWs). We find that impurities always segregate at the surface of unpassivated wires, reducing dramatically the conductance of the surface states. Upon passivation, we show that for wires as large as a few nanometers in diameter, a large proportion of dopants will be trapped and electrically neutralized at surface dangling bond defects, significantly reducing the density of carriers. Impurities located in the core of the wire induce a strong resonant backscattering at the impurity bound state energies. Surface dangling bond defects have hardly any direct effect on conductance. Upon surface trapping, impurities become transparent to transport, as they are both electrically inactive and do not induce any resonant backscattering.

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THE NANOSCALE SPIDER-WEB: A MOLECULAR SELF-ASSEMBLY DUE TO SUBSTRATE-MOLECULE INTERACTIONS

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One of the currently most active fields of research in Surface Science is the study of the self-assembling properties of relatively complex organic species. In solution or gas phase the geometry of the self-assembled nano-structures depends exclusively on the specific interactions between peripheral functional groups of the self-assembling molecules. On the other hand, for molecules adsorbed on a solid surface, the role of the surface cannot be neglected, and the resulting 2D molecular arrangement is the consequence of a subtle balance between molecule-substrate and molecule-molecule interactions, but very few cases (involving either vicinal [1] or chemically heterogeneous [2] surfaces) have been reported where the substrate dictates almost uniquely the 2D arrangement.

In this contribution we describe STM experiments showing how molecule-substrate interaction become the dominant force in the self-assembly of PCBM ([6,6]-phenyl C61 butyric acid methyl ester, Figure 1), a C60 derivative, on a chemically homogeneous surface, Au(111).

The 22 x √3 of the Au(111) surface has its origin in an uniaxial contraction along one close-packed [1-10] direction in which 23 atoms are distributed among 22 bulk sites, resulting in the occupation of both fcc and hcp sites. In addition, a more isotropic stress relief is obtained by the formation of stress domains in which the contraction alternates by 120º between two equivalent domains (Figure 2). It is this formation of stress domains which gives rise to the periodic network of surface lattice dislocations that make up the herringbone pattern [3].

During the first stages of deposition, PCBM adsorbs preferentially at the elbows of the reconstruction, a behavior already observed for some metals [4] and other organic molecules [5] on Au(111). But, contrary to these cases, further deposition proceeds by the formation of finger-like zigzag 1D structures (Figure 3). A close examination shows that these chains are actually formed by double rows of PCBM molecules nucleated, exclusively, within the fcc areas of the reconstruction. Upon increasing the coverage, the chains grow in length until they cover completely the fcc areas of the surface, giving rise to a highly organized network of PCBM double rows resembling a nanoscale “spiderweb” (Figure 4). Thus, the supramolecular ordering of at this stage is strictly governed by the substrate reconstruction. The origin of this preferential nucleation (a combination of both steric and electronic effects) will be discussed.

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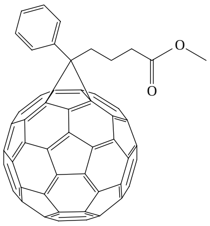

Figure 1: Chemical structure of PCBM.

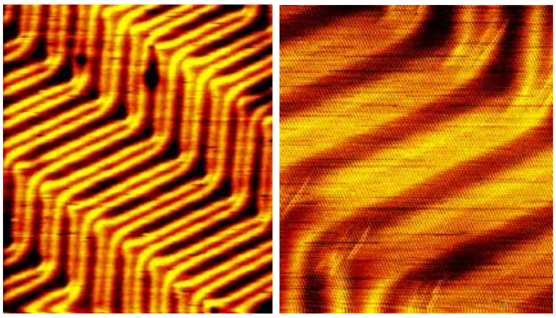

Figure 2: STM images (left: 58 nm x 66 nm, right: 23 nm x 26 nm) of the Au(111) surface showing the morphology of the "herringbone" reconstruction.

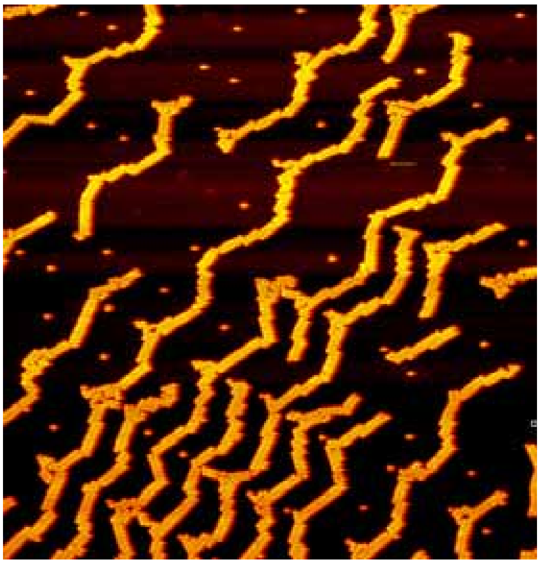

Figure 2: STM image (118 nm x 132 nm) of the Au(111) surface after depositing 0.2 ML of PCBM.

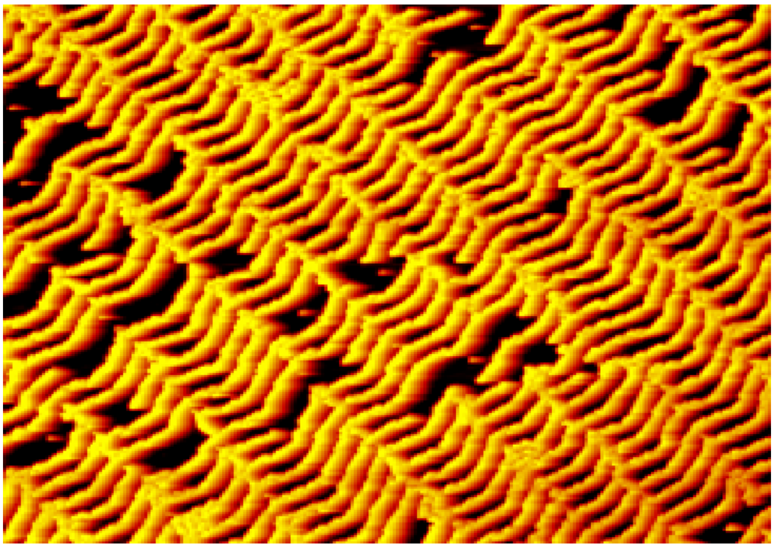

Figure 3: STM image (226 nm x 159 nm) of the Au(111) surface after depositing 0.5 ML of PCBM.

Abstract not available

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NANOTEC: A EXPERIENCE FROM THE UNIVERSITY LAB TO THE NANOTECHNOLOGY MARKET

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Scanning Force Microscopy has been proved to be one of the fundamental tools for the Nanoscience and Nanotechnology with a high potential for a wide range of applications. Allowing to visualize and manipulate surfaces with a very high resolution and control and capable to work with surfaces at different environments, even liquids for the study of biological material, it is clear that it is and will be a key tool for important developments at the nanoscale.

Nanotec Electrónica, spin-off from Universidad Autónoma de Madrid (UAM) since 1998, is a small enterprise focused on the Nanotechnology field and its activity is the design, development, manufacture and commercialization of Scanning Force Microscopes (AFM) and Scanning Tunneling Microscopes (STM). The origin of this company is at New Microscopies Laboratory at UAM, where during the 80s and 90s researchers worked on the development of the AFM and STM techniques with fundamental research purposes. Based on the acquired knowledge and experience and with the obtained technical results, the researchers from this lab started a company. Since then, Nanotec Electrónica has several products in the market and keeps on developing new applications for the analysis at the nanoscale. It is just the only Spanish company capable to develop this technology and it is already competing at a global level with the main manufacturers of these kind of tools; Nanotec has a commercial branch in the United States and distributors in central Europe, Japan and other Asian countries. Nanotec philosophy is still based on the high level development of the technology from the knowledge and experience. In this sense, it is growing with qualified staff both technically and scientifically and keeps strong links with research labs on different fields. It is also integrated in different consortiums for Research & Development projects on Nanotechnology.

The beginnings of Nanotec, which were not easy, were hosted by the Universidad Autonoma de Madrid. After more than eight years working and growing, it has an important presence in the field of the Nanotechnology. In this presentation we will describe some of the interesting steps of our experience to go from the university lab till the reality of being present at the international market.

RATIONAL DESIGN OF INORGANIC NANOPARTICLE CONJUGATES FOR BIOMEDICAL APPLICATIONS

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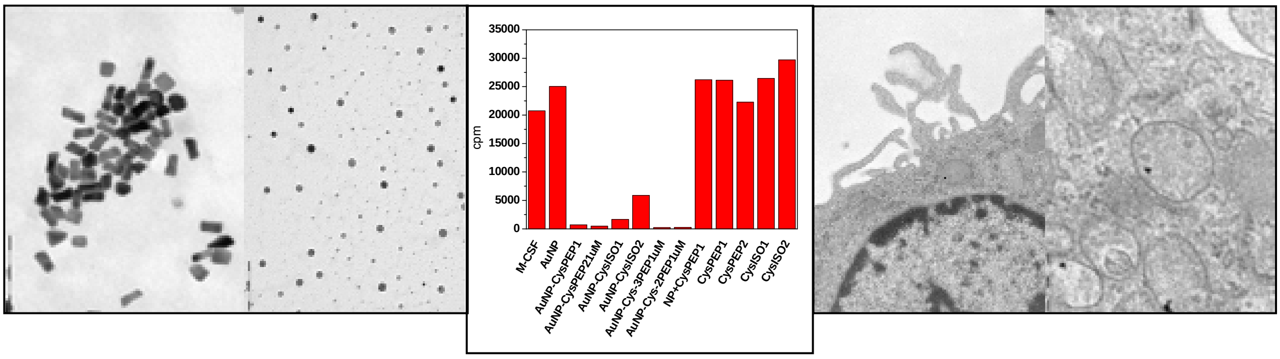
Recently, nanomaterials have received enormous attention for their potential applications in biology and medicine because is a revolutionary technology to address single molecules inside the cell.

Nanoparticles (NP) can be tailored with different properties such as fluorescence or magnetic moment [1,2]. These properties can be harnessed to use them as local nano-probes or nano-manipulators in biological and medical applications; e.g. fluorescence labelling of cellular compartments [1], use of fluorescent or magnetic particles as contrast agents, magnetic separation [3], targeted drug delivery [4].

Recently, NP conjugated with biological molecules have successfully been applied in materials science and biology. NP-macromolecules -like proteins or DNA- conjugates hold great promise both for biological diagnostics, where the NP could provide unique detection signatures, and for nanotechnology, where the information content of the biomolecule could be useful for spatial patterning of NPs. Many strategies, available for bioconjugation of NP, have been described: elastin [5], antisense [6], biotin-avidin [1], antigen-antibodies [7], peptides [8], proteins [9], among others. Furthermore, proteins have a particular interest in nanobiotechnology, because of their inherent programmability and biological activity [10].

Besides, in the same way that the organic molecule can modify the size, shape and therefore final properties of the growing NP [2,11], the inorganic nanoparticle has the ability to control the reactivity of the organic molecule attached to it (some preliminary evidence can be found in homogeneous catalysts [12] and antisenses [6] attached to AuNP). In this way, the NP has the ability to i) modify the local concentration of the molecule, ii) regulate the accessibility to the reactive sites, iii) control the molecule spatial orientation of different molecules attached to different crystal faces of the NP [13,2]) iv) allow the direct activation of the molecule by the remote excitation of the inorganic core to which it is attached [8]. In addition, the inorganic core has unique properties and signatures, facilitating conjugate detection, and consequently, surpassing complicated fluorescent or radioactive labelling.

In this scenario, preparation, isolation, control on the conjugation stability, and monitoring the conjugation, are conditions sine qua non to be able to properly interact with the biological machinery.



Synthesis of Gold Nanoparticles: rods and spheres (Left) DNA synthesis –proliferation assay- of cells in the presence of AuNP-peptide conjugates (center) AuNP-Peptide conjugates phagocited by macrophages (right)

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ELECTRONIC TRANSPORT OF CARBON NANOTUBES WITH INDUCED DEFECTS

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In this talk I will review our most recent achievements in the field of electronic transport in carbon nanotubes and graphene sheets.

Electronic transport in carbon nanotubes has been a field of intensive research in the last years. Up to date most of the works have been focused on the defect-free nanotubes, but defects are known to modify the electronic properties of carbon nanotubes. In this work we reported direct evidences of the influence of artificially induced defects, on the electronic quantum transport in single walled carbon nanotubes.

Defects were induced in single walled carbon nanotubes by Ar^+ ionic bombardment. Consecutive ion irradiation doses were applied to nanotubes producing a uniform density of defects. After each dose the electrical characteristics of the same carbon nanotube were measured by using a conductive atomic force microscopy. Using this method we were able to measure the resistance *vs*. Length characteristic of the nanotube [1] after each known dose of Ar^+ ions.

The results indicate electronic transport in the Anderson localization regime.

Theoretical studies based on first-principles Local Orbital Density Functional method and standard Green-function techniques showed the effects of mono and di-vacancies in the electronic transport properties of metallic SWNTs. From comparison between theory and experiments we concluded that only a 0.03% of di-vacancies produce an increment of three orders of magnitude in the resistance of a 400 nm carbon nanotube segment.

This study provided for the first time a quantitative experimental study of the influence of defects in the electronic transport properties of SWNT[2].

Very recently, the possibility of isolating graphene sheets has renewed the interest in graphitic structures. I will also talk about our preliminary results on oxidized graphene sheets.

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UNDERSTANDING CONDUCTANCE HISTOGRAMS OF SINGLE MOLECULAR JUNCTIONS

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When a single molecular junction is formed, there is a large range of possible detailed atomic configurations that can be realized. In order to extract significant values for the electrical properties of a characteristic molecule, a statistical analysis is required over many junctions realizations. In the literature, different results for molecular junctions based on simple molecules such as alkanethiols have been reported [1-5]. In this work, we establish that differences in the statistical treatment are not the cause of these discrepancies [6]. A mechanically controllable break junction technique has been used to explore the conductance of single molecular junctions based on octanedithiols, oligo(phenylene elthynylene)s and oligo(phenylene vinylene)s. All the experiments have been carried out at room temperature and in liquid environment. We perform different data treatments to collections of conductance traces recorded during ~100 breaking processes for several junctions. The variations in the conductance histograms due to these treatments are then described. In addition, we show that the histogram of the logarithmic of the conductance is the best representation to spot the molecule bridge contribution out of the Au-Au tunnelling background (see figure 1). The method shows to be suitable to distinguish between oligo(phenylene elthynylene)- and oligo(phenylene vinylene)-junctions by their electrical transport properties.

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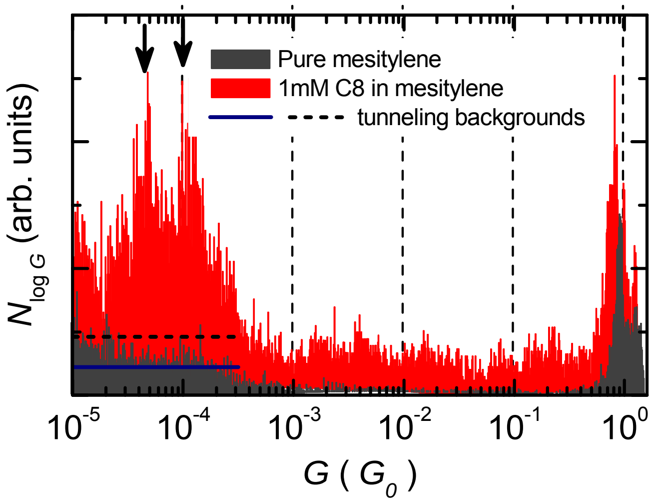
Figures:

Figure 1: Histogram of the logarithmic of the conductance built from approximately 100 conductance vs. displacement curves in pure mesitylene (grey) and in solution 1mM octanedithiol (red). The arrows indicate the conductance peaks that appear when octanedithiol is added. The tunnelling contribution to the histogram is a constant background (indicated by blue and dashed-black lines for pure mesitylene and octanedithiol respectively).



EFFICIENT PHOTOINDUCED ELECTRON TRANSFER IN FULLERENE BASED MOLECULAR WIRES

Fernando Langa,[a] *Frédéric Oswald,*[a] *Ruben Caballero,*[a] *Vincent Troiani,*[a] *Pilar de la Cruz,*[a] *D.-M. Shafiquil Islam,*[b, c] *Yasuyuki Araki,*[b] *Osamu Ito,*[b]

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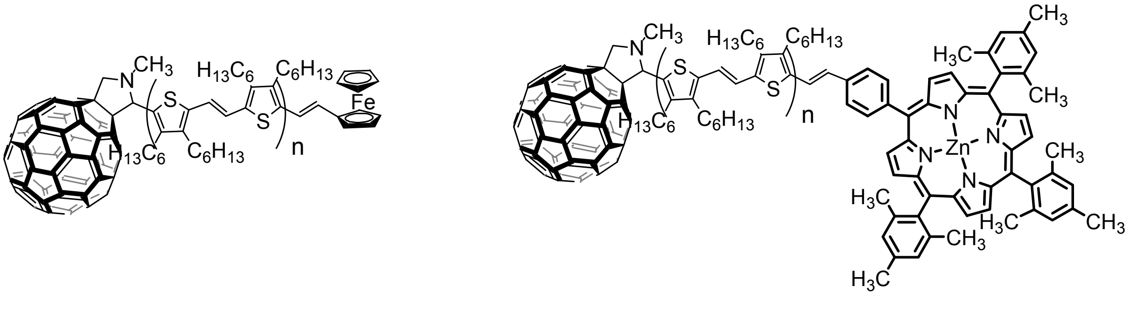
In recent years, donor-bridge-acceptor systems where a C_{60} cage and a strong donor are covalently linked by a linear π-conjugated system have attracted a great interest to obtain efficient photoinduced electron transfer.[1] π-conjugated oligomers exhibit intense and broad absorption bands in the visible region and due to their remarkable light harvesting capability, oligophenylene-vinylene (OPV) chains have been employed as bridge and antenna.[2] Moreover, dyads involving oligothienylenevinylenes (OTV) moieties, which exhibit low oxidation potentials, have been prepared and studied showing that the OTV units not only act as antenna but they are able to act as donor unit as well.

In the present study, new triads Ferrocene-OTV-C_{60} [3] and Zn-Porphyrin-OTV-C_{60} (Figure 1) have been designed and prepared in a multistep synthetic procedure. Efficient photoinduced charge separation with quantum yields close to unity and lifetimes for the charge separated state in the order of μs were found. The effect of the nature of the donor and the length (n = 2 to 8) of the OTV bridge in the photoinduced electron transfer processes will be discussed.

Figure 1



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FULLERENE BASED MOLECULES WITH LOW HOMO-LUMO GAP

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Molecular electronics can be defined as technology utilizing single molecules, small groups of molecules, carbon nanotubes, or nanoscale metallic or semiconductor wires to perform electronic functions.[1] For organic (molecular) electronic materials, the behavior of a single electron, including electron transfer/transport, n-/p-doping processes, and so forth, depends primarily on the energy of the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) levels and the orbital interactions. By designing molecules with tuneable HOMO and LUMO levels, one can achieve control over the properties of materials and the performance of the electronic devices based on them. The molecules with low HOMO/LUMO gaps are of particular importance due to their ability to easily donate (from HOMO) or accept (on LUMO) an electron, which is the basic process in all organic electronic devices.

There are two approaches to decreasing the HOMO-LUMO gap in a molecular system: a) to extend the π-conjugation or b) to link covalently electron donors (high HOMO) and electron acceptors (low LUMO) fragments.

In this presentation, we will show systems with HOMO-LUMO gap lower than 1 eV by linking covalently pyrazolinofullerene derivatives to strong electron donors -TTF[2] or Ferrocene[3]- as well as new triads where an oligothienylenevinylene wire (OTV, n = 2 to 8) act as a wire between the fullerene cage and donors (ferroceneor porphyrins) .[4] (Figure 1).

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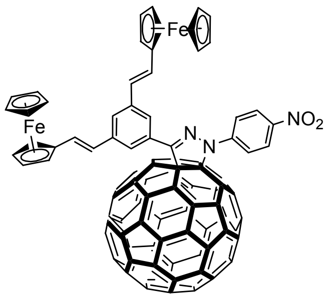
Figure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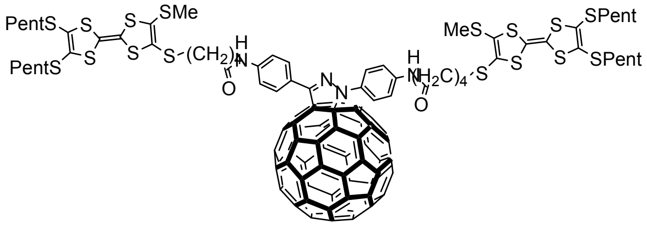
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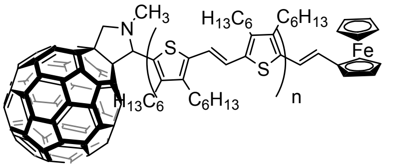
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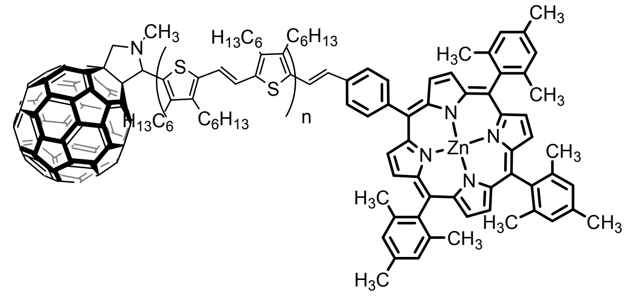
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NANOZAR S.L.: SOLUTIONS IN CARBON NANOTUBE RESEARCH

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NANOZAR S.L. is a spin-off company founded by leading scientists from the Spanish CSIC-ICB research institute that focuses on the development of the technologies for the dispersion of Carbon Nanotubes in a wide variety of matrix materials. This technology area has been identified as the key barrier-to-breakthrough for the development of composite CNT materials that are expected to be used in the majority of future CNT applications. With NANOZAR being the only company in Europe focussing on this essential but underestimated part of CNT development, the company will exploit a unique market position in the field of CNTs. The aim is to develop Carbon Nanotube composites for a broad range of applications.

Through its founders Nanozar combines the expertise available at leading research centre CSIC-ICB on the fabrication, functionalisation and compounding of Carbon Nanotube materials with the expertise available in the Group of Composite Materials at University of Zaragoza on the reinforcement of polymer materials with Carbon Nanotubes. In total the Nanozar team has more than 50 person-years experience in CNT-related research. Additionally, one of the founding shareholders in Nanozar is the company Willems & van den Wildenberg, a specialised consultancy firm with a track record of over 15 years in New Business Development and the creation high-tech start-ups.

This presentation gives a general introduction into the field of carbon nanotubes focussing on business opportunities and explains Nanozar's service portfolio.

LOCALIZATION OF NANOPARTICLES IN PLANT TISSUES: POTENTIAL USE AS SMART DELIVERY SYSTEMS

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In the last years, the nanotechnology is revolutionizing many areas of science and technology, and agriculture can not to be kept away from it. In this way, many applications have been suggested, including nanosensors and nanodevices, bioselective surfaces, nanomaterials, etc. [1, 2]. We have begun the development of a research line in order to find practical applications of nanotechnology in agriculture. Our goal is to find nanosystems which can be easily used as smart delivery systems in plants and select the most suitable ones according to the substances to be introduced into the plants (drugs, nucleic acids, etc.).

The great potential of nanoparticles as delivery systems to be directed to specific targets in living beings has been first explored for medical uses [3, 4]. The same principles can be applied to plants, for a broad range of uses in particular to tackle infections with nanosystems tagged to pesticides or other substances for efficient and local treatments, thus reducing the dose of chemicals released to the environment. For that reason, the first systems we have selected for preliminary assays are carbon coated magnetic nanoparticles [5, 6]. The magnetic core allows allocation of the nanoparticles in the site of interest (affected tissues) using small magnets. On the other side, the carbon encapsulation provides biocompatibility and a large adsorption surface. Thus, different types of molecules can be adsorbed on the carbon coating [5, 6]. It is also possible to functionalise with and/or conjugate the coating of the particles to different biomolecules, which is of great interest for its use as a smart delivery system to target specific tissues.

In order to explore the benefits of nanotechnology applications in agriculture, the first level of our research is to achieve the correct penetration and transport of the nanoparticles through the plant. In this context, the unambiguous localization of the particles in the plant tissues is pivotal. Our first work is aimed to put forward a number of tools for the detection and analysis of magnetic nanoparticles introduced into plants by using different techniques, ranging from conventional light microscopy to confocal and electron microscopy.

We have inoculated *in vitro* growing plants with a ferrofluid composed of carbon-coated magnetic nanoparticles. Tissue samples were then collected, fixed, cut and observed with different microscopical techniques to detect the presence of nanoparticles. These techniques include conventional light microscopy, fluorescence microscopy, confocal scanning laser microscopy and electronic microscopy, combined with different fixation and/or embedding processes.

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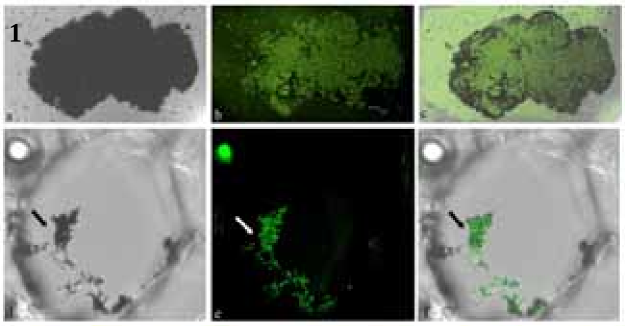
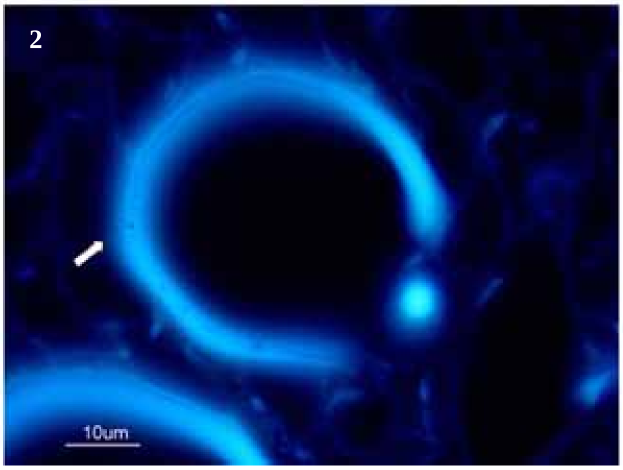
Figures:





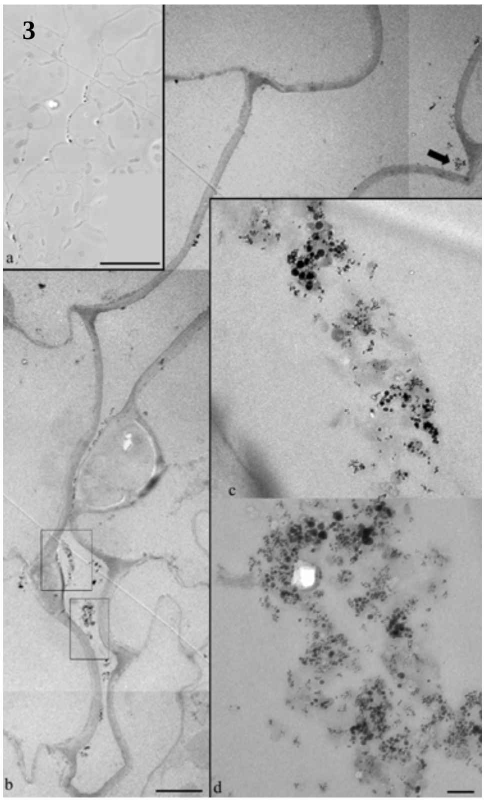


Figure 1: Detection of aggregates of nanoparticles in the solution injected into the plants on projections of 3D confocal stacks under Nomarski (a) and reflection (b). 1(c) shows the overlay between (a) and (b) with an almost complete colocalisation. Aggregates of nanoparticles were also detected into a cell of the stem (arrows), after 72 hours at the position of the magnet, on vibratome sections observed on the confocal microscope: (d) Nomarski, (e) reflection and (f) overlay.

Figure 2: Detection of nanoparticles on thick sections (7 µm) of paraffin-embedded plant tissues. The identified particles correspond to non-fluorescent areas (arrow) within the autofluorescent cell wall of xylem cells under an epi-fluorescence microscope.

Figure 3: Nanoparticles detected on correlated light and electron microscopy imaging of the same specimen after 24 hours at the injection site. a) the nanoparticles are seen as beads on a string along the cells on the outer side of the cell wall by phase contrast on a light microscope. b) the same area as in (a) imaged on the transmission electron microscope where electron dense areas can be seen (arrows). c and d) higher magnification of the boxed areas in (b) in which aggregates of nanoparticles can be clearly recognised in the apoplast.

KINETIC CONTROL IN THE SURFACE ASSEMBLY OF ONE-DIMENSIONAL COORDINATION POLYMERS

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A key issue in nanotechnology is the fabrication of nanoscale structures built up from functional blocks in a reproducible and efficient way. In this sense, coordination polymers on solid surfaces, also named metal-organic frameworks, are considered a promising candidate in view of their applications due to their interesting electrical, and magnetic properties, as well as host-guest interactions [1-3]. The practical application of these new materials requires controlling the nanoscale spatial order of the constituent blocks. The principles of the supramolecular chemistry allow, in many cases, controlling the architecture and dimensionality of the materials through the self-assembling of different molecular building blocks. The suitable selection of the building blocks may also predict some of their final properties. In this bottom-up approach, kinetics can also play an important role in the nanostructuration of these compounds on surfaces, which implies well understanding of the multiple and competing interactions (hydrogen bonds, coordination bonds, van der Waals forces,…). The knowledge of the dynamic processes that take place during the assembly of the nanostructures is an open topic with fundamental interest to the emergent nanoscience.

Here we show for first time the surface assembly of one-dimensional coordination polymers prepared from vapour phase (Fig. 1). The assembly phenomenon is based on the reversibility property of the coordination bonds of those compounds, which allows the polymers to be sublimated in form of small oligomers and reassembled forming different surface structures once on the substrate. Temperature-controlled transition to the one-dimensional morphology reflecting its equilibrium structure is observed and explained in terms of kinetically-limited anisotropic interactions between the oligomers. These results open a new way to the surface assembly of coordination frameworks.

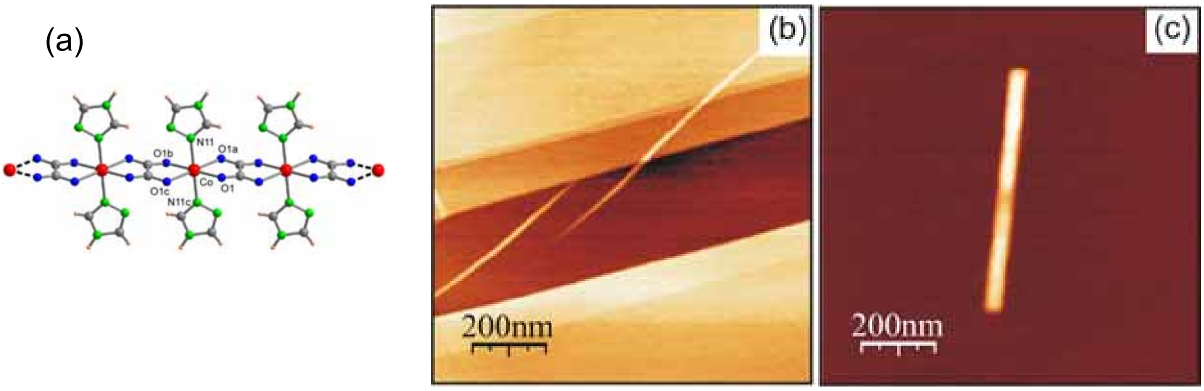

Figure 1: (a) Structural representation of the 1D coordination polymer $\{[Co(ox)(Htr)_2]\cdot 2H_2O\}_n$. (b, c) AFM images showing one-dimensional structures of this compound on HOPG (a) and mica (b) grown by sublimation in a high vacuum system.

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SUB-10nm NANOLITHOGRAPHY AT THE CT-ISOM

Jose Luis Prieto

Universidad Politecnica de Madrid, Spain

Abstract not available

SURFACE SELF-ASSEMBLED MONOLAYER OF A MULTIFUNCTIONAL ORGANIC RADICAL

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The ultimate goal of molecular bottom up approaches is to employ functional building blocks to construct nanometer scale devices addressed to specific applications. Furthermore, for practical device implementation the immobilisation of functional molecules on suitable surfaces is also often required. One powerful and versatile strategy for the modification of surfaces at the molecular level is via the preparation of self-assembled monolayers (SAMs).

Here, we describe the functionalisation of silicon oxide–based surfaces with polychorotriphenylmethyl (PTM) radicals via covalent and noncovalent interactions (Fig. 1).

The family of PTM radicals is chemically and thermally stable due to the fact that their open-shell centres are shielded by six bulky chlorine atoms.[1] These radicals are colored and also exhibit fluorescence in the red region of the spectra. More interestingly, PTM radicals are electroactive and can be easily and reversibly reduced (or oxidized) to their anionic (or cationic) species. [2] The oxidised and reduced states show different absorption spectra than the radical and are in addition non magnetic and non fluorescent. Therefore, the preparation of SAMs functionalised with PTM radicals (PTM SAMs) on solid substrates results in multifunctional surfaces which are electrochemically, optically and magnetically active. We also demonstrate that these SAMs can be used as chemical redox switches with optical (absorption and fluorescence) and magnetic responses.

In addition, the fabrication of surface patterns of these radical molecules has also been achieved using microcontact printing and visualized by fluorescence microscopy (Fig 2). The chemical flexibility and versatility of these molecules sheds lights on the huge potential of preparing surface self-assembled multifunctional molecular devices.

Acknowledgements

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Figures:

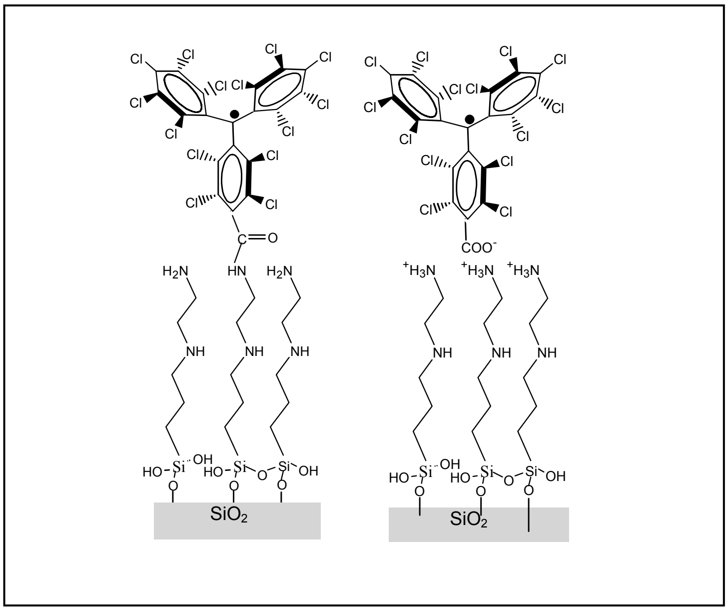

Fig. 1 PTM SAMs prepared via covalent and noncovalent interactions

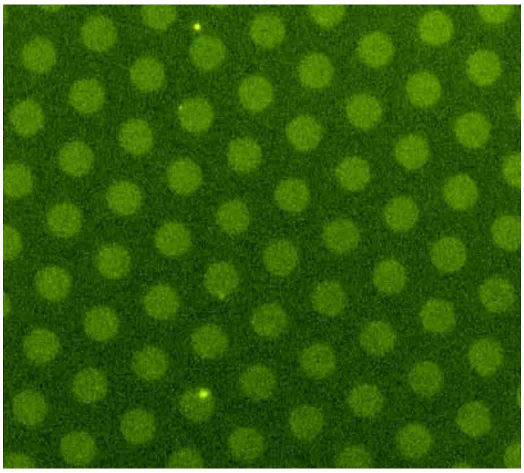

Fig. 2 Fluorescence microscopy image of a patterned PTM SAM by microcontact printing on glass (λ_{exc}=340-370 nm, spotsize of 10µm).

INFLUENCE OF THE SUBSTITUENT IN THE CRYSTAL PACKING OF COPPER(II) MALONATES

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There are different strategies to design and prepare new molecular materials with interesting magnetic properties such as the introduction of a co-ligand, the combination of several metal centres or the modification of the primary ligand. In the course of the investigation of our research group in copper(II)-malonate complexes [1], we have developed a study of the influence of the introduction of a substituent in methylene carbon atom of the malonic acid in its coordination chemistry.

Considering the variety of crystal packing exhibited by the copper(II)-malonate system with water molecules as unique coligands [2], we have synthesized and characterized new copper(II)-phenylmalonate, -methylmalonate, -ethylmalonate, etc. complexes (Figure 1 and 2). The crystal structures of these compounds range from discrete molecules in the malonate-containing complexes to two-dimensional structures in the methyl- and ethylmalonate-copper(II) compounds.

Subtle changes in the crystal packing can lead to variations in the magnetic behaviour. The study of these changes and the influence of the substituents in the formation of a given structural motif are the main objectives of this work.

We acknowledge the support of the Spanish Ministerio de Educación y Ciencia through projects MAT2004-03112 and “Factoría de Cristalización, Consolider-Ingenio2010” (CSD2006-015).

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[2] C. Ruiz-Pérez, J. Sanchiz, M. Hernández-Molina, F. Lloret, M. Julve, *Inorg. Chem.* **39**, (2000) 1363.

Figures:

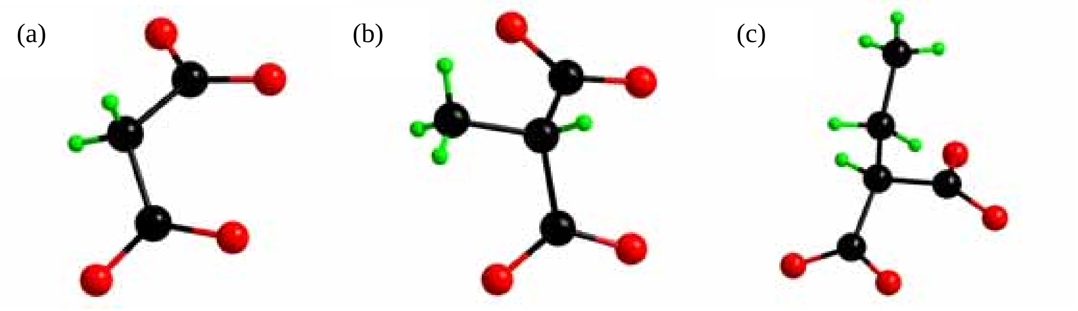

Figure 1. Malonate (a), Methylmalonte (b) and Ethylmalonate (c) ligands

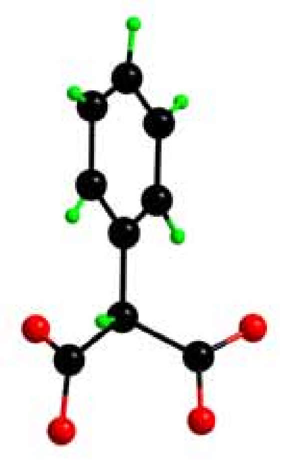

Figure 2. Phenylmalonate ligand

NANO-EMULSION FORMATION IN IONIC SURFACTANT SYSTEMS BY THE PHASE INVERSION COMPOSITION METHOD (PIC): OPTIMIZATION THROUGH AN EXPERIMENTAL DESIGN

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Nano-emulsions are colloidal dispersions formed by a liquid phase dispersed in another one in form of droplets. What makes them very interesting is the extremely small droplet size they have, in the range 20-500 nm, reason why they may appear transparent or translucent. They are thermodynamically unstable systems, and consequently, their properties depend on the preparation method. The low-energy preparation methods, in which the temperature or the composition are maintained constant, make use of the phase transitions that take place during the emulsification process as a result of a change in the spontaneous curvature of the surfactant[1]. As a result, it is not necessary to apply a high mechanical energy.

The formation of nano-emulsions stabilized with non-ionic surfactants has been widely reported in the bibliography[2,3]. However, there are few studies about the preparation of nano-emulsions stabilized with ionic surfactants by low energy or “spontaneous” methods[4,5]. In this work, a method to obtain nano-emulsions in ionic surfactant systems by the phase inversion composition method is presented. The aim of this new method is the use of a fatty acid as a cosurfactant, which is progressively neutralized during the emulsification process due to the continuous addition of an alkaline watery solution, obtaining the corresponding salt, which acts as the ionic surfactant.

The ionic system chosen was the anionic system water / potassium oleate-oleic acid-$C_{12}E_{10}$ / hexadecane. Potassium hydroxide solutions were added to the mixtures formed by water, hexadecane, $C_{12}E_{10}$ and oleic acid, being this last one component partially neutralized into potassium oleate during the emulsification process. The results obtained were compared with those obtained in the cationic system water / oleylamine chloride-oleylamine-$C_{12}E_{10}$ / hexadecane. In this system, chloride acid solutions are added to the mixtures formed by water, hexadecane, $C_{12}E_{10}$ and oleylamine. The oleylamine is partially neutralized into oleylamine chloride along the emulsification paths. The final water composition was 80% w/w in all cases.

Experimental design[6] was used to optimize the composition variables oleic acid/$C_{12}E_{10}$ or oleylamine/$C_{12}E_{10}$ ratios (depending on the system) and oil-surfactants ratios, at constant preparation conditions. Nano-emulsion droplet size has been selected as the main response as it determines whether an emulsion is a nano-emulsion or not.

The results of this study show that droplet size as a function of oleic acid/$C_{12}E_{10}$ or oleyalmine/$C_{12}E_{10}$ ratios and oil-surfactants ratio, can be approximated by quadratic equations, which develop the response surfaces represented in figure 1.

It can be seen from this graphics that there is an optimal oleic acid or oleylamine/$C_{12}E_{10}$ ratio in both systems. Referring to the oil/surfactant ratio, a linear behaviour is observed; the lower the O/S ratio, the smaller the droplet size in both systems.

Trying to explain these results, the phases present through the different emulsification paths were determined at 25ºC. It has been found a cubic liquid crystalline zone with Pm3m structure, which expands to higher hexadecane/surfactants ratios and makes narrower as the oleic acid or oleylamine/$C_{12}E_{10}$ ratio increases. Reaching or not the equilibrium in this phase during the emulsion formation process allows to explain the results obtained in the experimental designs. The smallest droplet sizes are obtained when the cubic phase is wider.

Finally, it has to be said that in the system using oleylamine chloride as ionic surfactant, the droplet size of the nano-emulsions obtained is smaller than with the other system, due to the fact that the cubic phase zone is wider in the system W / oleylamine chloride - $C_{12}E_{10}$ - oleylamine / hexadecane than in the system water / potassium oleate-oleic acid-$C_{12}E_{10}$ / hexadecane.

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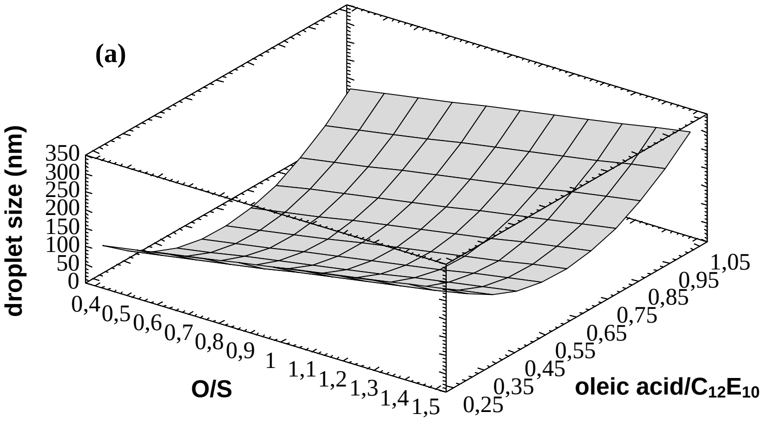
Figures:



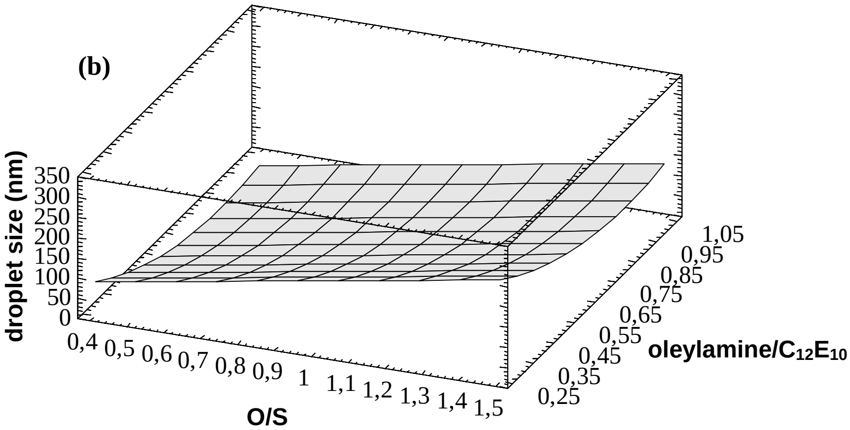


Figure 1. Response surfaces: droplet size as a function of the composition variables for the ionic system with potassium oleate as anionic surfactant **(a)** and for the ionic system with oleylamine chloride as cationic surfactant **(b)**.

TOWARDS PHTHALOCYANINE-BASED MOLECULAR MATERIALS

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Phthalocyanines are versatile building blocks for fabricating materials at the nanometer scale. These colored macrocycles exhibit fascinating physical properties which arise from their delocalized π-electronic structure. In this talk, it will be described why these molecules are targets for different scientific purposes and technological applications

Phthalocyanines (**Pc**)[1] and related macrocycles have drawn considerable attention as molecular materials that give rise to outstanding electronic and optical properties. [2,3] These properties arise from their electronic delocalization, and make these compounds applicable in different fields of materials science and promising as building blocks in nanotechnology.

Our group has been involved for many years in the synthesis of non-centrosymmetric phthalocyanines for second-order NLO and has carried out exhaustive studies on the structure-property relationships by varying the donor-acceptor substitution pattern and changing the central metal on the Pc core. Our efforts are now concentrated on the preparation of non-classical phthalocyanine-containing systems presenting both dipolar and octupolar features.

The concept donor-acceptor is not limited to the design of systems with NLO properties, but also to semiconducting and artificial photosynthetic systems with application in molecular electronic devices. Thus, for example, we have synthesized Pc- and SubPc-based donor-acceptor systems for studying energy and photoinduced electron transfer processes, and their potential use as building blocks for molecular-scale photovoltaic (both organic and dye-sensitized hybrid solar cells) and optoelectonic systems (LEDs, sensors).

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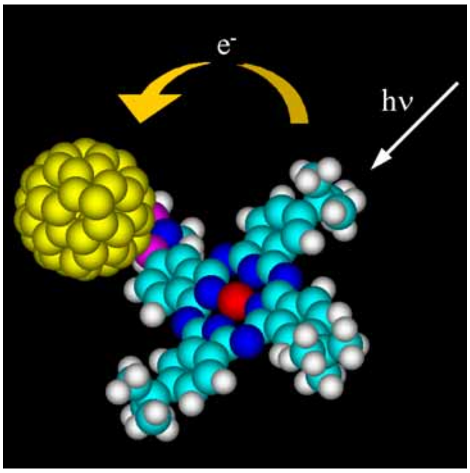
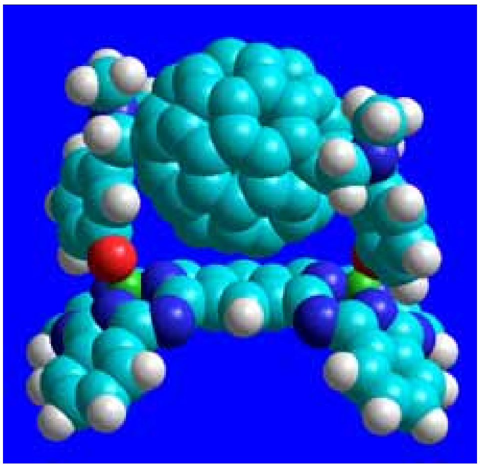
Figures:





http://www.uam.es/phthalocyanines

Posters (117) - Last Update (27-02-2007)

Only contributions from participants who confirmed their participation appear below

Last Name	Name	Topic	Title
Abad	Manuel David	NanoMaterials	*Palladium and gold nanoparticles for anti-wear applications*
Alarcón Ángeles	Georgina	Nanotubes	*Electrochemical response versus dopamine and ascorbic acid of a carbon nanotube modified electrode*
Alegre	Daniel	Nanomagnetism	*Superficial room temperature magnetism in the ZnO:CO3O4 system*
Algarabel	Pedro A.	NanoMaterials	*Description of NanoLab equipment in Zaragoza and first tests*
Almeida	Flávia	NanoMaterials	*From Nano to Microcrystalline HFCVD Diamond Coatings on Cutting Tools*
Alvarez	Pablo	Nanomagnetism	*Torsion-induced magneto-impedance in nanocrystalline Fe-based wires*
Ambrosi	Adriano	NanoBiotechnology / Nanomedicine	*Enhanced Electrochemical Immunoassay Based on Paramagnetic Platforms and Gold Nanoparticle Labels*
Andres Gonzalez	Juan Pedro	Nanomagnetism	*Reactive sputtering synthesis of exchange-biased Co-CoO/Ag nanostructures*
Ankiewicz	Amélia Olga	Nanomagnetism	*Electron Paramagnetic Resonance in Transition Metal Doped ZnO Nanostructures*
Aparicio	Francisco	NanoMaterials	*Optically active plasma polymers and nanocomposites for the fabrication of photonic devices*
Arroyo Rodríguez	Carlos	NanoElectronics / Molecular Electronics	*Measuring the conductance of molecular junctions*
Aznar Gimeno	Elena	NanoMaterials	*New advances in photochemical-chemical control of functional nanogated hybrid architectures*
Barbosa	Hélder	Simulation at the Nanoscale	*Computing Modeling of Organic Solar Cells - A Mesoscopic Scale Approach*
Bartasson	Maria Cristiane	NanoChemistry	*Fullerenes Synthesis*
Batista	Carlos	NanoMaterials	*Preparation and characterization of rf magnetron sputtered vox thin films*
Bellido	Elena	Nanotubes	*Carbon nanotube-based electrodes for electrochemical transduction and biosensing*
Blanco	Alvaro	NanoMaterials	*Three Dimensional Polimeric Photonic Crystals*
Bonanni	Alessandra	NanoBiotechnology / Nanomedicine	*"Signal amplification of impedimetric genosensing using gold-streptavidin nanoparticles"*
Borras	Ana	NanoMaterials	*Growth at low temperatures of Ag@TiO2 nano-fibers by plasma deposition*
Borrise	Xavier	NEMS / MEMS	*Nanofabrication with FIB (Focused Ion Beam). Fabrication and characterization of nanoresonant structures.*
Brunet	Ernesto	NanoMaterials	*Hydrogen Storage in Pillared Laminar Organic-Inorganic Materials*
Cartoixa	Xavier	NanoElectronics / Molecular Electronics	*Novel approach to the fabrication of ordered arrays of quantum wires*
Castañeda Briones	María Teresa	NanoBiotechnology / Nanomedicine	*New gold nanoparticles based genosensor design for detection of DNA hybridization*
Castellanos	Andrés	NanoElectronics / Molecular Electronics	*Procedure for the preparation of graphene samples using PMDS stamps*
Castro	Eduardo	NanoElectronics / Molecular Electronics	*Biased graphene bilayer: a tunable gap semiconductor*
Cebollada	Federico	Nanomagnetism	*Experimental and computational analysis of the angular dependence of the hysteresis processes in an antidots array*
Christian	Urban	NanoMaterials	*Creating a nano-scale porous network of porphyrin molecules*
Clavel	Guylhaine	NanoMaterials	*Magnetic Properties of Cobalt and Manganese Doped ZnO Nanocrystals*
Clavero	César	Nanomagnetism	*Morphology dependent capping layer effects in ultra-thin Co films and nanoparticles*
Coll	Carmen	NanoMaterials	*Selective and sensitive method for the colorimetric detection of anionic surfactants in water*
Comes Navarro	Maria	NanoMaterials	*Chromogenic sensing detection in functionalized porous silica*
Conesa	Jose Carlos	NanoChemistry	Effect of Cu clustering on activity and selectivity of CuOx/CeO2 catalysts for preferential oxidation of CO in H2 streams

Last Name	Name	Topic	Title
Correia	Helena	NanoElectronics / Molecular Electronics	*Quantum modelling of organic and biological materials for nanoelectronics*
de Carvalho Miranda	Maria Adelaide	NanoChemistry	*A photochemical approach for preparing gold nanotriangles: synthesis and morphological characterization*
De la Escosura Muñiz	Alfredo	NanoBiotechnology / Nanomedicine	*Electrocatalytical immunosensing methods based on gold nanoparticles*
De Teresa	Jose Maria	NanoElectronics / Molecular Electronics	*Magnetoresistance and Hall effect of Fe3O4 thin films on MgO substrates*
Delcea	Mihaela	NanoBiotechnology / Nanomedicine	*Hybrid polyelectrolyte/bacterial protein (nano)biomimetic surfaces: a model to study bacterial surface layer recovery and bacterial affinity*
Doria	Gonçalo	NanoBiotechnology / Nanomedicine	*Colorimetric assay for a swift detection of nucleic acids*
Echeverria	Carlos	Nanomagnetism	*Electronic Structure and Magnetic Properties of Mn-doped CdTe Quantum Dots from First-Principles*
Esquena	Jordi	NanoMaterials	*Preparation of meso/macroporous silica in highly concentrated emulsions by single-step methods*
Fernandez Barquin	Luis	Nanomagnetism	*Neutron spin-echo evidence of inter-particle spin correlations of Fe(Cu) nanoparticles in a Ag matrix*
Fernandez-Megia	Eduardo	NanoBiotechnology / Nanomedicine	*Polymeric Nanostructures for Biomedical Applications: Clickable Dendritic Polymers and PEG-grafted Chitosan*
Ferreira dos Santos	Catarina	NanoMaterials	*Synthesis of Hydroxyapatite nanoparticles*
Gallego	José M.	NanoChemistry	*The nanoscale spider-web: A molecular self-assembly due to substrate-molecule interactions*
García Gallastegi	Ainara	Nanotubes	*Nanocomposites based on carbon nanotubes for gas sensing*
Gerniski Macedo	Andreia	NanoMaterials	*Structural and Luminescent Properties of Europium Doped Gadolium Nanorods in Hydroxide or Oxide Phase*
Godinho	Vanda	NanoMaterials	*Microstructural, chemical and mechanical characterization of Si-O-N amorphous coatings obtained by magnetron sputtering*
Gomez Bastus	Neus	NanoBiotechnology / Nanomedicine	*Rational Design of Inorganic Nanoparticle Conjugates for Biomedical Applications*
González Pérez	Maria Teresa	NanoElectronics / Molecular Electronics	*Understanding conductance histograms of single molecular junctions*
Gonzalo	Jose	NanoMaterials	*Self-organized oriented Ag nanocolumns: Structure and optical properties*
Guerrero	Ruben	Nanomagnetism	*Coulomb blockade and low frequency noise anomalies in magnetic tunnel junctions Co|Al2O3|Si| Al2O3|Py.*
Guerrero García	Estefanía	NanoMaterials	*Preparation and characterisation of thiol- and phosphine-functionalized gold clusters and nanoparticles: An X-ray absorption spectroscopy study*
Guerrini	Luca	NanoChemistry	*Surface-enhanced Raman Scattering Detection of PAHs: Dithiocarbamate Calix[4]arene derivative as an Effective Supramolecular Host*
Guinea	Joaquin	NanoBiotechnology / Nanomedicine	*Evaluating in vivo toxicity of nanomaterials using the zebrafish embryo model*
Gunko	Yurii	Nanomagnetism	*Fluorescent and magnetic nanoparticles for biological imagine*
Hernandez-Ramirez	Francisco	NEMS / MEMS	*Bottom-up Gas Nanosensors based on Individual Tin-Oxide Nanowires*
Iglesias-Silva	Esther	NanoChemistry	*Synthesis of gold-coated magnetite nanoparticles*
Jaafar Ruiz	Miriam	Nanomagnetism	*Magnetic anisotropy changes of FePt thin films induced by high energy ion bombardment*
Jimenez	David	Nanotubes	*Magnetically-induced carbon nanotube field effect transistors*
Karmaoui	Mohamed	NanoChemistry	*Synthesis and optical properties of rare-earth-based lamellar nanohybrids*
Kuphal	Mathias	NanoBiotechnology / Nanomedicine	*Methods for Micro- and Nanostructuring Polymer Surfaces Developed Recently at the Barcelona Science Park*
Langa	Fernando	NanoChemistry	*Efficient Photoinduced Electron Transfer in Fullerene Based Molecular Wires*
Ledo Suarez	Ana	NanoMaterials	*Synthesis of thiol-functionalized polymers and grafting to silver and gold nanoparticles*
López Elvira	Elena	Scanning Probe Microscopies (SPM)	*Variable Temperature Scanning Force Microscope for the application to nanoscale polymer characterization*
López Ramírez	Maria Rosa	NanoMaterials	*Surface-enhance Raman scattering (SERS)*

Last Name	Name	Topic	Title
Luque	Aitor	Simulation at the Nanoscale	*MD simulation of nanoscratching of cu crystals with a hard spherical tip. influence of the tip-substrate adhesion and substrate orientation*
Macanas	Jorge	NanoMaterials	*Development and characterization of new amperometric sensors and biosensors based in polymer-metal nanocomposite materials*
Maestro	Vicente	Simulation at the Nanoscale	*Monte Carlo simulations on nanocatalysts: effect of active sites location in the CO-NO surface reaction*
Marin	Sergio	NanoBiotechnology / Nanomedicine	*DNA detection using cadmium sulphide nanocrystals as electrochemical tags*
Marques	Maria Teresa	NanoMaterials	*Energy study of Cu-NbC nanocomposite produced via mechanical alloying*
Marquez Posadas	Mª del Carmen	NanoMaterials	*Plasma treatments on polymer nanoimprint stamps*
Martinez Niconoff	Gabriel	Simulation at the Nanoscale	*Description of plasmonic self-imaging*
Martin-Gonzalez	Marisol	NanoMaterials	*Porous alumina in the control of position and shape of nanostructures*
Martins	Manuel	NanoMaterials	*Nanoscale integration of colloidal nanocrystals on optically active low dimensional epitaxial heteroestructures*
Maxim	Florentina	NanoChemistry	*Hydrothermal Synthesis of 1D BaTiO3 Nanostructures: the influence of titanium precursor*
Mecerreyes	David	Project_Management	*NANOTRON Project: Nanoscience and Nanotechnology for Micro- and Nanosystems*
Mendez	Javier	Scanning Probe Microscopies (SPM)	*Manipulation of Organic Nanostructures by field gradient diffusion induced with STM*
Mihi	Agustin	NanoMaterials	*Full Processing of Colloidal Photonic Crystals by Spin Coating*
Munuera	Carmen	Scanning Probe Microscopies (SPM)	*Conductive-SFM study of nanostructured iron prepared by sputtering at very low temperatures.*
Munuera	Carmen	Nanomagnetism	*MBE growth of Ag nanocrystals on self-organized striped Si(111) surfaces. Morphology and Magnetism of Co films formed on this Ag-Si template.*
Olivet	Aurelio	Simulation at the Nanoscale	*Sulfur Hexafluoride Adsorption Prediction in Mobil Catalytic Materials (MCM) by Molecular Simulations*
Osma	Johann	NanoBiotechnology / Nanomedicine	*Enzymatic immobilization on alumina pellets improved the decoloration of synthetic dyes*
Otero	Juan Carlos	NanoChemistry	*nUMALAB: An interdisciplinary laboratory on nanotechnology*
Palacios	Elisa	Scanning Probe Microscopies (SPM)	*Surface contact potential domains on poly(3-octylthiophene) studied by electrostatic force microscopy and Kelvin probe microscopy*
Paredes	Ricardo	NanoMaterials	*Ni nanocontacts ruptures: statistical study of last configurations before breaking*
Park	Seul Ki	NanoBiotechnology / Nanomedicine	*Photoprotective Effects of Oral Minerals in UVA-irradiated Human Dermal Fibroblast*
Patrício	Sónia	NanoChemistry	*Nanostructured [M(salen)]-based thin films prepared by electropolymerization and layer-layer assembly*
Peláez	Samuel	Simulation at the Nanoscale	*Edge energies and elastic properties of ordered metallic nanowires. An Embedded Atom Method study*
Pellejero	Ismael	NEMS / MEMS	*Development of microsystems with zeolite layers: mass sensors & micro-reactors*
Peres	Marco	NanoMaterials	*Photoluminescence Studies on Lanthanides Doped ZnO.*
Pérez de Luque	Alejandro	NanoBiotechnology / Nanomedicine	*Localization of nanoparticles in plant tissues: potential use as smart delivery systems*
Perez Garcia	Beatriz	NanoElectronics / Molecular Electronics	*Formation and rupture of Schottky nanocontacs on ZnO nanocolumns*
Pérez López	Briza	Nanotubes	*Carbon nanotube based electrochemical sensors*
Polop	Celia	NanoMaterials	*Kinetic control in the surface assembly of one-dimensional coordination polymers*
Primo Martín	Vicent	NanoMaterials	*Laser colouring of glasses by way of Silver ion exchange methods*
Puchol Estors	Victoria	NanoMaterials	*Mesoporous Materials with a Hierarchic Pore System by Means of Biomimetics Preparatory Approaches*
Quaresma	Pedro	NanoChemistry	*Monodisperse Fe3O4 and FePt magnetic nanoparticles for specific separation of oligonucleotides and proteins*
Ramalho	Ruben	NanoBiotechnology / Nanomedicine	*Microtubule behavior under strong electric fields: an Atomic Force Microscopy study*
Retolaza	Aritz	NanoElectronics / Molecular Electronics	*The use of automatic demolding in nanoimprint lithography processes*

Last Name	Name	Topic	Title
Ribeiro	Ana	NanoMaterials	*Study of pt dopant effect on photocatalytic activity of TiO2 thin films subjected to tensile fragmentation tests*
Rodriguez	Carlos	NanoMaterials	*A new route for the preparation of mesoporous and hybrid nanomaterials through templating of reverse liquid crystals*
Rodríguez Vazquez	Maria J.	NanoMaterials	*Synthesis and characterization of gold clusters by soft chemical routes*
Rogero	Celia	Scanning Probe Microscopies (SPM)	*Self-organized submonolayers of S-cysteine on Au(111)*
Ruiz	Virginia	NanoMaterials	*A multiresponse approach to the study of electrochemical processes in nanostructured materials*
Ruiz Perez	Catalina	NanoChemistry	*Influence of the substituent in the crystal packing of copper(II) malonates*
Sanches	Tatiana	NanoMaterials	*Surface impedance tensor behaviourin amorphous FeSiB and CoSiB wires*
Sanches	Pedro	NanoBiotechnology / Nanomedicine	*Detection of Magnetically Marked Structures in Cilia by Magnetic Force Microscopy*
Sanchez	Samuel	Nanotubes	*Advantages of CNT vs graphite polysulfone-composites screen-printed electrochemical biosensors*
Sanchez-Cortes	Santiago	NanoMaterials	*Preparation of Ag nanoparticles by gamma irradiation: Application to Surface-enhanced Raman Detection of fungicides*
Saravia	M Veronica	NanoBiotechnology / Nanomedicine	*Cell attachment and patterning on polyelectrolytes and bacterial proteins*
Silva	Nuno João	Nanomagnetism	*Structural And Magnetic Studies On Iron Oxide Nanoparticles In Hybrid And Polymeric Matrices*
Smit	Roel	Scanning Probe Microscopies (SPM)	*Low Temperature Scanning Tunneling Microscopy with the capability to measure forces*
Solé Font	Isabel	NanoChemistry	*Nano-emulsion formation in ionic surfactant systems by the phase inversion composition method (pic): optimization through an experimental design*
Suñol	Joan Josep	NanoMaterials	*Development of nanocrystalline soft magnetic materials by melt spinning and/or mechanical alloying*
Taborda	Ana	NanoBiotechnology / Nanomedicine	*Superparamagnetic Nanoparticles with relevant applications in Biomedicine: NMR studies*
Torres	Francesc	NEMS / MEMS	*Coupling Resonant Carbon Nanotube and Microcantilever to Improve Mass Responsivity by Detectability Product*
Villaluenga	Irune	NanoMaterials	*Photocatalytic Coatings*

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Only participants fully registered (payment done) appear in this list

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204

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Chapartegui	**Maialen**	Inasmet/Nanotechnology	Spain
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Coll Merino	**M Carmen**	Universidad Politecnica de Valencia	Spain
Comes Navarro	**Maria**	Universidad Politécnica de Valencia	Spain
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