Malaga [Spain] · March 23>26

NANOSPAIN CONF2010

PHANTOMS foundation

JUNTA DE ANDALUCIA
Fundación Progreso y Salud
CONSEJERÍA DE SALUD

ibec
Institute for Bioengineering of Catalonia

UAM
UNIVERSIDAD AUTONOMA
DE MADRID

INA
INSTITUTO UNIVERSITARIO DE INVESTIGACIÓN EN NANOCIENCIA DE ARAGÓN

DONOSTIA INTERNATIONAL PHYSICS CENTER
fundación
DIPC

NanoSciences
GRAND SUD - OUEST

CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR Portugal

MINISTERIO DE INDUSTRIA, TURISMO Y COMERCIO
CEM Centro Español de Metrología

During the last two decades, a revolutionary scientific new age, based on the capacity to observe, characterize, manipulate and organize matter in the nanometric 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 knowledge areas and methodologies in order to study, manufacture and characterize functional structures with dimensions of tens of nanometers..

In 2008, Spain, Portugal and France (through their respective networks NanoSpain, PortugalNano and C'Nano GSO) decided to join efforts in order that NanoSpain events facilitate the dissemination of knowledge and promote interdisciplinary discussions not only in Spain but among the different groups from Southern Europe.

Other objectives will also be to enhance industrial participation and permit considering the situation of Nanoscience and Nanotechnology in the south of Europe.

The NanoSpain2010 edition will be organised in Malaga (Spain) - to emphasise the importance at the Spanish and European level of the launch of the Centre for Research in Nanomedicine and Biotechnology, Bionand. This center, to be inaugurated in 2010, came into existence at the instigation of consejerías de Salud e Innovación de la Junta de Andalucía, Universidad de Málaga and Fundación Imabis and its ambition is to become Europe's top centre for innovation and expertise in Nanomedicine and Biotechnology.

In 2010, this event will therefore be organised again in collaboration with 3 networks:

NanoSpain (Spain): 281 Spanish groups with around 2000 researchers in total - one of the widest Spanish scientific networks
Portugalnano (Portugal): 188 Portuguese groups
C'Nano Grand Sud Ouest (France): 50 labs and more than 500 researchers

Other objectives will also be to enhance industrial participation and permit considering the situation of Nanoscience and Nanotechnology in the south of Europe.

In order to organise the various sessions and to select contributions, the meeting will be structured in the following thematic lines, but interactions among them will be promoted:

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

Thematic parallel sessions will also be organised to enhance information flow between participants and in particular:

-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 Thematic Sessions will be organised:

1. NanoBiotechnology (Coordinators: Josep Samitier, Jesus M. De la Fuente & Elena Martínez)
2. Nanoelectronics, NEMS and Nanofabrication (Coordinators: Francesc Pérez-Murano & Fernando Briones)
3. Industrial (Coordinators: José Luís Viviente, Jordi Reverter & Emilio Prieto)
4. NanoChemistry (Coordinators: Jaume Veciana & Nora Ventosa)
5. NanoOptics & NanoPhotonics (Coordinators: Juan José Sáenz & Antonio García Martín)

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.

THE ORGANISING COMMITTEE

Organising Committee

Jean-Pierre Aimé	Université Bordeaux I & C'Nano Grand Sud-Ouest (France)
Xavier Bouju	CEMES-CNRS & C'Nano Grand Sud-Ouest (France)
Fernando Briones	CNM/IMM-CSIC (Spain)
Antonio Correia*	Fundación Phantoms (Spain)
Jesús M. de la Fuente	Instituto Universitario de Investigación de Nanociencia de Aragón (Spain)
Pedro Echenique	Donostia International Physics Center (Spain)
Luis Melo	Fundação para a Ciência e a Tecnologia (Portugal)
David Pozo Perez	CABIMER - Andalusian Centre for Molecular Biology and Regenerative Medicine - CSIC-US-UPO-JA (Spain)
Emilio Prieto	Centro Español de Metrología - CEM (Spain)
Juan José Sáenz	Universidad Autónoma de Madrid (Spain)
Josep Samitier	IBEC / Universidad de Barcelona (Spain)
Daniel Sanchez Portal	CSIC - UPV/EHU - DIPC (Spain)

Advisory Board

Sabino Azcarate	Tekniker (Spain)
Jaime Colchero	Universidad de Murcia (Spain)
Pedro Echenique	Donostia International Physics Center (Spain)
Javier Méndez	ICMM-CSIC (Spain)
Rodolfo Miranda	IMDEA Nanociencia / Universidad Autónoma de Madrid (Spain)
Pablo Ordejon	Universidad Autónoma de Barcelona (Spain)
Fernando Palacio	Universidad de Zaragoza (Spain)
José Maria Pitarke	Asociación CIC nanoGUNE (Spain)
Emilio Prieto	Centro Español de Metrología (Spain)
José Rivas	Universidad de Santiago de Compostela (Spain) / INL (Portugal)
Juan José Sáenz	Universidad Autónoma de Madrid (Spain)
Josep Samitier	IBEC / Universidad de Barcelona (Spain)
Conchita Solans	Instituto de Investigaciones Químicas y Ambientales de Barcelona (Spain)
Jaume Veciana	Instituto de Ciencia de Materiales de Barcelona (CSIC) (Spain)
José Luís Viviente	INASMET-Tecnalia (Spain)

Technical Organising Committee

Carmen Chacon	Fundación Phantoms (Spain)
Viviana Estêvão	Fundación Phantoms (Spain)
Maite Fernández	Fundación Phantoms (Spain)
Concepción Narros	Fundación Phantoms (Spain)
Joaquín Ramón Laca	Fundación Phantoms (Spain)
José Luís Roldán	Fundación Phantoms (Spain)

*Contact person: Antonio Correia – antonio@phantomsnet.net

NanoSpain2010 Organisers

http://www.cnanogso.org

Co-Lead Organisers (2010 edition)

Malaga [Spain] · March 23>26

NANOSPAIN CONF2010

NanoSpain2010 Gold Sponsors

españa, technology for life.	ICEX	GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

NanoSpain2010 Sponsors

NanoSciences GRAND SUD - OUEST	MINISTERIO DE INDUSTRIA, TURISMO Y COMERCIO CEM Centro Español de Metrología	DONOSTIA INTERNATIONAL PHYSICS CENTER fundación DIPC
UAM UNIVERSIDAD AUTONOMA DE MADRID	ibec	FEI
DAYFISA	VIAJES El Corte Inglés	nanoICT coordination action
CATION	NANOGAP SUBnmPOWDERS	Liberté • Égalité • Fraternité RÉPUBLIQUE FRANÇAISE

NanoSpain2010 Exhibitors

JUNTA DE ANDALUCIA Fundación Progreso y Salud CONSEJERÍA DE SALUD	NANOTEC ELECTRONICA	alphaSIP	iesmat
Iberlaser, s.a. Electro-Óptica Científica e Industrial Instrumentación y Láseres www.iberlaser.com Tlf: 91 658 67 60	Raith INNOVATIVE SOLUTIONS FOR NANOFABRICATION AND SEMICONDUCTOR NAVIGATION	schaefer	mecwins Innovation in nanomechanics for biotechnology
IONER ION Explorer by Ramem	HAMAMATSU PHOTON IS OUR BUSINESS	ICEX españa, technology for life. PHANTOMS foundation	JPK Instruments
attocube systems explore your nanoworld	ZEISS	nanoaracat	SIE
MICOS POSICIONAMIENTO Y OPTOMECÁNICA IBERIA	Telstar Instruments for solutions	NANOANDMORE GMBH The World of Scanning Probes and More	I S T C М Н Т Ц

NanoSpain2010 Exhibitors

JUNTA DE ANDALUCIA
Fundación Progreso y Salud
CONSEJERÍA DE SALUD

Andalusia, in the south of Europe, is the most populated region of Spain (8.3 million inhabitants). It has been an autonomous region since 1981, and Andalusia aspires to become one of the leading regions in offering the latest therapeutic opportunities to its citizens. Therefore, the Regional Government, in line with the wishes of Andalusians, is committed to promoting advanced therapies research and its translation into clinical settings.
Recent research advances have given rise to new hope in the treatment and diagnosis of many illnesses for which there is currently no cure. Translational research in the fields of cell therapy and regenerative medicine, clinical genetic and genomic medicine, and nanomedicine seems to have a key role in solving these research riddles.

Each of the above strategic research programs have a specific thematic research centre: CABIMER, GENYO and BIONAND.

BIONAND is born as the Andalusian Reference Centre to promote high-quality research in the field of Nanomedicine. The Centre creates a multidisciplinary research environment that provides expertise and fosters collaborations for the design, development, and use of nanosystems for therapeutic and diagnostic purposes. BIONAND steers the convergence of recent advances in nanotechnology with modern biology and medicine: the new research domain of nanobiotechnology. BIONAND research includes the development of nano-based diagnostics for rapid monitoring and targeted therapies, as well as nano-based localized drug and gene-delivery, and improved cell-nanomaterial interactions. The Centre's vision will help to improve health by enhancing the efficacy and safety of new and existing therapeutic and diagnostic agents through the discovery and application of innovative nanosystems and devices.

BIONAND is the materialization of a common objective: to encourage scientific excellence and socio-economic development in Andalusia while setting the standards for the medicine of the 21st century.

Please contact us at info@bionand.es or visit our web page www.bionand.es for more information.

NANOTEC
ELECTRONICA

Nanotec Electronica is one of the leading companies in the Nanotechnology Industry. In only ten years Nanotec Electronica has established itself as one of the strongest companies that design, manufacture and supply Scanning Probe Microscopes (SPM). Our highly qualified team uses cutting-edge technology in order to provide a cost-effective tool to gain access to the nanometer scale for both scientific and industrial communities. With its headquarters based in Spain and distributors located around the world, Nanotec ensures global presence and guarantees total customer satisfaction.

Nanotec´s Cervantes FullMode Atomic Force Microscope (AFM) in its several configurations allows not only imaging samples with atomic precision but also the study of magnetic, electronic and mechanical properties at the nanoscale, making it a powerful tool for physicists, chemists, biologists and engineers willing to characterize their samples at the nanometer scale. Its robust design provides strong mechanical stability to ensure high imaging resolution, and its semi-automated and open design allows scientists to exploit the capability of SPM to its maximum for both research and academic purposes.

Nanotec Electronica also provides Dulcinea Control Systems, with an open and modular design that facilitates interfacing with any other standard AFM/SNOM/STM system available in the market. Highly versatile, it allows different modes of operation from Contact Mode to Frequency Modulation Mode and lithography ensuring a reliable and accurate performance of all SPM systems.
Nanotec has also developed and freely distributes SPM software WSxM. Its user-friendly interface ensures easy operation of SPM microscopes and data processing. WSxM is available for its free download at www.nanotec.es

Centro Empresarial Euronova 3
Ronda de Poniente 12, 2º C
28760 Tres Cantos (Madrid) **SPAIN**
Tel: +34 918043347 / www.nanotec.es

alphaSIP

Alpha San Ignacio Pharma is an early stage NanoBio Chip company, positioned to deliver a scalable sensor platform to the Molecular Diagnostics world. His first market for 4 year firs roll up phase is the anticoagulants treatment market. Oral Anticoagulants Treatments (*in Spanish TAO, tratamientos orales anticoagulantes*) is a core market in the developed countries markets. Around 1-1,5% of total population is affected. Comparative studies of the state of the art on the quality of oral anticoagulant therapy reflects a disjunctive choose (warfarin versus acenocoumarol). Mechanism target of coumarin action relies on the significance of vitamin K epoxide reductase inhibition. An a general reference index INR is treated to evaluate patient evolution, however part of the internal effects interaction are a black box and are some room for improvement. Combining nanotechnology and digital signaling is possible to obtain cost and time savings advantages. Combining advances of semiconductor industry looking directly electrical signaling instead of creating reaction, then spending 2-3 hours to observe results (needing to colored fluid) and altering substrate is possible to reach cost advantages (using less antibodies), saving time, and requiring less knowledge to use it as point of care system. Also at specialized central lab level research opportunities with this scalable and multiplexed technology unveil pharmacogenetics at a reasonable prize allowing not to study singe gen interaction but a most appropriate holistic approach exploring simultaneous interactions in different organ and systems interactions. Now that alphabet genome is interpreted is time to keep surveying words, and single sentences in gene expressions to reach personalized medicine.Alpha San Ignacio Pharma is focused in the enabling technologies and bridging platforms, trying to contribute to global research with easiest to use technologies at a lower cost following Intel business model with Pentium family that facilitate outsource and integration from different providers at a reasonable price to quality adjusted model that facilitate standard adoption.

Product Description
The basic product consists of a highly sensitive Field Effect Transistor (FET) based sensor, capable of detecting femtomolar concentrations of proteins or nucleic acid. The sensitivity of such a nanobio sensor is a function of many variables, but most importantly the receptor material, which in this case consists of functionalized Carbon Nano Tubes (CNTs). The Company plans to integrate the NanoBio Chip within the existing infrastructure of the Infectious Disease, Food Testing and Pharmacogentic Diagnostics Industries, in that order. There are many proven platforms for sample delivery, microfluidics and signal processing, and therefore the Company will focus efforts on providing the most compact, and sensitive device within a universally adaptable platform. Alpha San Ignacio Pharma.

European Headquarters
Azalea 135
El Soto de la Moraleja, 28109 Madrid **SPAIN**
Tel: +34 626 00 41 07
Email: mroncales@alphasip.es

Iberlaser, s.a.
Electro-Óptica Científica e Industrial
Instrumentación y Láseres

Iberlaser was setup in 1993, and is based in Madrid-Spain. Our principal mission statement is provide research Spanish market with the novel instrumentation and highly qualified servicing. Our lines of products include:

Bio-technology: Complete Microscopy solutions.
Laser Technology. CW and Pulsed lasers covering the range UV-VIS-IR
Low light Imaging: High performance digital cameras and imaging software packages
Solar Simulators and illumination sources
Spectroscopy: Spectrographs and detectors. Time resolved and steady state fluorimeters.
Surface chemistry: Interface Analysis, Dip coaters, Monolayers preparation and characterization. Microbalance QCM.

Contact us:
Web site: www.iberlaser.es
Email: info@iberlaser.com
Tel: +34 91 658 67 60 / Fax: + 34 91 654 17 00
Avenida Pirineos, 7 - Oficina 2-8b
28700 San Sebastián de los Reyes (Madrid) **SPAIN**

Iesmat is a Spanish company that supplies, installs and provides technical and application support in the world of Materials and in particular in the Characterization of Particles, Surfaces and Liquid Dispersions.

Among the instrumentation offered by Iesmat, Nanotechnology receives particular emphasis and attention:

Malvern Instruments
Particle Size, Zeta Potential and Molecular Weight analysers, "Zetasizer Nano", capable of measuring particles in a size range between 0.6nm and 6000nm, molecular weights between 1000 and 2x10-7 Daltons, and zeta potential distribution in a single instrument. It is also possible to analyse parameters such as the melting point of biomolecules, agregation factor, 2nd virial coefficient and critical micelle concentration, using two patented technologies DLS-NIBS and M3-PALS.
The new protein dedicated instrument, Zetasizer uV is a unique instrument requiring extremely low amount of sample, only 2μ, "Auto Plate Sampler" available in the fully automated Zetasizer APS runnning up to 384 samples fully unattended.

Viscotec - Malvern Instruments
Systems for characterization of molecular structures for all types of macromolecules such as proteins, natural and synthetic polymer systems through GPC / SEC TDAmax, 270max, Rimax and Viscotek HT-GPC
Iesmat product range include other very interesting instrumentation in the characterization of materials, like particle size analysers by laser diffraction technology and rotational and capillary rheometers and viscometers from Malvern Instruments, systems and surface characterization and water adsorption on porous materials from Quantachrome, optical systems for stability studies of all types of liquid dispersions from Formulaction, chemical imaging systems SyNIRgi from Malvern, Raman systems from DeltaNu and ion mobility systems and FTIR for pharmaceutical validation from Smiths Detection.

IESMAT goal is to achieve full customer satisfaction in using the latest technologies from our selected list of leading manufacturers in scientific instrumentation.

If you need our expertise, please contact us at
IESMAT, S.A.
Parque Empresarial Miniparc II – Edificio M - C/ Caléndula 95
28109, Alcobendas, Madrid **SPAIN**
Tel. : 902 012 027 (International: +34 91 650 8005) / Fax: +34 91 650 7990 / Email: info@iesmat.com

The **Schaefer** group distributes over Continental Europe equipment for research, industry and education: **Nanotechnology – Materials Analysis – Vacuum Technology – Measuring Instruments.**
The technical experience of Schaefer Group is an additional value to the customer, who receives an excellent pre- and after-sale support.

Please visit our booth to discover our instruments. Among them, you will see how to:

Count, Size and visualize Nanoparticles with Nanosight LM20. 0.3 ml samples are introduced to the viewing unit using a disposable syringe and, enhanced by a near perfect black background, nanoparticles appear individually as point-scatterers moving under Brownian motion. Polydisperse and multimodal systems are instantly recognisable and quantifiable, as are agglomerates and contaminants. The image analysis Nanoparticle Tracking Analysis (NTA) software suite allows the user to automatically track and size nanoparticles on an individual basis. Results are displayed as a frequency size distribution graph and output to spreadsheet. Video clips of images can also be retained. www.nanosight.eu

Contact Veronique Pires
Schaefer Techniques
1, rue du Ruisseau Blanc - 91620 Nozay **FRANCE**
Phone : +33 (0)1 64 49 63 50 / E-mail : info@schaefer-tech.com
New Web : www.schaefer-tec.com

Raith
INNOVATIVE SOLUTIONS FOR NANOFABRICATION AND SEMICONDUCTOR NAVIGATION

Since 30 years **Raith GmbH** has been developing and selling high-tech systems in the domain of nanotechnology worldwide.

Main areas of operations are designing and manufacturing of systems enabling fabrication of superfine surface structures down to the range of less than 10 nanometers (electron and ion beam lithography) and semiconductor inspection tools for industry (defect review).

Renowned customers such as Infineon Technologies or the Massachusetts Institute of Technology in Boston avail themselves of the know-how Raith has acquired since its early being in business. With its highly educated staff of physicists, engineers and technicians Raith offers optimum service and support for answers to technical and application related questions.

Worldwide Raith qualifies its personnel to provide fast and competent help to its customer requests. Since 1985 Raith has pioneered the way for SEM lithography. Today complete turnkey lithography system solutions complement Raith product portfolio. These systems are used in state-of-the-art research in Physics, Electrical Engineering and other R&D related fields.

Raith GmbH
Konrad-Adenauer-Allee 8
(Phoenix-West)
44263 Dortmund **GERMANY**
Phone: +49 (0)231 / 95 004-0
Fax: +49 (0)231 / 95 004-460
E-mail: sales@raith.com
Web: www.raith.com

HAMAMATSU
PHOTON IS OUR BUSINESS

Hamamatsu is dedicated to using photonics technologies to address the needs of mankind through practical application, as well as using photons as a tool to create scientific knowledge and explore matter, energy, distance and time.

Our manufacturing divisions support our vision by the design, manufacture and sales of products for the detection and generation of light, which our customers apply in fundamental research in diverse fields. Many sensors which were made using conventional methods need to be completely redesigned using new nanotechnologies . In addition, the possibilities of these techniques open new challenges for new application dedicated to biology, drug discovery and medical fields.

3 700 people work for Hamamatsu all over the world.

In Europe Sales offices operate in France, Germany, UK, Italy, Sweden, Belgium, Switzerland, Spain and Portugal.

HAMAMATSU
Centro de Empresas de Nuevas Tecnologias
Parque Tecnologico del Vallés
E-08290 Cerdanyola (Barcelona) **SPAIN**
Phone : +34 93 582 44 30
Fax : +34 93 582 44 31
Please contact us at spain@hamamatsu.com or visit our web page www.hamamatsu.es for more information.

IONER
ION Explorer by Ramem

RAMEM has developed under its brand IONER® a full line of scientific instruments for the generation, charging, classification and detection of volatiles and nanoaerosols. The core of the technology is the measurement by Differential Mobility Analysis (DMA) of the electrical mobility of ions and nanoparticles. This technology has been protected under three international patents.

The mentioned technology has application in the following fields:

- Analytical Chemistry: environmental pollution control, security (explosive and illegal substances detection), quality control, agro-feeding industry, medicine (breath analysis for clinical diagnosis), biology (protein analysis), etc
- Aerosol Science and Technology: atmospheric monitoring, diesel and industrial exhaust emission.
- Nanoscience: electrospray deposition of isolated nanoparticles and macromolecules from liquid dispersions and size classification of nanoaerosols.

The following list includes the products marketed under IONER®:

- Electrospray source: ES-3020
- Ultra-low current electrometres: EL-5010, EL-5020 and EL-5030
- Planar NanoDMA: ND-1010
- High voltage sources: HV-7010, HV-7020 and HV-7030
- Corona charger: CC-8020
- X1 Plane Parallel VOC-DMA
- Aerosol Flow Control: AM-4020
- Sheath Flow Control: SM- 2020

Contact us:
Web site: www.ioner.eu
Email: ioner@ioner.eu
Tel: (+34) 914044575
Fax: (+34) 914034596
Address: C/ Sambara 33, 28027 Madrid **SPAIN**

PHANTOMS foundation
españa, technology for life.
ICEX

The **Spanish Institute for Foreign Trade (ICEX)** ("Instituto Español de Comercio Exterior") is the Spanish Government agency serving Spanish companies to promote their exports and facilitate their international expansion, assisted by the network of Spanish Embassy's Economic and Commercial Offices and, within Spain, by the Regional and Territorial Offices.

It is part of the Spanish Ministry of Industry, Tourism and Trade ("Ministerio de Industria, Turismo y Comercio").

ICEX: www.icex.es

España, Technology for life: www.spainbussiness.com

The **Phantoms Foundation** (non-profit organisation) was established on November 26, 2002 (in Madrid, Spain) to provide high level Management profile to National and European scientific projects. The Phantoms Foundation works in close collaboration with Spanish and European Governmental Institutions such as MEC (Spanish Ministry of Science) and ICEX (Spanish Institute for Foreign Trade), or the European Commission to provide focused reports on Nanoscience & Nanotechnology related research areas (infrastructure needs, emerging research, etc.) and develop activities to stimulate commercial nanotechnology applications (Spanish Pavilion at nanotech2008).

WEB: www.phantomsnet.net

mecwins
Innovation in nanomechanics for biotechnology

MecWins is committed to developing new **biosensing nanotechnologies** addressing the needs for fast, easy and highly sensitive genetic analysis. The goal of MecWins is to provide **cutting edge tools for genetic analysis** for disease prognosis, diagnosis and Pharmacogenomics.

MecWins applies the latest advancements of Nanotechnology in the Sensors field through close collaboration with key research groups in Nanomechanical sensing.

Nanomechanical biosensors are based on the principle that molecular recognition on the surface of a bio-functionalized micromechanical system (e.g., a cantilever) results in a bending (deflection) of few nanometers (static mode) or in a change of the resonant frequency (dynamic).

Mecwins has also signed a Transfer of Knowledge Agreement with CSIC*, one of the major scientific players in Spain.

Advantages of MecWins technology

The combination of advanced instrumentation for the optical read-out of the nanomechanical signal together with the study of the hydration forces in the biolayers provides key advantages to MecWins technology, including:

1. Label-free detection.
2. Parallel detection in bench top equipment.
3. Robust response in a flexible platform: Any cantilever design and cantilever number is addressable by the same read-out platform with MecWins technology.
4. Shorter analysis time.
5. Lower cost.
6. High sensitivity: Over 100 fold higher sensitivity than the label dependent microarrays.
7. Excellent specificity: Clear imprints for matching, non-matching and SNP mismatching DNA are obtained by Mecwins technology.

Application fields

Research

1. Biomedicine
2. Pharmacogenomics
3. Drug discovery
4. microRNA
5. Surface characterization
6. MEMS monitoring and characterization

Analysis

1. Medical diagnostics
2. Environmental monitoring
3. Genetic análisis

Contact us:
Mecwins S.L.
Santiago Grisolía,2
28760 Tres Cantos (Spain)
Tel.: +34 918 049 064
Email: info@mecwins.com
Web: www.mecwins.com

JPK Instruments AG is a world-leading manufacturer of nanoanalytic instruments - particularly atomic force microscope (AFM) systems and optical tweezers - for a broad range of applications reaching from soft matter physics to nano-optics, from surface chemistry to cell and molecular biology. JPK was recognized as Germany's fastest growing nanotechnology company in 2007 and 2008 (Deloitte). From its earliest days applying atomic force microscope (AFM) technology, JPK has recognized the opportunities provided by nanotechnology for transforming life sciences and soft matter research. This focus has driven JPK's success in uniting the worlds of nanotechnology tools and life science applications by offering cutting-edge technology and unique applications expertise. Headquartered in Berlin and with direct operations in Dresden, Cambridge (UK), Singapore and Tokyo, JPK maintains a global network of distributors and support centers and provides on the spot applications and service support to an ever-growing community of researchers.

Contact us:
JPK Instruments AG
Bouchéstr. 12 - 12435 Berlin **GERMANY**
Tel: +49 30 5331 12070 / fax: +49 30 5331 22555
Email: office@jpk.com / Web: www.jpk.com, www.nanobioviews.net

attocube systems AG manufactures and distributes a complete line of easy-to-use scanning probe microscopes and nanopositioning systems for temperatures in the range from 300 K down to 10 mK! The innovative nanopositioners are also compatible with high vacuum and ultra high vacuum environments as well as with high magnetic fields up to 31 Tesla.

Central to our proven suite of low temperature microscopes is our powerful combination of fully automated and absolute reliable low temperature positioning devices with modular and flexible scanning probe sensors, designed specially to meet the needs of today's low temperature research. Our instruments give users the ability to analyze samples down to the atomic level, even at Milli-Kelvin temperatures.

atto**cube** systems AG
Koeniginstr. 11a RGB - 80539 Muenchen – **GERMANY**
Phone: +49-89-2877809-0 / Fax: +49-89-2877809-19
Email: info@attocube.com / Web: www.attocube.com

The Electron Microscopy Division is an integral part of **Carl Zeiss** developing, producing, selling and servicing SEM, TEM and Particle Beam instruments designed to set unique high quality standards and to provide customer focused solutions for the Semiconductor, Material Analysis and Life Science application fields worldwide. Development and production facilities are based in Oberkochen (Germany), Peabody, MA (USA) and Cambridge (UK).

The history of electron microscopy at Carl Zeiss dates back to 1949 when the first commercial TEM was launched. Nowadays, the company's extensive know-how also comprises ion-beam technology and e-beam based analysis technology enable us to deliver innovative solutions for your business. Our global applications and service network guarantees fast, reliable and high quality support focussed on customer requirements. Combined with dedicated upgrade strategies, this will protect your investment for its entire lifetime.

The New and Powerful Combination of FIB and GEMINI® Column: NVision 40®. and **AURIGA®**

For more information, please contact:
Carl Zeiss MicroImaging, S.L.
c/Frederic Mompou,3 - 08960 Sant Just Desvern - **SPAIN**
Tel.: +34 93 480 29 52 / Fax: +34 93 371 76 09 / Web: www.zeiss.es/micro

nanoaracat

Nanoaracat is a collaboration agreement framework among the Spanish Communities Aragon and Catalonia, to encourage a series of joint actions in I+D+i in the area of the Nanoscience and the Nanotechnology. Since 2006 this initiative promotes the research collaboration and the technology transfer among 13 research centres and 5 universities from both communities participating in the project. Find in our Web page www.nanoaracat.com more information about the members.

Current projects and activities:

- Organization of Nanoscience scientific conferences and technology transfer sessions with the academic and industrial sectors. (see events on the Webpage)
    - AIN IV (4th Nanotechnology Industrial Applications Workshop). 16th June. Barcelona. Casa Llotja de Mar".
- Promotion of scientific interchanges to provide facilities and equipment of other centers, including the payment for the journey and the accommodation.
- Financing training courses for researchers and technicians in Catalonia and Aragon.
- Financing visits to set new projects.
- Financing scientific exchanges among these communities.

Researchers in Nanoscience and Nanotechnology areas from Catalonia and Aragon can request budget for those activities applying at: http://www.nanoaracat.com/solicitudes.html
The applications will be revised by the scientific commission, which will decide the appropriateness of the request, as we as the amount of the financing of the action in about 10 days.

More information:

Instituto de Nanociencia de Aragón (INA)
Susana Sangiao Barral
Promoción tecnológica
Telf. 976 762 891 / 628 547 330
Email: ina.promocion@unizar.es

Institut Català de Nanotecnologia (ICN)
Jordi Reverter Cendrós
Tel. +34 93 581 49 17 / +34 676 93 56 90
Email. Jordi.reverter.icn@uab.es
Ana de la Osa
Tel. +34 93 581 49 63
Email: ana.delaosa.icn@uab.es

SIE

Sistemas Informáticos Europeos specializes in cluster and machines dedicated to Scientific Calculus and Parallelization Technology. Our company was founded in 1990 and for ten years we have been working in this field.

The company has applied the HPC Technology to the field of Scientific Research that has very specific requirements different to those needed in other disciplines.

Thanks to the cooperation with scientists through the R+D agreements, our customer experiences feedback and the improvement accomplished with time, we have been able to get to this point.
Nowadays, hundreds of Scientists calculate with our SIE Ladon (clusters and machines), not only from Spain, but in many cases from remote parts of the World. Dozens of Universities and Calculus Centers, public and private, use day by day our systems which allow them to advance in the High Technology Areas.

SIE feels modestly proud to have contributed to the achievements with the Linux Open Source Developments. All systems Sie Ladon have three years warranty onsite and the best price-quality relation.

More information:
SISTEMAS INFORMÁTICOS EUROPEOS. S.L.
C/ Marqués de Mondéjar 29-31 2ºPlanta
28028 Madrid **SPAIN**
Tel: +34 913.61.10.02 / Fax: +34 913.61.10.87
Email: info@sie.es / Web: www.sie.es

NanoAndMore GmbH was founded 2002 with the objective to supply the scanning probes microscopes (SPM) community in the best possible way with a wide range of consumer goods from SPM probes, calibration standards, substrates to coating material, and more.

As an independent company our mission is to enable our customers to choose from a broad variety of products, brands and manufactures the SPM probe suitable for their needs. Since 1991 we have experience in this market, nobody else has more insight into in the world of SPM probes.

As of January 1st 2005 **NanoWorld Holding AG** acquired 100% of the **NanoAndMore GmbH**.

Our products are optimized for research, development, and process control applications when visualization, modification, and measurement of nanometre-sized surface structure is critical.
Our first aim is to pursue the idea of bringing new developments in the field of measurement instrumentation to the laboratories in scientific research and industry, and on customers demand.

Currently we offer brands as: **BioForce NanoScience, BudgetSensors**, **Mantis Deposition Ltd.**, **NANOCRAFT**, **NANOSENSORS**, **NanoTOOLS**, **NANOWORLD**, **SiMetrics**, **SmartTip, sQube** and **Team NanoTec**. We will continue to extend our product scope.

NanoAndMore GmbH
Steinbuehlstrasse 7 - Spilburg Bld. A1 - 35578 Wetzlar **GERMANY**
Tel: +49 (0)6441 8706272 / Fax: +49 (0)6441 8706274
Web:www.nanoandmore.com / Email: info@nanoandmore.com

TELSTAR INSTRUMAT, S.L. develops high technology instrumentation sales for research and industry, offering suitable technological tools adapted to each application, in order to improve the scientific researches or productive processes of our clients. In these last few years, TELSTAR INSTRUMAT has strengthened its activities representing leading companies in Spain & Portugal in the following applications:

- Surface and material characterisation and metrology
- ThinFilm deposition systems
- Vacuum and cryogenics instrumentation and technology
- Radiometry and photometry

TELSTAR INSTRUMAT, S.L. counts amongst its customers the principal Official Organisation Investigation Centres and private customers in the microelectronic, aerospace, automotive, optical, food and pharmaceutical industries and in innovative fields such as biotechnology and nanofabrication.
Some of our principals that are specifically of interest for the attendees to this conference are listed below:

- Veeco Instruments (SPM, Optical and Mechanical Profilers)
- Sopralab (ellipsometry and thin film pororisty)
- MicroMaterials Ltd (Nanoindentation Systems)
- SPECS GmbH (Surface Analysis, XPS, AFM-STM in UHV)

The company's head office is in Sant Cugat del Vallès (Barcelona) and it also has a branch office in Madrid.

Telstar Instrumat, S.L.
-Avda. Alcalde Barnils, 70, 3ª Planta
08174 Sant Cugat del Vallès **SPAIN**
Tel. +34 935 442 320 / Fax. +34 935 442 911
-C/ Santibáñez de Béjar, 228042 Madrid
Tel. +34 913 717 511 / Fax. +34 917 477 538
E-mail: comercial@telstar-instrumat.com / Web: www.telstar-instrumat.com

MICOS IBERIA SL is specialized in the distribution of high-tech components and systems in Spain and Portugal in the following fields:

1. Micro- and nanopositioning
2. Optics and optomechanics
3. Fiber optical sensors
4. Solid State ultra fast lasers

The concentration of its activities in the area of Fotonics and Motion Control, the wide range of specialized products as well as the high experience in the market allow MICOS IBERIA to offer qualified assistance and optimized solutions to the applications of its clients.

Of particular interest are customized developments for applications where standard products cannot warrant the success of a project, and solutions for low temperature and ultrahigh vacuum conditions.

MICOS IBERIA SL
C/ Carlets 25 1º 1ª - 08800 Vilanova i la Geltrú (Barcelona) **SPAIN**
Tel.: +34 93 816 03 80 / Fax: +34 93 816 03 79
Email: thomas.etzkorn@micos-online.com / Web: www.micos.es

ISTC is an intergovernmental organization dedicated to international scientific cooperation. Established by international agreement in 1992 and based in Moscow, ISTC coordinates the efforts of numerous governments, international organizations and private sector organizations, providing scientists from Russia, Georgia and other countries of the Commonwealth of Independent States (CIS) opportunities to use their talents for EU partners.

ISTC has projects in the following areas:
- Counter Terrorism and Global Security
- Biotechnology, Public Health and Agriculture
- Advanced Nuclear Energy Technology, Nuclear Fuel Cycle and Nuclear Safety
- Environmental Remediation and Climate Change Mitigation
- Renewable and Environmental Friendly Energy Technologies
- High Energy Physics based on Advanced Accelerator Technology (also called Particle Physics)
- Nanotechnologies
- Space and Aeronautics
- Laser Technology

Partner Program
The Partner Program assists private companies, government agencies and nongovernmental organizations to identify and engage highly skilled Russian and CIS scientists and R&D project teams.
Benefits of becoming a Partner:
- Cost free technology-demand matchmaking
- Moderate R&D costs
- Full project management services
- Full control of project funds by Partner
- Direct and transparent payment to scientists
- Tax and custom exemption
- Intellectual Property Rights (IPR) protection
- Co-financing of projects that meet national priority areas

For more information on ISTC contact:
Albert Gozal,
ISTC EU Promotion Manager
32-34 Krasnoproletarskaya ulitsa, 127473, Moscow, **RUSSIAN FEDERATION**
Tel: +7 (495) 982-3281 / E-mail: gozal@istc.ru / Web: www.istc.ru

SCIENTIFIC PROGRAMME

SCIENTIFIC PROGRAMME

Tuesday March 23, 2010

08h00-08h50	**Registration**	
08h50-09h10	**Opening**	
09h10-09h50	**Mihail Roco** (NNI and NSF, USA)	**I**
p. 67	*"Current Progress and Future Opportunities in Nanotechnology"*	
09h50-10h30	**Lajos P. Balogh** (University of Buffalo, USA)	**I**
p. 53	*"Composite nanodevices for the imaging and therapy of cancer"*	
10h30-11h00	**Coffee Break – Poster Session & Instrument Exhibition**	
(Session: Nanooptics & Nanophotonics) - Chairman: Antonio Garcia-Martin (Spain)		
11h00-11h20	**Juan Jose Saenz** (Universidad Autónoma de Madrid, Spain)	**O**
p. 117	*"Particle Dynamics in Non-Conservative Optical Vortex Fields"*	
11h20-11h40	**Raúl J. Martín-Palma** (Universidad Autónoma de Madrid, Spain)	**O**
p. 103	*"Towards the development of biomimetic optical devices"*	
11h40-12h00	**Daniel Jaque García** (Universidad Autónoma de Madrid, Spain)	**O**
p. 99	*"Ultrafast laser inscribed near field lenses in Lithium Niobate crystals"*	
12h00-12h20	**María Ujué González** (IMM-CNM-CSIC, Spain)	**O**
p. 95	*"Tailoring the modulation depth in Au/Co/Au magnetoplasmonic switches"*	
12h20-12h40	**Luis Froufe** (ICMM-CSIC, Spain)	**O**
p. 91	*"Observation of enhanced optical gain in photonic crystals"*	
12h40-13h00	**Ibon Alonso Villanueva** (Tekniker, Spain)	**O**
p. 73	*"Efficient organic distributed feedback lasers fabricated by thermal nanoimprint"*	
13h00-13h30	**Poster Flash Contributions**	
13h30-15h00	**Lunch**	
(Session: SPM) - Chairman: Juan Jose Saenz (Spain)		
15h00-15h40	**Pierre-Emmanuel Milhiet** (CBS / CNRS-INSERM, France)	**I**
p. 59	*"Nanoscale imaging of artificial membrane using AFM"*	
15h40-16h20	**Philippe Leclere** (Université de Mons/Materia Nova, Belgium)	**I**
p. 57	*"Scanning Probe Microscopy insights into supramolecular π-conjugated nanostructures for optoelectronic applications"*	
16h20-16h40	**Marco Chiesa** (IMM-CNM-CSIC, Spain)	**O**
p. 79	*"Large-scale nanopatterning of single proteins used as carriers of magnetic nanoparticles"*	
16h40-17h00	**M. Teresa Cuberes** (University of Castilla-La Mancha, Spain)	**O**
p. 85	*"Ultrasonic Force Microscopy characterization of a new scaffold formed of polyelectrolyte complexes"*	
17h00-17h30	**Poster Flash Contributions**	
17h30-20h00	**Coffee Break – Poster Session & Instrument Exhibition**	
21:00	**Welcome reception**	

SCIENTIFIC PROGRAMME

Wednesday March 24, 2010

	(Session: Nanochemistry) - Chairman: Jaume Veciana (Spain)	
09h00-09h40	**Christof Woell** (Karlsruher Institut für Technologie (KIT), Germany)	**I**
p. 69	*"Surface-templated assembly of functional networks: Entering the third dimension"*	
09h40-10h00	**Jose M. Domínguez-Vera** (Universidad de Granada, Spain)	**O**
p. 89	*“Multifunctional Ferritin Nanoparticles for Multimodal MRI-OI-SPECT Imaging”*	
10h00-10h20	**Veronica Mugnaini** (ICMAB-CSIC, Spain)	**O**
p. 107	*“2-D Confined Hydrogen Bonded Networks of Polychlorotriphenylmethyl Radicals on Au(111) Surfaces”*	
10h20-10h40	**M. Olga Guerrero-Pérez** (Universidad de Málaga, Spain)	**O**
p. 97	*“New highly active and selective nanostructured oxide catalysts”*	
10h40-11h40	**Coffee Break – Poster Session & Instrument Exhibition**	
	(Session: Nanoelectronics) - Chairman: Benjamin Lassagne (France)	
11h40-12h20	**Stephan Roche** (CEA-INAC, France)	**I**
p. 65	*"When Chemistry meets Nanoelectronics: Graphene, a new playground for Science and Innovation"*	
12h20-13h00	**Danny Porath** (Hebrew University, Israel)	**I**
p. 63	*“Bio-Templated Systems for Nanoelectronics”*	
13h00-14h30	**Lunch**	
14h30-17h00	**Thematic Parallel Sessions**	
	Nanobiotechnology – Chairmen: Josep Samitier, Jesús M. De la Fuente & Elena Martínez	
	Nanofabrication – Chairmen: Francesc Pérez Murano & Fernando Briones	
	Industrial – Chairmen: José-Luís Viviente, Emilio Prieto & Jordi Reverter	
	Nanochemistry – Chairmen: Jaume Veciana & Nora Ventosa	
	NanoPhotonics & NanoOptics – Chairmen: Juan José Sáenz & Antonio García Martín	
17h00-17h30	**Coffee Break – Poster Session & Instrument Exhibition**	
	(Session: Nanomagnetism) - Chairman: Andreas Berger (Spain)	
17h30-18h10	**Hans Peter Oepen** (University Hamburg, Germany)	**I**
p. 61	*"Magnetic investigations on the nanoscale"*	
18h10-18h30	**José Luis Costa Kramer** (IMM-CNM-CSIC, Spain)	**O**
p. 83	*“Magnetostriction driven cantilevers for Dynamic Atomic Force Microscopy”*	
18h30-18h50	**Miguel Ángel García** (ICV-CSIC, Spain)	**O**
p. 93	*“Magnetism in oxide nanoparticles: Surface effects”*	
21h30	**Conference Dinner**	

Satellite Course (organised by the nanoICT Coordination Action in collaboration with Nanotec Electrónica S.L.)*

nanoICT SPM Training Course		
Wednesday March 24, 2010		
Theoretical Introduction		
14h30-17h00	Introduction to SPM Techniques	
	AFM Advanced Modes	
	WSxM: an introduction to the SPM Software Tool for Data Acquisition and Analysis	
17h00-17h30	**Coffee Break – Poster Session & Instrument Exhibition**	
AFM Practical Training		
17h30-19h30	Depending on the previous SPM knowledge and research interests of the students, different operation modes will be practiced during the practical session. We encourage the students to bring their own samples.	
	nanoICT coordination action	NANOTEC ELECTRONICA

***Assistance restricted (only participants registered)**

Programme – NanoBiotechnology Thematic Session **Wednesday March 24, 2010**		
14h30-15h00	**Africa González** (Universidad de Vigo - Spain)	**K**
p. 159	*“Biocompatibility and immune response to nanoparticles: a key issue.”*	
15h00-15h30	**Pilar Marco (IQAC - Spain)**	**K**
p. 163	*"New Opportunities for Diagnostics using Nanobiotechnological Approaches"*	
15h30-15h45	**Ana Catarina Baptista** (CENIMAT/I3N - Portugal)	**O**
p. 179	*"Electrospun cellulose-based membranes for bioelectrochemical devices"*	
15h45-16h00	**Wolfgang Parak** (Philipps Universität Marburg - Germany)	**O**
p. 199	*"Colloidal nano- and microparticles towards sensing applications in biology"*	
16h00-16h15	**Rebecca Klippstein** (CABIMER-Andalusian center for Molecular Biology and Regenerative Medicine-CSIC-Univ. Seville-UPO-Junta de Andalucia - Spain)	**O**
p. 191	*"Nanotechnology approaches for improved based-drug delivery systems of the immunomodulatory neuropeptide vasoactive intestinal peptide"*	
16h15-16h30	**Wim Busing** (FEI Europe - Netherlands)	**O**
p. 185	*"Electron microscopy techniques for nano-particle analysis"*	
16h30-16h45	**Bob Carr** (NanoSight Ltd - United Kingdom)	**O**
p. 187	*"Simultaneous, Real-time, Mutli-parameter Analysis of Nanoparticles in Liquids"*	
16h45-17h00	**Discussion & Conclusion**	

Programme – Nanoelectronics, NEMS and NanoFabrication Thematic Session **Wednesday March 24, 2010**		
14h30-15h00	**Julio Gómez Herrero** (UAM - Spain)	**K**
p. 157	*"Characterization of MMX polymers by conductance AFM: a new type of molecular wires"*	
15h00-15h30	**Sergio Valenzuela** (CIN2; ICN-CSIC - Spain)	**K**
p. 175	*“Spin currents and spin dynamics in metallic nanostructures”*	
15h30-15h45	**Emanuela Buccafurri** (INL - INSA Lyon - France)	**O**
p. 183	*"High frequency resonant tunneling behavior: Testing an analytical small signal equivalent circuit with time dependent many-particle quantum simulations"*	
15h45-16h00	**Nicolás F. Martínez** (MecWins - Spain)	**O**
p. 197	*"Multifunctional nanomechanical systems for multiplexed highly selective and sensitive biological detection"*	
16h00-17h00	**Discussion & Conclusion**	

Programme – Industrial Thematic Session (Nanotoxicology) **Wednesday March 24, 2010**		
14h30-14h50	**Miquel Borrás** (PCB-UB - Spain)	**O**
p. 149	*"Acute toxicity of Cobalt Ferrite and Gold nanoparticles: in vitro and in vivo study"*	
14h50-15h10	**Anna García** (GRISC - Spain)	**O**
p. 155	*"Governance of nanotechnologies: some socio-legal impacts" – Part 1*	
15h10-15h30	**Ramón Moles** (GRISC - Spain)	**O**
p. 167	*"Governance of nanotechnologies: some socio-legal impacts" – Part 2*	
15h30-15h50	**Albert Gozal** (International Science and Technology Center - Russia)	**O**
p. 161	*“Open Innovation in Russia and CIS”*	
15h50-16h10	**Isaac Ojea** (ICN - Spain)	**O**
p. 171	*“Toxicological and Environmental Issues of Inorganic Nanomaterials”*	
16h10-17h00	**Discussion & Conclusion**	

Programme – NanoChemistry Thematic Session **Wednesday March 24, 2010**		
14h30-15h00	**Juan Casado Cordon** (UMA - Spain)	**K**
p. 153	*"Molecular Biradicals: Towards Functional Nano-Scale Biradicals"*	
15h00-15h30	**Marta Mas-Torrent** (ICMAB - Spain)	**K**
p. 165	*"Functional Molecular Self-Assembled Monolayers"*	
15h30-15h45	**Laura Bonel** (Universidad de Zaragoza - Spain)	**O**
p. 181	*"Nanostructured electrochemical aptasensors for ochratoxin A (OTA) determination"*	
15h45-16h00	**Mariana Köber** (IMM-CNM-CSIC - Spain)	**O**
p. 193	*"Decrease of the adhesion force with vapor pressure"*	
16h00-16h15	**Kilian Piettre** (Laboratoire de Chimie de Coordination - France)	**O**
p. 201	*"Cu/SiO2 films for 3D filling in microelectronic applications by an organometallic chemical liquid deposition (OMCLD) route"*	
16h15-17h00	**Discussion & Conclusion**	

Programme – NanoPhotonics & NanoOptics Thematic Session **Wednesday March 24, 2010**		
14h30-15h00	**José Calleja** (UAM - Spain)	**K**
p. 151	*"Microcavity-mediated coupling of two distant semiconductor quantum dots"*	
15h00-15h30	**Fernando Moreno Gracia** (Universidad de Cantabria- Spain)	**K**
p. 169	*"Numerical Analysis of the Electromagnetic Interaction of Metallic Nanoparticles with Substrates"*	
15h30-16h00	**Riccardo Sapienza** (ICFO - Spain)	**K**
p. 173	*"Controlling light emission: from single molecules to random lasing"*	
16h00-16h15	**Ignacio Iglesias** (Universidad de Murcia - Spain)	**O**
p. 189	*"Optical Scattering Forces Generated By High Numerical Aperture Microscope Objectives"*	
16h15-16h30	**Martín López García** (ICMM-CSIC - Spain)	**O**
p. 195	*"Enhanced emission in self assembled photonic crystals by hybrid photonic-plasmonic modes"*	
16h30-17h00	**Discussion & Conclusion**	

SCIENTIFIC PROGRAMME		
Thursday March 25, 2010		
(Session: Cnano GSO) - Chairman: Jean-Pierre Aimé (France)		
09h40-10h20	**Alexander Bittner** (CIC nanoGUNE - Spain)	**I**
p. 129	*"How to coat plant viruses"*	
10h20-10h40	**Sébastien Chevalier** (CNRS, France)	**O**
p. 137	*"Cadherin-mediated cell adhesion : From nanomechanical measurements between single molecules to living cells"*	
10h40-11h00	**Thierry Ondarçuhu** (CEMES, France)	**O**
p. 143	*"Liquid nanodispensing: molecules deposition and manipulation of ultrasmall droplets"*	
11h00-11h30	**Poster Session / Coffee Break & Instrument Exhibition**	
(Session: Cnano GSO) - Chairman: Xavier Bouju (France)		
11h30-12h10	**Benjamin Lassagne** (INSA - LPCNO - France)	**I**
p. 131	*"Carbon Nanotube Electromechanical Resonators for Ultra Sensitive Mass/Force Sensing"*	
12h10-12h30	**Antoine Tiberj** (CNRS, France)	**O**
p. 145	*"Raman spectroscopy of long isolated graphene ribbons grown on the C face of 6H-SiC"*	
12h30-12h50	**Juan Elezgaray** (CNRS, France)	**O**
p. 139	*"Decorating DNA origamis with gold nanoparticles"*	
12h50-13h10	**Joulia Larionova** (CNRS, France)	**O**
p. 141	*"Coordination polymer nanoparticles for biomedical applications"*	
13h10-13h30	**Guillaume Baffou** (ICFO, Spain)	**O**
p. 135	*"The rise of Thermo-plasmonics"*	
13h30-15h00	**Lunch**	
(Session: Nanoelectronics / Molecular Electronics) - Chairman: Stephan Roche (France)		
15h00-15h40	**Leonhard Grill** (Freie Universität Berlin, Germany)	**I**
p. 55	*"Model systems for molecular electronics studied by scanning probe microscopy"*	
15h40-16h00	**Linda Angela Zotti** (Universidad Autonoma de Madrid, Spain)	**O**
p. 125	*"Revealing the role of anchoring groups in the electrical conduction through single-molecule junctions"*	
16h00-16h20	**Xavier Cartoixa** (Universitat Autonoma de Barcelona, Spain)	**O**
p. 77	*"Fabrication of arrays of silicon nanowires"*	
16h20-16h40	**Joan Daniel Prades** (Universitat de Barcelona, Spain)	**O**
p. 109	*"Parallel Alignment of Nanowires for Fast Fabrication of Nanowire Based Gas Sensors"*	
16h40-17h00	**Ana Borras** (CSIC-US/ICMSE, Spain)	**O**
p. 75	*"General One step dry method for the synthesis of supported single-crystal organic nanowires and 1D heterostructures: perylenes, porphyrins and phthalocyanines"*	
17h00-19h00	**Coffee Break – Poster Session & Instrument Exhibition**	

Satellite event: International Workshop on Nanomedicine*

JUNTA DE ANDALUCIA

Fundación Progreso y Salud
CONSEJERÍA DE SALUD

NANOSPAINCONF2010 / March 25th 2010 / Málaga
INTERNATIONAL WORKSHOP ON NANOMEDICINE
Translation of nanosciences and nanotechnologies to clinical applications

More info: www.nanospainconf.org/2010/workshop.php

***Assistance restricted (only participants registered)**

SCIENTIFIC PROGRAMME
Friday March 26, 2010

(Session: Nanomaterials) - Chairman: Xavier Cartoixa (Spain)		
09h00-09h20	**Félix Quintero Martínez** (Universidad de Vigo, Spain)	**O**
p. 113	*"Production of glass nanofibres by a novel technique: Laser Spinning"*	
09h20-09h40	**Javier Méndez** (ICMM-CSIC, Spain)	**O**
p. 105	*"Metalorganic Nanostructures with a pure coordination bond"*	
09h40-10h00	**Vito Despoja** (Donostia International Physics Center (DIPC), Spain)	**O**
p. 87	*"Electronic excitations in thin metallic films"*	
10h00-10h20	**Stefano Chiussi** (University of Vigo, Spain)	**O**
p. 81	*"Patterned heteroepitaxial SiGe thin films through UV Excimer Laser radiation"*	
10h20-10h40	**José Luis Sánchez-Rojas** (UCLM, Spain)	**O**
p. 119	*"AlN-actuated piezoelectric MEMS/NEMS resonators"*	
10h40-11h00	**Emilio Prieto** (Centro Español de Metrología, Spain)	**O**
p. 111	*"Nanometrology, nano-eco-toxicology and standardization"*	
11h00-11h40	**Coffee Break – Poster Session & Instrument Exhibition**	
(Session: Nanobiotechnology / Nanomedicine) - Chairman: David Pozo (Spain)		
11h40-12h00	**Pilar Rivera Gil** (Universität Marburg, Germany)	**O**
p. 115	*"Quantum dot-based time-resolved adhesion assay for cell co-cultures"*	
12h00-12h20	**Marco Marradi** (CIC biomaGUNE, Spain)	**O**
p. 101	*"Magnetic Glyconanoparticles as MRI Probes"*	
12h20-12h40	**Jesús Sanz** (Universidad Miguel Hernández, Spain)	**O**
p. 121	*"Choline dendrimers as versatile tools for the development of new antibiotics and tissue imaging"*	
12h40-13h00	**Javier Tamayo** (IMM-CNM-CSIC, Spain)	**O**
p. 123	*"New paradigms and New Devices based on Nanomechanics for Ultrasensitive Biological detection"*	
13h00-13h40	**Philippe Barthélémy (Université Victor Segalen Bordeaux 2 - France)**	**I**
p.	**"Nucleolipid based nanomaterials: from supramolecular to biomedical applications"**	
13h40-14h00	**Concluding Remarks / NanoSpain2011 announcement**	

Poster Flash Contributions			
Tuesday March 23, 2010			
13h00-13h05	**Santiago Cuesta-López** (Universidad Politécnica de Madrid, Spain)	**NanoBiotechnology**	*“Physical view of biomolecular interactions in nano-technological applications.”*
13h05-13h10	**Lorena Diéguez** (Institute for Bioengineering of Catalonia, Spain)	**NanoBiotechnology**	*“Fabrication of optical gratings coated with Si3N4 for efficient immunosensing monitored by Optical Waveguide Spectroscopy”*
13h10-13h15	**Teresa Galán Cascales** (IBEC, Spain)	**NanoBiotechnology**	*“Fabrication by Dip-Pen Nanolithography of Polypyrrole Nanowires for DNA biosensors”*
13h15-13h20	**Diana Padilla** (Universidad de Málaga, Spain)	**NanoChemistry**	*“Simultaneous ir (1064 nm) pulsed laser deposition and annealing of zno films with an splitted 1064 nm beam”*
13h20-13h25	**María Paz Fernández García** (Universidad de Oviedo, Spain)	**Nanomagnetism**	*“Striking nano-onion nanoparticles with core (gamma-Fe)/ double shell (alfa-Fe/ Fe-oxide): synthesis, microstructure and magnetism”*
17h00-17h05	**Álvarez Lucia** (ICMM-CSIC, Spain)	**Nanomaterials**	*“XPS and STM study of Metalorganic nanostructures”*
17h05-17h10	**Mercedes Fernández** (Instituto de Polímeros Polymat (UPV/EHU), Spain)	**Nanomaterials**	*“Striking effect of temperature on conductivity of polyurethane/CNT nanocomposites”*
17h10-17h15	**Plamen Kirilov** (ENSCR, France)	**Nanomaterials**	*“Cationic Surfactants Based on Renewable Raw Materials: New Emulsifiers for Elaboration of Nanoparticles of Dispersed Oil”*
17h15-17h20	**Chris Popeney** (Free University of Berlin, Germany)	**Nanotubes**	*“Polyglycerol-Based Amphiphiles for the Water Solubilization and Aggregate Disruption of Single-Walled Carbon Nanotubes: Structure-Property Relationships”*
17h20-17h25	**María Vizuete** (Instituto Nanociencia, Nanotecnología y Materiales Moleculares (INAMOL), Spain)	**Nanotubes**	*“Supramolecular Assembles of Carbon Nanohorns and Porphyrin for Photovoltaic Devices”*

ABSTRACTS

INDEX - Invited Contributions (Plenary Session) (9)

INDEX - Oral Contributions (Plenary Session) (27)

INDEX - Invited Contributions (CNano GSO Session) (2)

INDEX - Oral Contributions (CNano GSO Session) (6)

INDEX - Keynote Contributions – Parallel Sessions (14)

INDEX - Oral Contributions – Parallel Sessions (12)

INDEX - Alphabetical Order (70)

Sébastien Chevalier (CNRS, France)	**ORAL CNano Session**	**p. 137**
“Cadherin-mediated cell adhesion : From nanomechanical measurements between single molecules to living cells”		
Marco Chiesa (IMM-CNM-CSIC, Spain)	**ORAL**	**p. 79**
“Large-scale nanopatterning of single proteins used as carriers of magnetic nanoparticles”		
Stefano Chiussi (University of Vigo, Spain)	**ORAL**	**p. 81**
“Patterned heteroepitaxial SiGe thin films through UV Excimer Laser radiation”		
José Luis Costa Kramer (IMM-CNM-CSIC, Spain)	**ORAL**	**p. 83**
“Magnetostriction driven cantilevers for Dynamic Atomic Force Microscopy”		
M. Teresa Cuberes (University of Castilla-La Mancha, Spain)	**ORAL**	**p. 85**
“Ultrasonic Force Microscopy characterization of a new scaffold formed of polyelectrolyte complexes”		
Vito Despoja (Donostia International Physics Center (DIPC), Spain)	**ORAL**	**p. 87**
“Electronic excitations in thin metallic films”		
José M. Domínguez-Vera (Universidad de Granada, Spain)	**ORAL**	**p. 89**
“Multifunctional Ferritin Nanoparticles for Multimodal MRI-OI-SPECT Imaging”		
Juan Elezgaray (CNRS, France)	**ORAL CNano Session**	**p. 139**
“Decorating DNA origamis with gold nanoparticles”		
Luis Froufe (ICMM-CSIC, Spain)	**ORAL**	**p. 91**
“Observation of enhanced optical gain in photonic crystals”		
Miguel Ángel García (ICV-CSIC, Spain) –	**ORAL**	**p. 93**
“Magnetism in oxide nanoparticles: Surface effects”		
Anna García (GRISC, Spain)	**KEYNOTE Parallel Session**	**p. 155**
“Governance of nanotechnologies: some socio-legal impacts”		
Julio Gómez Herrero (Universidad Autónoma de Madrid., Spain)	**KEYNOTE Parallel Session**	**p. 157**
“Characterization of MMX polymers by conductance AFM: a new type of molecular wires.”		
Africa González (Universidad de Vigo, Spain)	**ORAL Parallel Session**	**p. 159**
“Biocompatibility and immune response to nanoparticles: a key issue.”		
María Ujué González (IMM-CNM-CSIC, Spain)	**ORAL**	**p. 95**
“Tailoring the modulation depth in Au/Co/Au magnetoplasmonic switches”		
Albert Gozal (International Science and Technology Center, Spain)	**KEYNOTE Parallel Session**	**p. 161**
“Open Innovation in Russia and CIS”		
Leonhard Grill (Freie Universität Berlin, Germany)	**INVITED**	**p. 55**
"Model systems for molecular electronics studied by scanning probe microscopy"		

M. Olga Guerrero-Pérez (Universidad de Málaga, Spain)	**ORAL**	**p. 97**
“New highly active and selective nanostructured oxide catalysts”		
Ignacio Iglesias (Universidad de Murcia, Spain)	**ORAL** **Parallel Session**	**p. 189**
“Optical Scattering Forces Generated By High Numerical Aperture Microscope Objectives”		
Daniel Jaque García (Universidad Autónoma de Madrid, Spain)	**ORAL**	**p. 99**
“Ultrafast laser inscribed near field lenses in Lithium Niobate crystals”		
Rebecca Klippstein (CABIMER-Andalusian center for Molecular Biology and Regenerative Medicine-CSIC-Univ. Seville-UPO-Junta de Andalucia, Spain)	**ORAL** **Parallel Session**	**p. 191**
“Nanotechnology approaches for improved based-drug delivery systems of the immunomodulatory neuropeptide vasoactive intestinal peptide”		
Mariana Köber (IMM-CNM-CSIC Spain)	**ORAL** **Parallel Session**	**p. 193**
“Decrease of the adhesion force with vapor pressure”		
Joulia Larionova (CNRS, France)	**ORAL** **CNano Session**	**p. 141**
“Coordination polymer nanoparticles for biomedical applications”		
Benjamin Lassagne (INSA - LPCNO, France)	**INVITED** **CNano Session**	**p. 131**
“Carbon Nanotube Electromechanical Resonators for Ultra Sensitive Mass/Force Sensing.”		
Philippe Leclere (Université de Mons/Materia Nova, Belgium)	**INVITED**	**p. 57**
"Scanning Probe Microscopy insights into supramolecular π-conjugated nanostructures for optoelectronic applications"		
Martín López García (ICMM-CSIC, Spain)	**ORAL** **Parallel Session**	**p. 195**
“Enhanced emission in self assembled photonic crystals by hybrid photonic-plasmonic modes”		
Pilar Marco (IQAC, Spain)	**KEYNOTE** **Parallel Session**	**p. 163**
“New Opportunities for Diagnostics using Nanobiotechnological Approaches”		
Marco Marradi (CIC biomaGUNE, Spain)	**ORAL**	**p. 101**
“Magnetic Glyconanoparticles as MRI Probes”		
Raúl J. Martín-Palma (Universidad Autónoma de Madrid, Spain)	**ORAL**	**p. 103**
“Towards the development of biomimetic optical devices”		
Nicolás F. Martínez Cuadrado (MecWins, Spain)	**ORAL** **Parallel Session**	**p. 197**
“Multifunctional nanomechanical systems for multiplexed highly selective and sensitive biological detection”		
Marta Mas-Torrent (ICMAB, Spain)	**KEYNOTE** **Parallel Session**	**p. 165**
“Functional Molecular Self-Assembled Monolayers”		

Javier Méndez (ICMM-CSIC, Spain)	**ORAL**	**p. 105**
“Metalorganic Nanostructures with a pure coordination bond”		
Pierre-Emmanuel Milhiet (CBS / CNRS-INSERM, France)	**INVITED**	**p. 59**
"Nanoscale imaging of artificial membrane using AFM"		
Ramón Moles (GRISC, Spain)	**KEYNOTE** **Parallel Session**	**p. 167**
“Governance of nanotechnologies: some socio-legal impacts”		
Fernando Moreno Gracia (University of Cantabria, Spain)	**KEYNOTE** **Parallel Session**	**p. 169**
“Numerical Analysis of the Electromagnetic Interaction of Metallic Nanoparticles with Substrates”		
Veronica Mugnaini (ICMAB-CSIC, Spain)	**ORAL**	**p. 107**
“2-D Confined Hydrogen Bonded Networks of Polychlorotriphenylmethyl Radicals on Au(111) Surfaces”		
Hans Peter Oepen (University Hamburg, Germany)	**INVITED**	**p. 61**
“Magnetic characterization of single nanostructures“		
Isaac Ojea (ICN, Spain)	**KEYNOTE** **Parallel Session**	**p. 171**
“Toxicological and Environmental Issues of Inorganic Nanomaterials”		
Thierry Ondarçuhu (CEMES, France)	**ORAL** **CNano Session**	**p. 143**
”Liquid nanodispensing: molecules deposition and manipulation of ultrasmall droplets”		
Wolfgang Parak (Philipps Universität Marburg, Germany)	**ORAL** **Parallel Session**	**p. 199**
“Colloidal nano- and microparticles towards sensing applications in biology”		
Kilian Piettre (Laboratoire de Chimie de Coordination, France)	**ORAL** **Parallel Session**	**p. 201**
“Cu/SiO2 films for 3D filling in microelectronic applications by an organometallic chemical liquid deposition (OMCLD) route”		
Danny Porath (Hebrew University, Israel)	**INVITED**	**p. 63**
“Bio-Templated Systems for Nanoelectronics”		
Joan Daniel Prades (Universitat de Barcelona, Spain)	**ORAL**	**p. 109**
“Parallel Alignment of Nanowires for Fast Fabrication of Nanowire Based Gas Sensors"		
Emilio Prieto (Centro Español de Metrología, Spain)	**ORAL**	**p. 111**
“Nanometrology, nano-eco-toxicology and standardization”		
Félix Quintero Martínez (Universidad de Vigo, Spain)	**ORAL**	**p. 113**
“Production of glass nanofibres by a novel technique: Laser Spinning”		
Pilar Rivera Gil (Universität Marburg, Germany)	**ORAL**	**p. 115**
“Quantum dot-based time-resolved adhesion assay for cell co-cultures”		
Stephan Roche (CEA-INAC, France)	**INVITED**	**p. 65**
"When Chemistry meets Nanoelectronics: Graphene, a new playground for Science and Innovation"		

Mihail Roco (NNI and NSF, USA)	**INVITED**	**p. 67**
"Current Progress and Future Opportunities in Nanotechnology"		
Juan José Sáenz (Universidad Autónoma de Madrid, Spain)	**ORAL**	**p. 117**
“Particle Dynamics in Non-Conservative Optical Vortex Fields”		
José Luis Sánchez-Rojas (UCLM, Spain)	**ORAL**	**p. 119**
“AlN-actuated piezoelectric MEMS/NEMS resonators”		
Jesús Sanz (Universidad Miguel Hernández, Spain)	**ORAL**	**p. 121**
“Choline dendrimers as versatile tools for the development of new antibiotics and tissue imaging”		
Riccardo Sapienza (ICFO - The Institute of Photonic Sciences, Spain)	**KEYNOTE Parallel Session**	**p. 173**
“Controlling light emission: from single molecules to random lasing”		
Javier Tamayo (IMM-CNM-CSIC, Spain)	**ORAL**	**p. 123**
“New paradigms and New Devices based on Nanomechanics for Ultrasensitive Biological detection”		
Antoine Tiberj (CNRS, France)	**ORAL** **CNano Session**	**p. 145**
“Raman spectroscopy of long isolated graphene ribbons grown on the C face of 6H-SiC”		
Sergio Valenzuela (CIN2;ICN-CSIC, Spain)	**KEYNOTE Parallel Session**	**p. 175**
“Spin currents and spin dynamics in metallic nanostructures”		
Christof Woell (Karlsruher Institut für Technologie (KIT), Germany)	**INVITED**	**p. 69**
"Surface-templated assembly of functional networks: Entering the third dimension"		
Linda Angela Zotti (Universidad Autonoma de Madrid, Spain)	**ORAL**	**p. 125**
“Revealing the role of anchoring groups in the electrical conduction through single-molecule junctions”		

Malaga [Spain] · March 23>26
NANOSPAIN
CONF2010

INVITED SPEAKERS

PLENARY SESSION

Composite nanodevices for the imaging and therapy of cancer

Lajos P Balogh

Editor-in-Chief, Nanomedicine: Nanotechnology, Biology and Medicine (Elsevier)

Although modern drugs can very effectively address one or two of the needs of an ideal medicine, they are simply not complex enough. Complexity of the devices is unavoidable to deliver the required number of actions. Only nanoscale medical devices will be able to provide the level of complexity ideally needed. Functional nanodevices (FND) are assembled from various parts that carry out the desired functions (targeting moieties, contrast materials, apoptosis detectors, therapeutic molecules and so on) and a platform to assemble and hold together all the primary components.

The platform of our composite nanodevices (CND) consist of poly(amidoamine) (PAMAM) dendrimer templates that can be made in discrete sizes, with multiple surface functionalities, and regulated surface charges. These targeted nanodevices deliver anticancer drugs to specific organs and tissues. Other components consist of inorganic material(s), such as gold or silver metal clusters that are topologically trapped in the organic dendrimer matrix without having covalent bonds between the components. For several years we have pioneered composite nanodevices and their interactions with complex biological systems in an attempt to understand the characteristics that govern their biodistribution in mouse tumor model systems. The aim is to determine principles that may be applied in the future to predict key characteristics of nanodevices. We have also pioneered the development an angiogenic tumor microvascular targeted composite nanodevice, partly designed based on the nanodevice biodistribution data above, and we will discuss the experiments to greatly improve tumor nanomolecular imaging.

Similar CNDs are also being developed for novel forms of radiation therapy, both nanobrachytherapy and a nano-systemic targeted radiation therapy (NanoSTaRT), and photomechanical therapy, which procedures will be briefly described.

Model systems for molecular electronics studied by scanning probe microscopy

Leonhard Grill

Fritz-Haber-Institut of the Max-Planck-Society
Department of Physical Chemistry
Faradayweg 4-6, 14195 Berlin, Germany
e-mail: lgr@fhi-berlin.mpg.de

Molecules that are equipped with a specific function are of great interest for future applications in “molecular nanotechnology” where they should be used as single-molecule “devices”. A detailed understanding of the molecular function when being adsorbed on a surface or in contact with other molecules is required. The scanning tunneling microscope (STM) represents a highly suitable instrument for the investigation of such molecules, because it can not only image molecules with submolecular resolution but is also capable to manipulate single molecules by chemical/electrostatic forces or electronic processes [1, 2].

A key challenge in the field of molecular electronics is the bottom-up construction of stable molecular networks with pre-defined topology and shape. Ideally, such networks should be capable of charge transport between the building blocks as individual molecules in future applications will have to be linked by conducting connections. Based on these requirements, covalent bonds are desired for the intermolecular connections, but mainly supramolecular networks have been reported on surfaces.

In this talk, various examples of manipulations of single molecules by low temperature STM will be given. The controlled assembly of functional molecules by “on-surface-synthesis” [3] will be presented, whereas the shape of the molecular nanostructures can be precisely tuned by the initial building blocks. By pulling a polymer from a metallic surface, the conductance can be measured for a single molecular wire as a continuous function of the electrode-electrode distance [4]. Finally, the adsorption and growth of such organic nanostructures on inorganic crystallites, thus creating a hybrid system [5], will be discussed.

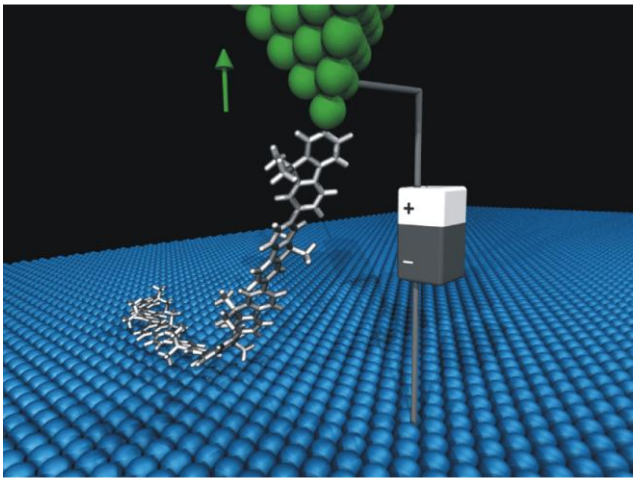


Figure1: Scheme of the pulling of single molecules from a gold surface. By applying a bias voltage, the conductance can be measured as a continuous function of the molecular length

References

[1] L. Grill, Journal of Physics: Condensed Matter 20, 053001 (2008)
[2] L. Grill, Journal of Physics: Condensed Matter 22, 084023 (2010)
[3] L. Grill et al., Nature Nanotechnology **2** (2007) 687
[4] L. Lafferentz et al., Science 323, 1193 (2009)
[5] C. Bombis et al., Ang. Chem. Int. Ed. 48, 9966 (2009)

Scanning Probe Microscopy Insights into Supramolecular π-Conjugated Nanostructures for Optoelectronic Applications

Philippe Leclere

University of Mons (UMons)
Laboratory for Chemistry of Novel Materials
Centre of Innovation and Research in Materials an Polymers (CIRMAP)
Place du Parc, 20, B- 7000 Mons (Belgium)
philippe.leclere@umons.ac.be

Well-defined conjugated materials play an important role in organic electronics because of their precise chemical structure and architecture. This gives rise to well-defined functional properties and facilitate control over their supramolecular organization. The solid state properties of organic electronic materials are determined not only by those of individual molecules but also by those of ensembles of molecules. This ability to control the building of nanoscopic and mesoscopic architectures represents a starting point for the construction of (supra)molecular electronic devices or even circuits (through surface patterning) with nanometer-sized semiconducting objects.
The role of self-assembling processes in these systems is demonstrated here for thiophene-, phenylene-, phenylenevinylene-, and fluorene-based conjugated oligomer (and polymer) linear and branched systems [1]. It appears that the presence of bulky side chains, or chiral centers, or hydrogen bonding groups is drastically affecting the final morphology.

During these processes, the interplay between the conjugated molecules, the solvent, the substrate surface, or an external templating structure, such a single strand DNA [2], is the main key-parameter governing the formation of these supramolecular assemblies. Depending on these interactions, one-dimensional (nanowires) or two-dimensional (platelets) objects can be generated. Atomic Force Microscopy (AFM) operating in Amplitude Modulation or Frequency Modulation are used to investigate the morphologies of self assembled conjugated systems starting from molecularly dissolved solutions or from aggregates already formed in solution [3]. Moreover, molecular modelling calculations are essential in this field of research for a better understanding on how the molecules are organized within these nanostructures and therefore rationalize the experimental data.

By using AFM-derived techniques (such as Conducting AFM, Kelvin Probe Force Microscopy), electrical properties can be measured at the local scale (together with the morphological characterization of the samples) helping the optimization of the device performances. Some practical examples such as photovoltaic devices, field effect transistors and white-light emitting diodes [4] will be discussed.

References

[1]. Ph. Leclère, M. Surin, P. Brocorens, M. Cavallini, F. Biscarini, and R. Lazzaroni, Mater. Sci. and Eng. – Reports, 55 (2006), 1-56.
[2]. M. Surin, P.G.A. Janssen, R. Lazzaroni, Ph. Leclère, E.W. Meijer, and A.P.H.J. Schenning, Adv. Mater. , 21 (2009), 1126-1130.
[3]. B. Grévin, R. Demadrille, M. Linares, R. Lazzaroni, and Ph. Leclère, Adv. Mater. 21 (2009), 4124-4129.
[4]. R.A. Abbel, Ch. Grenier, M.J. Pouderoijen, J.W. Stouwdam, Ph. Leclère, R.P. Sijbesma, E.W. Meijer, and A.P.H.J. Schenning, J. Am. Chem. Soc., 131 (2009), 833-843.

Nanoscale imaging of artificial membrane using AFM

Pierre-Emmanuel Milhiet, Bastien Seantier, Christian Le Grimellec
Centre de Biochimie Structurale, UMR5048 CNRS, UMR554 INSERM, Montpellier, France
pem@cbs.cnrs.fr

Stéphanie Pace, Jean-Marie Devoisselle, Frédérique Cunin
CNRS (UMR 5618) - ENSCM Laboratoire des Matériaux Catalytiques et Catalyse en Chimie Organique
Montpellier, France

Manuela Dezi and Daniel Levy
Institut Curie, UMR168 CNRS, Paris, France

Laura Picas, M. Teresa Montero and Jordi Hernandez-Borrell
Departament de Fisicoquímica, Facultat de Farmàcia, Universitat de Barcelona, and Institut de Nanociència i Nanotecnologia de la Universitat de Barcelona, Spain

Thanks to their ability to mimic biological membranes and their relative ease to be handled, supported lipid bilayers (SLBs) represent an attractive system in the development of membrane-inspired biosensors [1]. The issue for biosensor applications is to get bilayers separating two compartments for studying the properties of cell membranes such as permeability, active transport or signal transduction by transmembrane proteins.

In this talk, we will briefly describe the main strategies to prepare SLBs that are suitable for AFM analysis, a technique allowing topology of the membrane to be delineated with a resolution in the nanometer range. This approach has been recently used in the development of a membrane biosensor platform using mesoporous silicon [2]. Porous materials have emerged as good candidates for supporting lipid membranes, providing a reservoir of buffer below the membrane. Porous silicon obtained by electrochemically etching of crystalline silicon wafers is especially interesting because it behaves as a photonic crystal reflector and can be used as a label-free optical biosensor. Deposition of a continuous planar phospholipid bilayer at the surface of porous silicon has validated the proof of concept.

In the last part of the talk, we will stress on the incorporation of functional transmembrane proteins within bio-inspired membranes that still remains a challenge. I will introduce a technique developed in the laboratory and based on the direct incorporation of protein within SLBs destabilized by low cmc detergents. This technique requires very small amount of purified proteins (in the picomole range) allowing protein oligomerization to be delineated by AFM [3,4].

References

[1] B. Seantier, M.C. Giocondi, C. Le Grimellec, and P.E., Current Opinion in Colloid & Interface Science **13** (2008) 326–337
[2] S. Pace, P. Gonzalez, J.M. Devoisselle, PE Milhiet, Daniel Brunel and F. Cunin, N. J. Chem. (2010) **in press**.
[3] P.E. Milhiet, F. Gubellini, A. Berquand, P. Dosset, J.L. Rigaud, C. Le Grimellec and D. Lévy, Biophysical J **91** (2006), 3268-3275.
[4] Picas, L., Teresa Montero, J.L. Vazquez-Ibar, Seantier, B., Milhiet, P.E. and Hernández-Borrell, J. BBA Biomembranes (2010), **in press**.

Magnetic characterization of single nanostructures

Hans Peter Oepen

Department of Physics, University of Hamburg, Hamburg, Germany

The research on nanoscale magnetic structures is still a great challenge in today's research. The technological demands are twofold. On the one hand for the fabrication of nanoscale objects it needs either highly sophisticated techniques to artificially create nanostructures or chemical/physical processes that support the formation of systems with small sizes. On the other hand concerning the experimental characterization either the sensitivity of instruments has to be dramatically increased to detect the signal from the vanishing small systems or the spatial resolution of imaging techniques has to be improved and pushed into the ultimate resolution. The limits of the former approach are often surpassed by studying ensemble of identical particles. Using an ensemble of particles raises dramatically the need for homogeneity, which tightens up the condition for the fabrication process as the high perfectness has to be ensured on scales that must fit the measuring area, i.e. usually mm^2. The demanding prerequisite for high homogeneity becomes obvious when considering that in nanoscale systems the properties are strongly influenced by the surfaces and shape of the object. Thus, apparently small deviations in size and shape have strong impact on the magnetic properties. Consequence is that in the ensemble the distribution of sizes (and its shape) has a strong impact on the found magnetic behavior. The resulting properties are washed-out and the single particle behavior is concealed. Additionally, a limited sensitivity usually enforces the creation of nanostructure ensemble with high density. The close packing of the nanomagnets, however, causes the interaction between the individual elements. Such an interaction again affects the results of the magnetic characterization. Moreover it brings a new facet into play which is the surrounding of the individual element. Missing or damaged structures in the vicinity of perfect nanostructures or structures at the periphery alter the magnetic behavior hiding the real nanostructure properties.

In this contribution we present new approaches to study the magnetic behavior of single nanostructures and the interaction between nanostructures. In principal a micro- or nanoscaled device is built that gives access to the magnetic properties of individual nanostructures. Concerning interactions, it is generally believed that in arrays of nanomagnets exhibiting flux closure structure the elements do not interact. Recently, we could demonstrate that there is a strong coupling between rectangles that reveal the so called Landau configuration (Fig. 1). The image (Fig. 1) obtained by Scanning Electron Microscopy with Polarization Analysis (SEMPA or spin-SEM) demonstrates that the magnetic fine structure in a single Permalloy (Py) element is influenced by adjacent elements. A macroscopic structure representing the state of lowest energy is generated. To quantify the interaction between nanostructures exhibiting such flux closure domain pattern we have developed a new technique to study the magnetization behavior in single elements. Utilizing a highly focused ion beam (FIB) we create structures in a thin film including electrical contacts, which allows to measuring the energy state of the individual element via anisotropic magnetoresistance. The sizes of the magnetic Py structures vary between 300 x 600 nm^2 and 500 x 1000nm^2. The energy of the magnetic ground state is measured via the reversal magnetization behavior on applying a magnetic field along the short axis of the rectangles. When identical elements are positioned next to the rectangle the magnetization behavior changes depending on the separation between the structures. This is used to quantify the interaction between the elements.

To fabricate smaller structures with diameters below 20 nm we use low energy ion milling to structure thin films or multilayers. For that purpose we deposit nanosized particles on Co/Pt multilayers. The particles protect the magnetic multilayers locally from being removed by the ions while between the particles the magnetic multilayer is erased. On applying the correct dose an array of magnetic multilayer dots is created (Fig. 2). The nanodots are single domain. The anisotropy and the total amount of magnetic material per nanodot can be purposely tuned varying the Co thickness, Pt thickness, and the interface quality of the multilayer. Thus we can set the magnetic property of the dots from ferromagnetic to superparamagnetic behavior. The magnetization behavior of the dots is determined utilizing the Anomalous Hall Effect (AHE). To attain a Hall voltage crosses are fabricated by lithographical methods on which the multilayer is deposited. Performing the above mentioned procedures of transferring the nanoscale structure into the film we generate Hall geometries that contain only very small amounts of nanoparticles. Up to now we were able to measure the magnetic behavior of ensemble with a minimal number of about 30 nanodots. Based on our experience we estimate that the technique has the potential for the investigation of single nanodots magnetization behavior.

Financial support by the DFG via SFB668 is gratefully acknowledged.

Figures

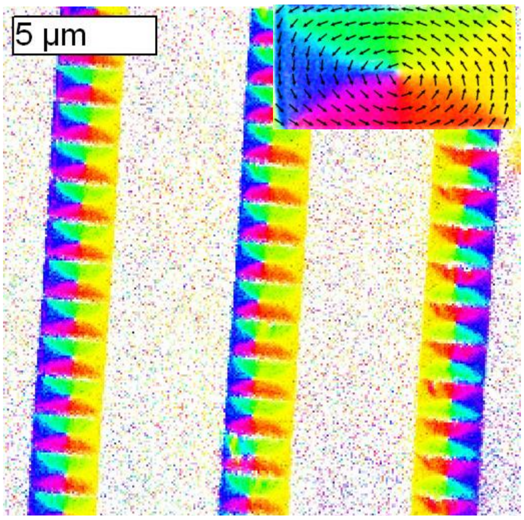


Figure 1. Coupled Permalloy rectangles. The rectangles in the rows have a separation of 200 nm (thickness 23 nm). Along the row a macroscopic magnetic structure is formed minimizing the total energy. The Landau pattern of a single rectangle is shown in the inset. The magnetization orientation of the large domains (green and red) is tilted out of the direction parallel to the edges.

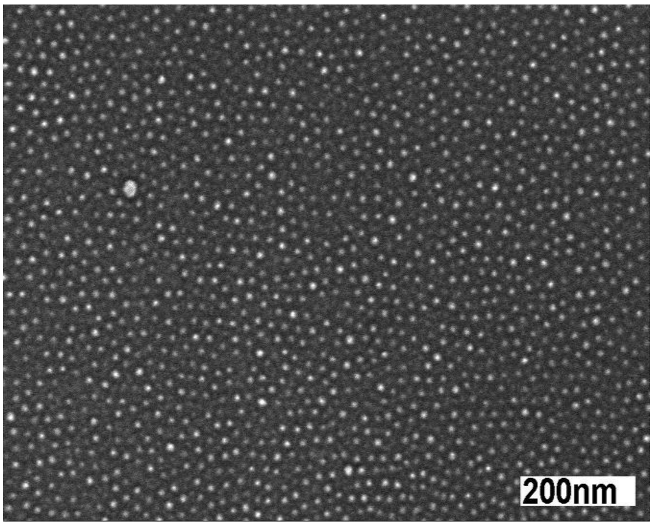


Figure 2. Magnetic nanodots. The dots have a diameter of 12 nm on the average. The nanostructures are created from multilayers with composition ($Co_{7Å}/Pt_{20Å})_2$. The easy axis of magnetization is perpendicular to the substrate surface.

Bio-Templated Systems for Nanoelectronics

Danny Porath

Physical Chemistry Department, The Hebrew University of Jerusalem, Israel and Center for Nanoscience and Nanotechnology of the Hebrew University
porath@chem.ch.huji.ac.il

In our research we use bio-templated systems to realize one-dimensional conducting nanowires and nanodevices for scientific investigation of electrical charge transport in these systems, for nanoelectronics and for nanotechnology applications. One example is dsDNA and its synthetic derivatives. Within this frame we measured electrical charge transport in dsDNA, measured the energy level spectrum of dsDNA, showed polarizability of DNA derivatives and more. I will briefly review this activity. Another example for bio-templated systems is the SP1 protein hybridized with various nanoparticles to form memory units and protein-particles conducting chains. We demonstrate The construction of various building blocks, acquiring specific attachment to gold or Si surfaces, array formation and finally charging and logic operations in hybrid SP1-nanoparticle systems. I will review this activity in more details. The research is conducted by my group in close collaboration with several groups from complementary fields.

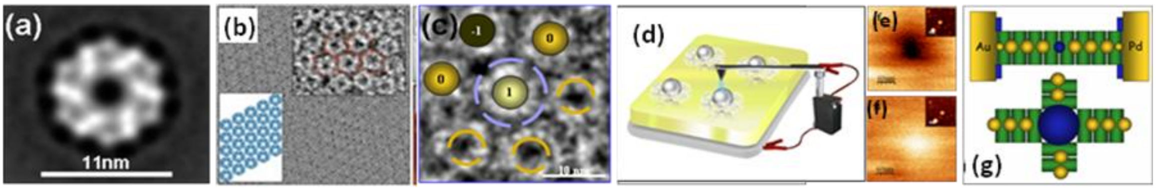


Figure 1: SP1 protein as a basis for nanoelectronic applications: (a) TEM of a single SP1 protein. (b) a large packed ordered array of SP1 molecules. Lower inset: a scheme of the array, upper inset: enlargement of part of the array, where the hexagonal packing is marked. (c) Overlaid scheme of the suggested memory array. (d) Scheme of the suggested omplementation, where the writing is by charging individual particles with AFM and reading by EFM. (e-f) Two charged states of the hybrid and topography (inset). (g) Scheme of chain structures.

References

[1] “Direct Measurement of Electrical Transport Through Single DNA Molecules of Complex Sequence”, Hezy Cohen, Claude Nogues, Ron Naaman and Danny Porath, PNAS 102, 11589 (2005).

[2] “Electrical characterization of self-assembled single- and double-stranded DNA monolayers using conductive AFM”, Hezy Cohen et al., Faraday Discussions 131, 367 (2006).

[3] “Long Monomolecular G4-DNA Nanowires”, Alexander Kotlyar, Nataly Borovok, Tatiana Molotsky, Hezy Cohen, Errez Shapir and Danny Porath, Advanced Materials 17, 1901 (2005).

[4] "Polarizability of G4-DNA Observed by Electrostatic Force Microscopy Measurements", Hezy Cohen Hezy Cohen et al., Nano Letters 7(4), 981 (2007).

[5] “High-Resolution STM Imaging of Novel Poly(G)-Poly(C)DNA Molecules”, Errez Shapir, Hezy Cohen, Natalia Borovok, Alexander B. Kotlyar and Danny Porath, J. Phys. Chem. B 110, 4430 (2006).

[6] “Electronic structure of single DNA molecules resolved by transverse scanning tunneling spectroscopy”, Errez Shapir et al., Nature Materials 7, 68 (2008).

[7] “SP1 Protein Based Nanostructures and Arrays”, Izhar Medalsy et. al., Nano Letters 8, 473 (2008).

[8] "Float And Compress: A Honeycomb Like Array Of A Highly Stable Protein Scaffold", Arnon Heyman et al., Langmuir 25, 5226 (2009).

[9] “Protein Scaffold Engineering Towards Tunable Surface Attachment”, Arnon Heyman et al., Angewandte Chemie Int. Ed., 48, 9290 (2009).

[10] "Logic implementations using a single nanoparticle-protein hybrid", Izhar Medalsy et. al., Nature Nanotechnology, In Press.

When Chemistry meets Nanoelectronics: Graphene, a new playground for Science and Innovation

Stephan Roche

CIN2: Centre d'Investigació en Nanociència i Nanotecnologia (CSIC-ICN),
Campus de la U.A.B., Bellaterra (Spain) and
CEA, INAC, SP2M, L_sim, 17 rue des Martyrs, 38054 Grenoble (France)

Graphene is a two-dimensional monolayer of sp^2 bonded carbon atoms in a dense honeycomb crystal structure which behaves electronically as a zero-gap semiconductor with exceptional chare mobilities. However the engineering of innovative devices demand fot the extensive use of chemical treatment to clean or functionalize the raw material.

This talk will overview some salient features of charge transport properties in chemically-doped or functionalized graphene based materials, with first the consideration of two-dimensional disordered graphene. In agreement with the 2D localization theory, the system will be shown to undergo a conventional 2D Anderson transition in the low temperature limit, providing inter-valley scattering processes are allowed, or say differently provided the material is sufficiently damaged. The sensitivity of localization phenomena in regards to edge symmetries and change of transport dimensionality or disorder scale will be further outlined [3]. The effect of chemical disorder, including Boron and Nitrogen substitutions, topological defects, vacancies and grafted molecules will be also discussed [4]. Chemical modifications of graphene material will be demonstrated to strongly impact on electronic properties of graphene, opening in some situation genuine perspectives for improved device performances and horizons for a carbon based nanoelectronics.

References

[1] J.C. Charlier, X. Blase and S. Roche, **Rev. Mod. Phys.** 79, 677 (2007). A. Cresti et al., **Nano Research** 1, 361-394 (2008).
[2] R. Avriller, S. Latil, F. Triozon, X. Blase, S. Roche, **Modern Physics Letters** B 21, 1955 (2007). A. Lopez-Bezanilla et al. **Nano Letters** 9 (3), 940 (2009)
[3] A. Lherbier, B. Biel, Y.M. Niquet, S. Roche, **Phys. Rev Lett.** 100, 036803 (2008). A. Lherbier, X. Blase, Y.M. Niquet, S. Roche, **Phys. Rev Lett.** 101, 036808 (2008).
[4] B. Biel, X. Blase, F. Triozon, S. Roche, **Phys. Rev. Lett.** 102, 096803 (2009). B. Biel, F. Triozon, X. Blase, S. Roche, **Nano Letters** 9 (7), 2725 (2009). S.M.M. Dubois et al. **ACS Nano (in press)**

Current Progress and Future Opportunities in Nanotechnology

Mihail C. Roco

National Science Foundation and National Nanotechnology Initiative, U.S.

Nanotechnology R&D has changed its focus, industrial relevance and governance since 2000 when was proposed in various national programs as a key science and technology development for 21st century [1]. This presentation outlines the progress in foundational knowledge development, its current status supporting about $80 billion production incorporating nanoscale components only in the United States, and likely evolution towards a general purpose technology by 2020. Nanotechnology has already powerful implications in knowledge foundation, advanced materials, nanoelectronics, molecular medicine, energy conversion and storage.

In the first decade (about 2001-2010) the main goals have been understanding individual basic phenomena, synthesize components as building blocks for potential future applications, tool advancement, and improving existing products by using relatively simple nanoscale components. In the second foundational phase (about 2011-2020), there is a R&D transition towards direct measurements on three-dimensional domains with good time resolution, science – based design of fundamentally new products and mass use of nanotechnology. The focus of R&D and applications is expected to shift to complex nanosystems, new disciplines and areas of relevance leading to novel products and services. An increased focus is on sustainable resources including water, food, energy, materials and clean environment. The convergence of nanotechnology, modern biology, the digital revolution and other areas are expected to bring about tremendous improvements in transformative tools and societal outcomes.

General trends in nanotechnology funding, publications and technology transfer will be outlined.
For illustration, the number of patent applications has increased at an annual rate of about 35% between 2001 and 2008 [2], about 10% faster than the annual rate of increase of paper publications. At the same time, in 2008, the relative proportion of nanotechnology contributions is about 11% in National Science Foundation new awards, about 4.5% in journal articles and 1.5% in USPTO patent awards (see Figure 2, after [3, 4])

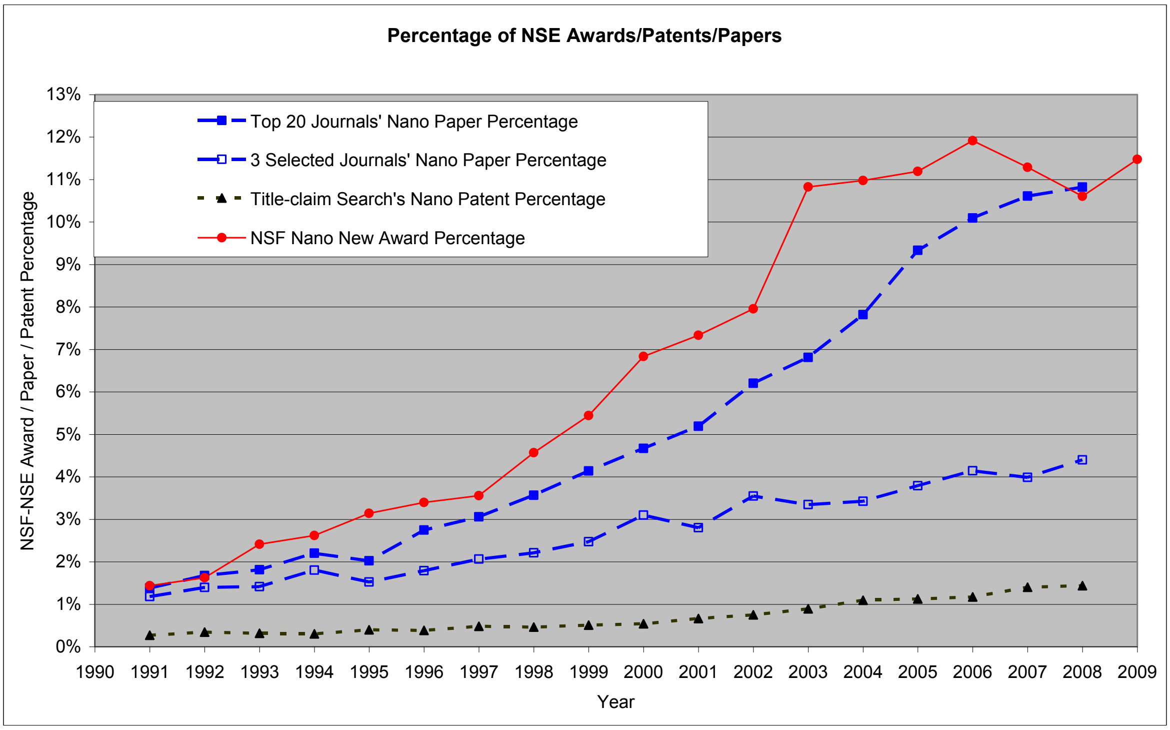


Figure 1. Nanotechnology contents in NSF awards, ISO papers and USPTO patents (1991-2009).

We will discuss possibilities for a transformative, global, long-term view and responsible governance approach of nanotechnology. Regulation may be an enabling or constraint of technological innovation, two sides of the same coin. Five ideas are advanced to address the challenges of the new generations of nanomaterials: (1) making available open sources systems to promote global self-regulation, (2) creating and leveraging S&T nanotechnology platforms, (3) addressing the sustainablility of resources as well as environment, health, and safety (EHS) issues and unexpected consequences, (4) support global communication and international cooperation, and (5) commiting to a long-term, global, priority-driven governance supported by reliable system to monitor developments and detect problems. o the need to transform education in the face of such radical technological and risk governance challenges.

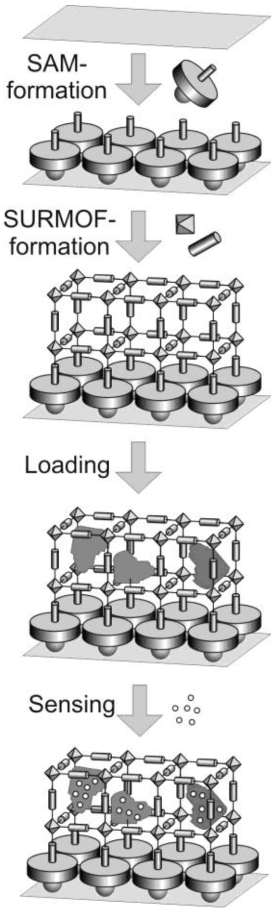
References

[1] “Nanotechnology Research Directions” (MC Roco, RS Williams and P Alivisatos), Springer, Dordrecht, 1999; and US National Science and Technology Council, Washington, D.C., 2000.
[2] “Trends in Worldwide Nanotechnology Patent Applications: 1991 to 2008” (Y Dang, HC Chen and MC Roco), J. Nanoparticle Res., Vol. 11 (3), 2010.
[3] “National Nanotechnology Initiative: Past, Present, Future” (MC Roco), Handbook on Nanoscience, Engineering and Technology, 2nd Ed., Taylor and Francis, 2007, 3.1-26.
[4] “Mapping Nanotechnology Innovations and Knowledge” (HC Chen and MC Roco), Springer, 2009.

Surface-templated assembly of functional networks: Entering the third dimension

Christof Wöll

Institut für Funktionelle Grenzflächen, Karlsruhe Institute of Technology, 76021 Karlsruhe, Germany



Supramolecular chemistry holds unique prospects for the fabrication of novel functional materials. Molecularly precisely defined, nanometer-sized subunits which may already be rather complex self-assemble to form even more complex structures which exhibit functionalities not provided by the individual building blocks. In two dimensions, the understanding of a surface-templated assembly of organic molecules (ligands) interacting through hydrogen bonds or ionic interactions has been significantly advanced in recent years.[1]

Here we extend the fabrication of surface-anchored networks beyond the formation of planar, two-dimensional adlayers by demonstrating the synthesis of highly-ordered, three-dimensional porous metalorganic frameworks (MOFs) nucleated on organic surfaces exposed by different types of self-assembled thiolate-based monolayers (SAMs).We will demonstrate the principle of liquid phase epitaxy [2] for the case of $[Cu_3(BTC)_2(H_2O)_n]$ (HKUST-1) grown on COOH- and OH-terminated SAMs using Cu(II) acetate as the metal precursor and BTC (benztricarboxylic acid) as the organic ligand. SPR (surface plasmon resonance) spectroscopy is used to monitor the growth in-situ. XRD data reveal the formation of highly ordered crystalline MOF thin-films with a structure identical to that observed in the bulk on both SAMs. The XRD data also reveal different growth orientations, depending on the termination of the SAM. AFM characterization of patterned substrates by micro-contact printing (µCp), shows clearly the selective and homogeneous deposition on both surfaces [3]. It should be noted, that the LPE-process not only allows for fabricate very homogenous coatings but also provides rather detailed insight into the basic mechanisms of the MOF synthesis process, in particular about the role of secondary building blocks (SBUs)[4]. In addition, the rather different fabrication mechanisms underlying the LPE-process – alternating exposure to the reactants in contrast to the standard slothermal synthesis – allows to access novel MOF-structures and makes it possible to control the phenomenon of interpenetration [5].

The availability of porous frameworks rigidly anchored to solid surfaces opens the prospect of adding additional functionality to these ultrathin surface coatings by placing nanoobjects inside the the pores within the MOFs, e.g. metal clusters or dye molecules. We will demonstrate the potential of this approach by loading the three-dimensional porous scaffolds with metal-containing molecules such as ferrocene.

References

[1] J.V. Barth, *Annual Review of Physical Chemistry* ***58***, 375 (2007)
[2] O. Shekhah, H. Wang, S.Kowarik, F.Schreiber, M.Paulus, M.Tolan, C.Sternemann, F.Evers, D.Zacher, R.A. Fischer, Ch.Wöll, *J.Am.Chem.Soc.* **129**, 15118 (2007)
[3] C. Munuera, O. Shekhah, H.Wang, Ch. Wöll, C. Ocal, PCCP. **10**, 7257 (2008)
[4] O. Shekhah, H. Wang, D. Zacher, R.A. Fischer, Ch. Wöll, Angew. Chem. Int. Ed., **48**, 5038 (2009)
[5] O. Shekhah, H. Wang, M. Paradinas, C. Ocal, B. Schupbach, A. Terfort, D. Zacher, R.A. Fischer, Ch. Wöll, Nat. Mater. **8**, 481 (2009)

Malaga [Spain] · March 23>26
NANOSPAIN
CONF2010

ORAL CONTRIBUTIONS

PLENARY SESSION

Efficient organic distributed feedback lasers fabricated by thermal nanoimprint

V. Trabadelo[1], A. Juarros[1], A. Retolaza[1], S. Merino[1], **I. Alonso**[1], V. Navarro-Fuster[2], M.G. Ramirez[2], P.G. Boj[2], I. Vragovic[2], J.M. Villalvilla[2], J.A. Quintana[2], M.A. Díaz-García[2]

[1]Micro and Nanotechnology Department, Tekniker, Avda. Otaola 20, 20600 Eibar, (Spain)
[2]Instituto Universitario de Materiales de Alicante, Universidad de Alicante, 03080 Alicante, (Spain)

ialonsovillanueva@tekniker.es

Solid-state lasers based on semiconducting polymers have become an active field of research in the past few years [1]. Polystyrene (PS) films doped with perylenediimide (PDI) derivatives have shown a great potential in this regard due to its highly photostable optically-pumped amplified spontaneous emission (ASE) at low threshold [2]. On the other hand, the use of distributed feedback (DFB) structures as resonant cavities, significantly enhance the lasing properties of organic materials, providing single-mode emission and lower pumping thresholds [1]. In order to get such a structured medium, nanoimprint lithography (NIL) is one of the most promising techniques for grating fabrication, even for future industrial applications, because its high throughput, low cost and high fidelity pattern transfer.

In this work we first present the fabrication by NIL and dry etching of second-order DFB gratings in SiO_2 (periodicity of 368 nm and equal line and space, fig. 1) on which PS films doped with 0.5 wt% of a PDI derivative were spin-coated afterwards [3]. The embossing was carried out at 180 ºC and the applied force (20000 N) was held for 900 s. The residual layer was removed using an O_2 plasma and the grating was transferred to the SiO_2 by CHF_3/Ar plasma etching. Several grating depths (340, 220 and 105 nm) were obtained by varying the etching time. Furthermore, we also imprinted DFB gratings directly on the active material using the same master stamp. After spin-coating a 880 nm-thick PS film doped with 0.5 wt% of PDI on a SiO_2 wafer, it was embossed at 155 ºC applying 15000 N for 900 s. This way the dry-etching step can be avoided, so the fabrication process for this kind of devices becomes more cost-effective.

Both types of lasers showed highly photostable laser emission at around 572 nm, when pumped at 533 nm with a pulsed Nd:YAG laser. As shown in Fig. 2, thresholds were drastically reduced with respect to the ASE threshold of a sample without grating. Moreover, the performance of the devices with gratings directly embossed on the doped PS film was superior, in terms of threshold, than that of devices with gratings imprinted on SiO_2 .

Acknowledgements: This work is funded by the “Ministerio de Ciencia e Innovación” and the European Community (FEDER) through grant MAT2008-06648-C02. MGR is supported by a CSIC fellowship within the program JAE.

References

[1] I. D.W. Samuel, G.A. Turnbull, Chem. Rev., **107** (2007) 1272.
[2] E. M. Calzado, J. M. Villalvilla, P.G. Boj, J. A. Quintana, R. Gómez, J. L. Segura, M. A. Díaz-García, Appl. Opt., **18** (2007) 3836.
[3] V. Trabadelo, A. Juarros, A. Retolaza, S. Merino, M.G. Ramírez, V. Navarro-Fuster, J.M. Villalvilla, P.G. Boj, J.A. Quintana, M.A. Díaz-García, Microelectron. Eng. (2009) *in press*, doi:10.1016/j.mee.2009.11.142

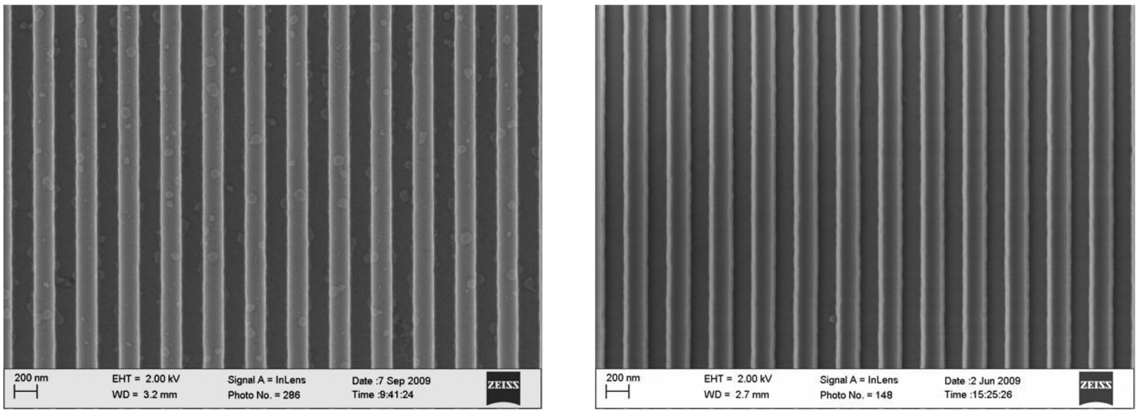


Figure 1. FE-SEM micrograph (Inlens detector) showing a representative area of the DFB grating in the stamp (left) and transferred in SiO_2 after NIL (right).

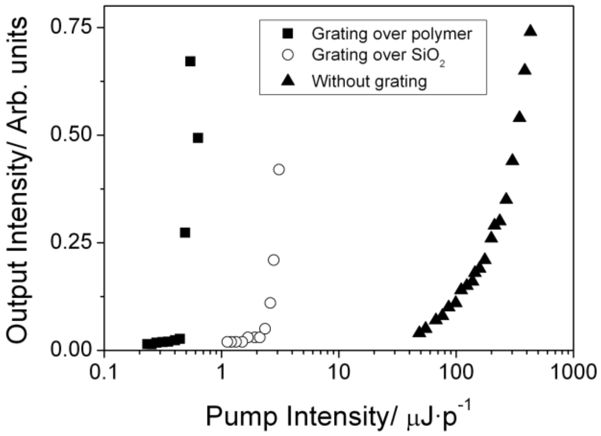


Figure 2. Output intensity versus pump intensity for DFB devices with gratings on the polymer and on SiO_2. For comparison purposes, data for a film deposited on SiO_2 without grating are included.

General One step dry method for the synthesis of supported single-crystal organic nanowires and 1D heterostructures: perylenes, porphyrins and phthalocyanines

Ana Borras*[1] and Pierangelo Gröning[2]

(1) Surfaces, Interfaces and Thin Films Lab., Instituto de Ciencia de Materiales de Sevilla (ICMSE, CSIC-US),
Avd. Americo Vespucio 49, 41092, Seville, Spain.
(2) Nanotech@surfaces Lab. EMPA, Swiss Federal Laboratories for Materials Testing and Research,
Feuerwerkerstrasse 49, 3602, Thun, Switzerland.

anaisabel.borras@icmse.csic.es

In this communication we present a general one step method for the growth of supported perylene, porphyrin and phthalocyanine single-crystalline nanowires. The successfully deposition of high-density arrays of semiconductor nanowires on metal nanoparticles and different oxide thin films by a vapor transport process is shown. High quality nanowires with squared footprint and belt shape grow with a homogeneous cross section from the substrate (c.f. Figure 1) [1]. The HRTEM and ED results demonstrate that the nanowires are form by columns of molecules showing a Pi-Stacking along the column axe and a herringbone arrangement with a tilt angle of “15º or 30°” between those [2]. This one step dry method presents significant advantages over other solution and template methodologies such its simplicity, mild conditions, relative low substrate temperature, as well as the high homogeneity and crystallinity of the nanowires synthesized (Fig. 1 c). In addition, the nanowires grown by this method are in solid contact with the substrate (metal nanoparticle or oxide thin film). The universal character of the process for different types of molecules allows the fabrication of 1D organic heterostructures. The formation of two new types of 1D heterostructures is addressed: binary nanowires consisted either by two metal porphyrins or two metal htalocyanines and the open core@shell organic nanowires. The latter heterostructured nanowires consist in an inner wire of porphyrin or perylene partially wrapped by a phthalocyanine nanobelt (c.f. Figure 2) [1, 2]. On other hand, we will also demonstrate a new route for the ohmic connection of organic nanowires based on this new methodology [3].

References

[1] Borras, A.; Aguirre, M.; Lopez-Cartes, C.; Groening, O.; Groening, P. Chem. Mater **24** (2008) 7371.
[2] Borras, A.; Groening, O.; Aguirre, M.; Gramm, F.; Groening, P. Langmuir (Under revision).
[3] Borras, A.; Groening, O.; Koeble, J.; Groening, P. Adv. Mater. DOI: 10.1002/adma.200901724 (2009).

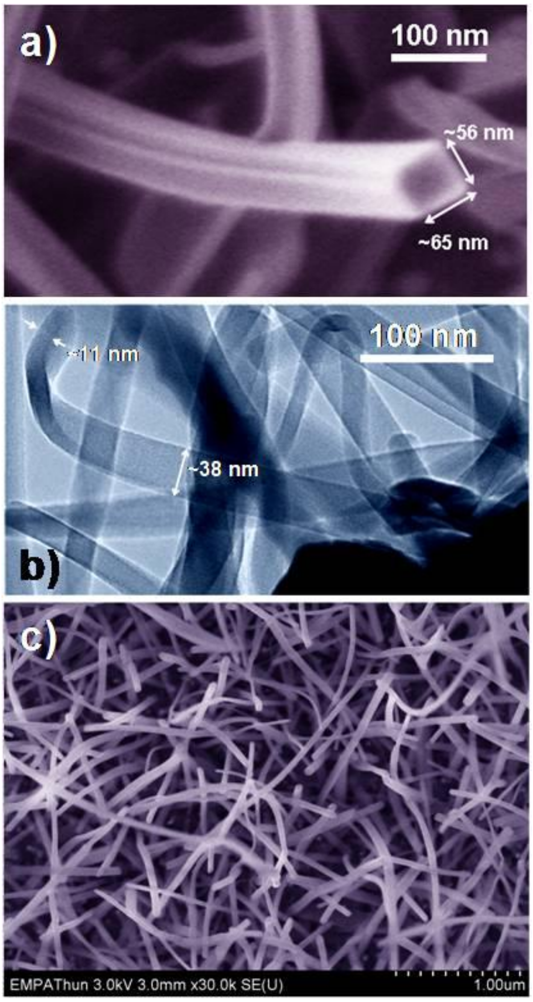


Figure 1. a) and b) TEM micrographs of a porphyrin squared nanowire and phthalocyanine nanobelt correspondently. c) Planar view SEM image of a high density of porphyrin nanowires grown on silver nanoparticles.

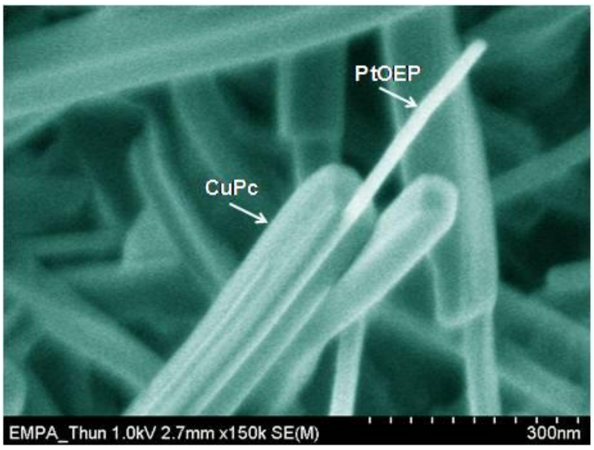


Figure 2. SEM image of a open core@shell nanostructure formed by an inner PtOEP nanowire partially wrapped by a CuPc nanobelt.

Fabrication of arrays of silicon nanowires

X. Cartoixà,[1,] * Y. Gebremichael,[1,2] A. Sánchez,[2] X. Borrisé,[2, 3] R. Rurali,[4] J. Suñé,[1] M. Schmidt,[4] M. I. Alonso,[4] A. R. Goñi,[4] and F. Pérez-Murano[2]

[1]Departament d´Enginyeria Electronica,,
Universitat Autonoma de Barcelona, 08193 Bellaterra, Barcelona, Spain
[2] Institut de Microelectronica de Barcelona CNM-IMB (CSIC), 08193 Bellaterra, Barcelona, Spain
[3]Institut Catala de Nanotecnologia - CIN2 (CSIC-ICN), 08193 Bellaterra, Barcelona, Spain
[4] Institut de Ciencia de Materials de Barcelona
ICMAB (CSIC), 08193 Bellaterra, Barcelona, Spain

Xavier.Cartoixa@uab.es

Silicon nanowires (SiNWs) hold great promise to integrate conventional Si devices in future nanoelectronics applications [1], and their use as bipolar transistors, logic gates, non-volatile memories, solar cells, biological sensors and energy conversion devices has been reported. Most of these applications demand a high level of positioning control and homogeneity regarding the electrical (doping profile) and morphological (eg. length, diameter, crystalline orientation) properties, which can be easily achieved with top-down fabrication methods.

We have recently proposed a fabrication strategy for arrays of nanowires based on the nanopatterning of holes into a substrate [2]. Calculations show that the electronic states are located preferentially at the interstitial part between the holes, and the degree of coupling between these preferential locations could be tuned at fabrication time from an array of isolated quantum wire states, Fig. 1.(a), to a strongly coupled artificial solid built from nanowires, Fig. 1.(b). This method of fabrication benefits, of course, of all the advantages of the top-down nanofabrication methods mentioned above and, in addition, its exclusive features include the variable tuning degree of the electronic coupling between the wire states, the superior mechanical stability of the nanostructure and, most importantly, a typical wire size limited by the positioning precision of the used lithography technique rather than the minimum dot size. There exists experimental indication that this approach might be feasible, since an analogous behavior at the intersection between reduced dimensionality heterostructures, the so-called T-shaped quantum wires, was first verified almost two decades ago [3].

A project has been recently started to experimentally demonstrate these effects [4]. With a combination of electron beam lithography and a specially developed reactive ion etching process, holes with diameters from 30 nm up to 600 nm, and pitch from 90 nm up to 1000 nm (Fig. 2) were fabricated, achieving no observable scalloping [5]. In order to reduce the size of interconnects and interstitials, the sample has been thermally oxidized, and afterwards the silicon oxide was removed by HF acid (Fig. 3). Quantum confinement effects have been probed by photoluminescence (PL). Measurements were performed with a 488 nm laser source and a high throughput spectrometer equipped with confocal microscope in a wide spectral range from near infrared (900 nm) up to 400 nm, observing the presence of a PL peak reminiscent of those appearing in Si nanocrystals embedded in SiO2 matrices, a first indication that the interstitials are supporting quantum-confined states.

We acknowledge the financial support of the Spanish Ministerio de Ciencia e Innovación under contract No. TEC2008-01865-E.

References

[1] R. Rurali, Rev. Mod. Phys. (2010), in press.
[2] R. Rurali, J. Suñe, and X. Cartoixa, Appl. Phys. Lett. 90, 083118 (2007).
[3] A. R. Goñi, L. N. Pfeiffer, K. W. West, A. Pinczuk, H. U. Baranger, and H. L. Stormer, Appl. Phys. Lett. 61, 1956 (1992).
[4] X. Cartoixa, R. Rurali, I. Fernandez-Cuesta, F. Perez-Murano, and J. Suñe, J. Phys.: Conf. Ser. 100, 052049 (2008).
[5]Y. Gebremichael, A. Sanchez, X. Borrise, M. Schmidt, A. R. Goñi, M. I. Alonso, R. Rurali, J. Suñe, X. Cartoixa, and F. Perez-Murano, Microelectron. Eng. (2010), URL http://dx.doi.org/10.1016/j.mee.2009.11.086

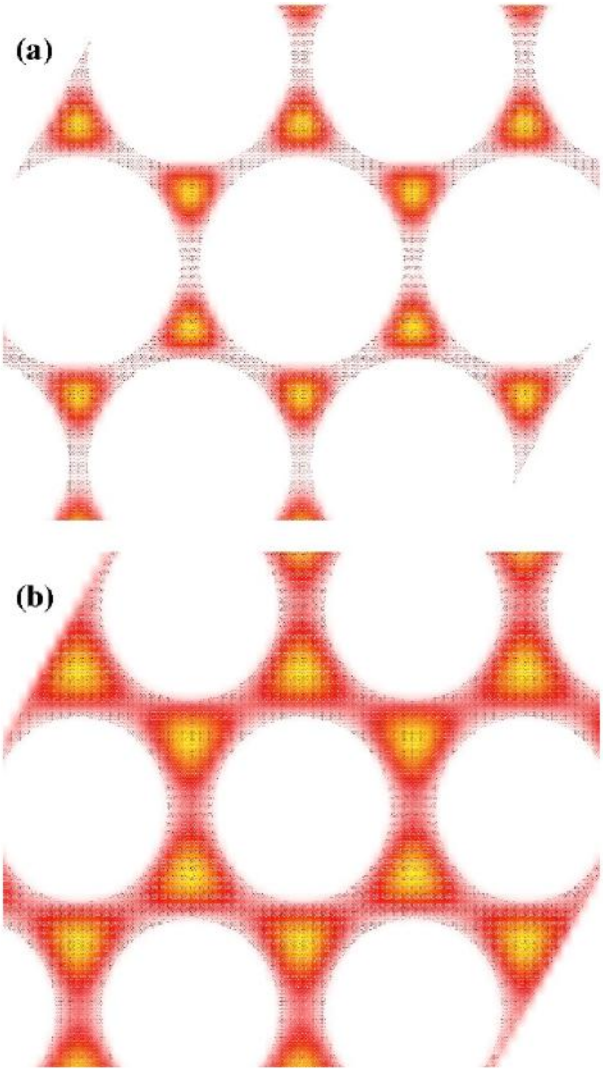


Figure 1. GaAs substrate, (a) interconnect thickness ~3.2 nm and hole diameter ~37.2 nm and (b) interconnect thickness ~8.4 nm and hole diameter ~32.0 nm: charge density corresponding to the bottom of the conduction band state, featuring (a) independent and (b) coupled nanowire behavior.

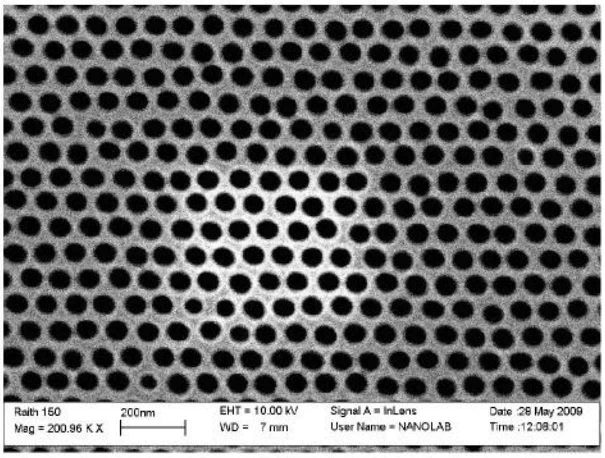


Figure 2. 70 nm diameter holes with a 100nm pitch on a silicon substrate.

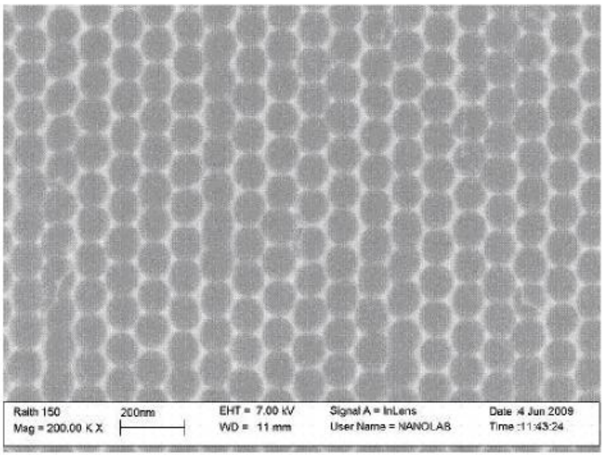


Figure 3. 70 nm diameter holes with a 100 nm pitch on a silicon substrate, after thermal oxidation and removal by HF.

Large-scale nanopatterning of single proteins used as carriers of magnetic nanoparticles

Ramsés V. Martínez, Javier Martínez, **Marco Chiesa**, Ricardo García

Instituto de Microelectrónica de Madrid, CSIC, Isaac Newton 8, 28760 Tres Cantos, Madrid (Spain)

mchiesa@imm.cnm.csic.es

Accurate and reproducible patterning of proteins and functional nanoparticles is essential to exploit their properties in nano and microscale devices [1]. Electrostatic interactions, capillary forces, surface functionalization and nanolithography can be used in combination or independently to achieve the desired protein organization [2]. Here, we report a simple yet efficient method to deposit ferritin proteins with nanoscale accuracy over large areas. The selective deposition is driven by the electrostatic interactions existing between the proteins and nanoscale features. The efficiency of the deposition process can be controlled by changing the pH of the solution. By combining a top-down tip-based nanolithography [3] and bottom-up electrostatic interactions we have formed regular arrays of ferritin molecules with an accuracy that matches the protein size (~10 nm). Magnetic force measurements confirm the magnetic activity of the deposited nanoparticles.

References

[1] W. Cheng, T. Walter, D. Luo *et al*., Nature Nanotechnology **3** (2008) 682.
[2] R.V. Martinez, R. Garcia, E. Coronado *et al*., Adv. Mater. **19** (2007) 291.
[3] R.V. Martínez, J. Martínez, M. Chiesa *et al*., Adv. Mater. **DOI: 10.1002/adma.200902568**

Figures

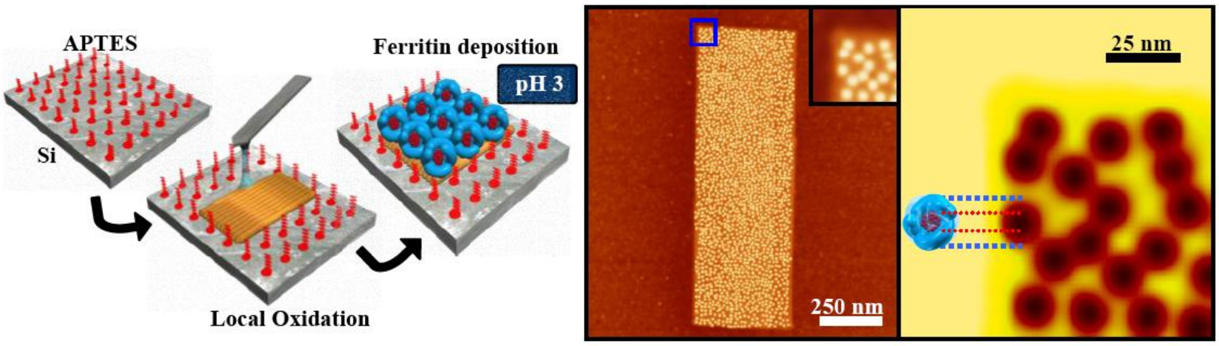


Fig. 1: Patterning of ferritin molecules by local oxidation nanolithography and silicon functionalization by APTES at low pH values.

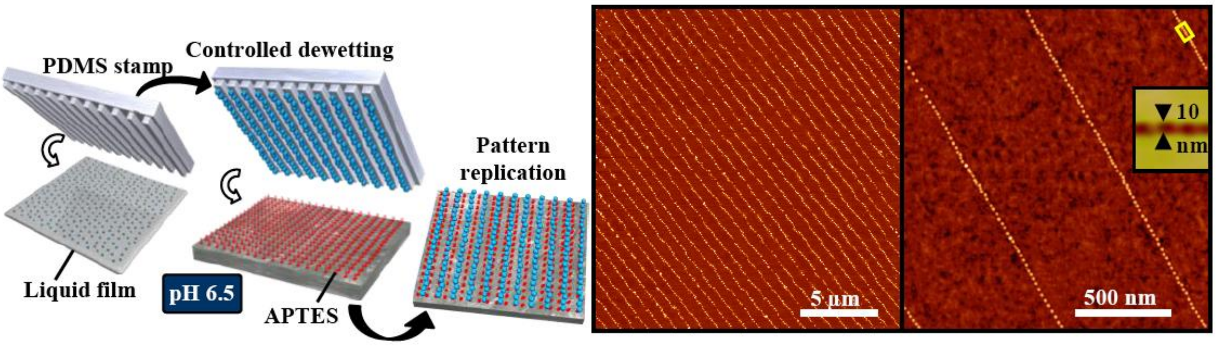


Fig. 2: Patterning of ferritin molecules over cm2 areas by controlled dewetting and surface functionalization at neutral pH values.

Patterned heteroepitaxial SiGe thin films through UV Excimer Laser radiation

S. Chiussi, F. Gontad, J. C. Conde, E. Martin[1] A. Benedetti[2], C. Serra[2], J.Serra, P. González, B. León

Dpto. Física Aplicada, [1]Dpto. Mecánica, Máquinas, Motores Térmicos y Fluido E.T.S.I.Industriales,
[2]C.A.C.T.I;, Universidade de Vigo, Campus Universitario Lagoas Marcosende, 36310 Vigo, (Spain)
schiussi@uvigo.es

Silicon-Germanium (SiGe) alloys and hetero-structures combining ultra-thin Si, SiGe and Ge films are well established components for a great variety of microelectronic and biomedical devices as well as photovoltaic thin film solar cells. Their effectiveness as virtual buffer layers or as active layers in micro-electronic devices is well established and the benefits of using such structures as sacrificial layers for the production of Micro-Electro- Mechanical- Systems (MEMS) or Silicon On Nothing (SON) devices explored. For producing such hetero-structures, the control of the interfaces between layers and of both, their composition and their crystalline structure is of greatest importance due to the dramatic influence of these characteristics on the optoelectronic, thermo-dynamical and mechanical properties of the material. To guarantee such a control, a careful and exhaustive research, dedicated to improve the growth processes through conventional IC technologies, has therefore been done and a tailoring of crystal lattices and interfaces to atomic scale precision been achieved. Nowadays, in addition to these challenges, the aim of lowering costs by including bottom-up steps in the growth processes for reducing processing steps and the emergent interest in using temperature sensible substrates or multilayer structures for reducing costs and improving device properties is also drawing more and more attention. These last conditions restrict the applicability of various conventional IC processing technologies, thus encouraging the research on new alternative techniques that avoid high substrate temperatures, allow a very precise local control of the temperature profiles in the heterostructures and also permit the development of bottom-up processes. This contribution will present the combination of two UV-Excimer laser assisted techniques for obtaining thin patterned amorphous Si/Ge-bilayers on Si(100) through stencil assisted ArF-Excimer Laser induced Chemical Vapour Deposition (LCVD) in parallel configuration. The regular patterns, achieved using these type of shadow masks, has then been irradiated under Pulsed Laser Induced Epitaxy (PLIE) conditions for transforming them into heteroepitaxial SiGe alloys with a Ge rich ultra-thin layer buried under a stressed Si-rich heteroepitaxial top layer. The aim of these experiments was to continue recent studies done with similar bi-layer structures that were not previously patterned. The result of those previous studies demonstrated the efficiency of the Laser assisted processes for producing the proposed hetero-epitaxial Si/SiGestructures on Si(100) and their applicability as sacrificial layers for SON or MEMS production. Moreover, numerical simulation of the process confirmed that the applied PLIE conditions produce ultra-short melting and solidification cycles in the sub-microsecond time scale, that are expected to induced the epitaxial growth and a reduced inter-diffusion of the bilayer elements, as observed in the experiments [1-3].

In a first step, single chamber ArF-Excimer Laser (193 nm at 25 ns, Lambda Physik LPX 220i) induced Chemical Vapour Deposition (ArF-LCVD) in parallel configuration has been used for growing, at 250 ºC, thin a-Si:H/a-GeH bi-layer structures. Total pressure/precursor gas flows during LCVD processes were for Si_2H_6 1.2 kPa // 0.3 cm^3/min and for GeH_4 5.3 kPa // 3 cm^3/min. Film thicknesses were approximately 50 and 25 nm for a-Si:H and a-Ge:H coatings, respectively. All processes have been done using 50 cm^3/min He as buffer gas and 1000 cm^3/min He as window purge. The bi-layers have been grown on a Si(100) wafer through SiN shadow masks (nanostencils) and, after removing the stencil, been irradiated in He atmosphere with 10 laser pulses with a fluence of 240 mJ/cm^2. The 193 nm laser radiation impinging normally to the substrate has been spatially homogenized using a fly-eye homogenizing system (Exitech Limited Beam homogenizer EX-HS-700D) and „in situ‟ controlled (Ophir PE50-DIF) as described elsewhere [1, 2]. Bi-layers and hetero-structures have been analyzed through Interferometric profiler (NT 1100 Wyko), Raman spectroscopy (Horiba Jobin Yvon LabRam HR 800) and TOF-SIMS (IonTOF TOF-SIMS-IV) As indicated in the introductory part and described in previous papers, the combined laser process produced the desired epitaxial growth in the PLIE irradiated spot, but also provokes Ge segregation that follows the movement of the solidification front [1,4]. A careful adjustment of the laser fluence and number of pulses for avoiding Ge island formation is therefore required. However, even if both parameters are optimized, the borders of the laser spot always will show an alteration of the structure, due to the reduction of the laser intensity and consequently the thermal profile of the treated material. Typical structures obtained in such zones can be observed in the AFM pictures (Fig.1). For avoiding these borders, patterned amorphous layers have therefore been produced through LCVD. Fig.2 shows images of a regular pattern obtained the using a SiN stencils as shadow masks. After the PLIE treatment of these patterns at conditions (10 pulses of 240 mJ/cm^2) that should guarantee the formation of an hetero-epitaxial alloy and also allow a good intermixing of the bi-layer elements, the size of the pattern features seems to remain similar, according to Interferometric profiler results. 488 nm Raman spectroscopy corroborated the formation of a crystalline Si, Ge and an SiGe alloy, thus the success of the PLIE process. However, the observation of the pattern with a optical microscopy revealed a new substructure that could be corroborated by TOF-SIMS analysis (Fig.3) revealing the existence of a Ge rich ring in the perimeter of each microstructure. A careful analysis of the patterns by TOF-SIMS revealed that the inner part of each structure is a crystalline hetero-structure with a buried Ge rich layer, while the ring is a SiGe alloy. The results indicate that, in contrast to “conventional” treatment of large areas, a control of the process in the complete treated irradiated area can be achieved. The enrichment of Ge in the perimeter of each micro-structure can be attributed to the segregation of Ge following the PLIE induced solidification front. This movement should start from the Si substrate used as crystal seed and end on surface of each isolated microstructure. Since the lateral dimensions of these micro-structures are far bigger than their height and the temperature of solidification for the under-laying Ge rich layer is far lower than the one of the Si rich top layer, segregation to the lateral walls of the microstructures can be assumed.

Acknowledgment

Financial support was given by Xunta de Galicia and Ministerio de Educación y Ciencia. Special thanks to J.Brugger, L.Doeswijk and M. van den Boogaart from EPFL Lousanne for providing the nanostencils, L.Fornarini from ENEA Frascati for helping with Numerical simulation as well as T.Sulima and I.Eisele from UniBW München for fruitful cooperation.

References

[1] E.López, S.Chiussi, J.Serra, P.González, B.León, Thin Solid Films 508 (2006) 48-52
[2] S. Chiussi, F. Gontad a, R. Rodríguez, C. Serra, J.Serra, B. León, T. Sulima, L. Höllt, I.Eisele, Applied Surface Science 254 (2008) 6030–6033
[3] J.C.Conde, L.Fornarini, S.Chiussi, F.Gontad, P.González, B.Leon and S.Martelli, Thin Solid Films, 517 (2008) 222-226
[4] S.Chiussi, E.López, J.Serra, P.González, C.Serra, B.León, F.Fabbri, L.Fornarini, S.Martelli, Appl.Surf.Science 208-209 (2003) 358-363

Figures

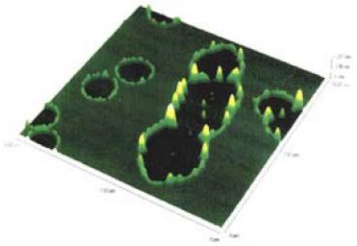


Figure 1

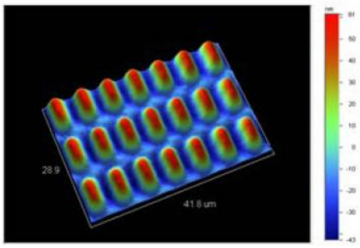


Figure 2

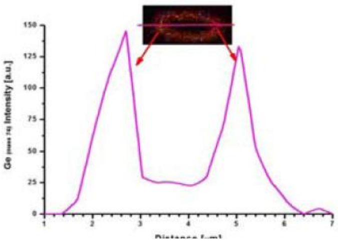


Figure 3

Magnetostriction driven cantilevers for Dynamic Atomic Force Microscopy

Fernández-Martínez, M. Penedo, **J. L. Costa-Krämer**, M. Luna and F. Briones

Instituto de Microelectrónica de Madrid, IMM (CNM-CSIC)
C/Isaac Newton, 8 (PTM) 28760 - Tres Cantos. Madrid (Spain)

ivan@imm.cnm.csic.es

The development during the last decade of the Atomic Force Microscopy (AFM) technique focused on biological systems, has initiated a new form of biomolecular physics since this technique has introduced a new approach to the study biological processes. This success is largely due to the emergence of dynamic modes operated in physiological environments. Herein we present a novel cantilever mechanical excitation technique based on the magnetostrictive effect [1] that exhibits important advantages with respect to other methods. Commercial silicon nitride cantilevers were sputtered on the opposite side of the tip with magnetostrictive and soft magnetic thin iron-boron-nitrogen films. This amorphous magnetic alloy presents excellent magnetic properties [2], good corrosion resistance in liquid environments, and nearly zero deposition induced stress [3] for optimized sputtering parameters. In the presence of an alternating magnetic field the coated top side of the cantilever periodically extends, thus generating a mechanical oscillatory movement on the cantilever. This new actuation mode can be operated in physiological environments, lacks the unwanted heating of tip and/or sample, avoiding thermal drift problems. It also exhibits high resolution and stability, low noise and compatibility with the use of an inverted optical microscope. As an operational example we present low noise and high resolution topographic images acquired in liquid environment to demonstrate the method capability.

References

[1] M. Penedo, I. Fernández-Martínez, J. L. Costa-Krämer, M. Luna and F. Briones, Applied Physics Letters, **95** (2009) 143505.
[2] I. Fernández-Martínez, M.S. Martín-González, R. González-Arrabal, R. Álvarez, F. Briones and J. L. Costa-Krämer, Journal of Magnetism and Magnetic Materials, **320** (2008) 68.
[3] I. Fernández-Martínez, J. L. Costa-Krämer and F. Briones, Journal of Applied Physics, **103** (2008) 113902.

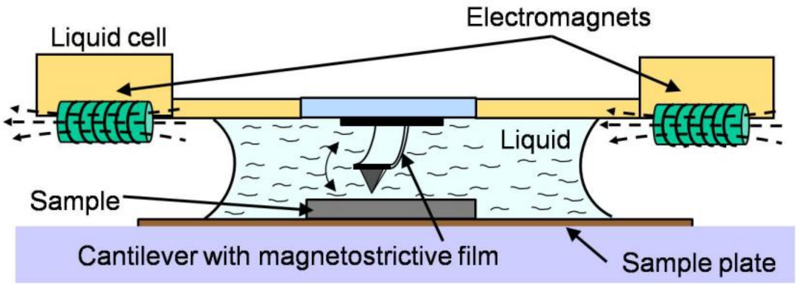


Figure 1: Scheme of the dynamic AFM driven by magnetostriction.

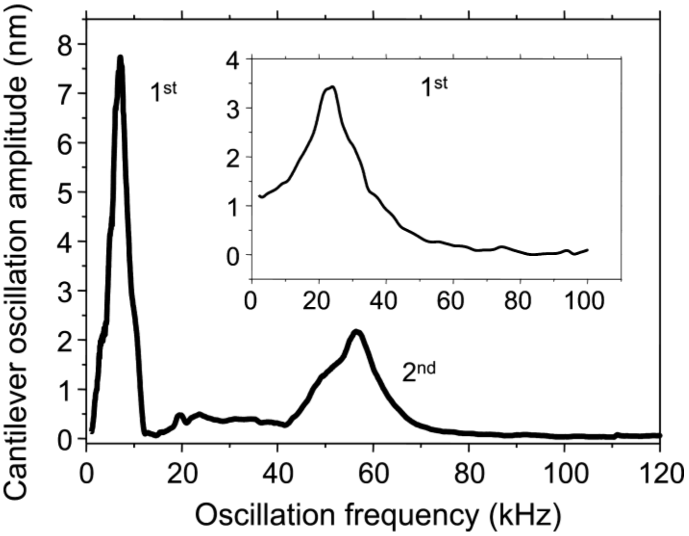


Figure 2: Oscillation amplitude spectra of a silicon cantilever immersed in water driven by the magnetostrictive effect. The first resonance peak is at 7.10 kHz, while the second is founded at 58.15 kHz. The inset shows the oscillation amplitude spectra of a silicon cantilever immersed in water driven by the magnetostrictive effect. The first resonance peak is at 21.60 kHz. In both cases, the current through the electromagnets is 25 mA while the thickness of the magnetostrictive coating is 50 nm

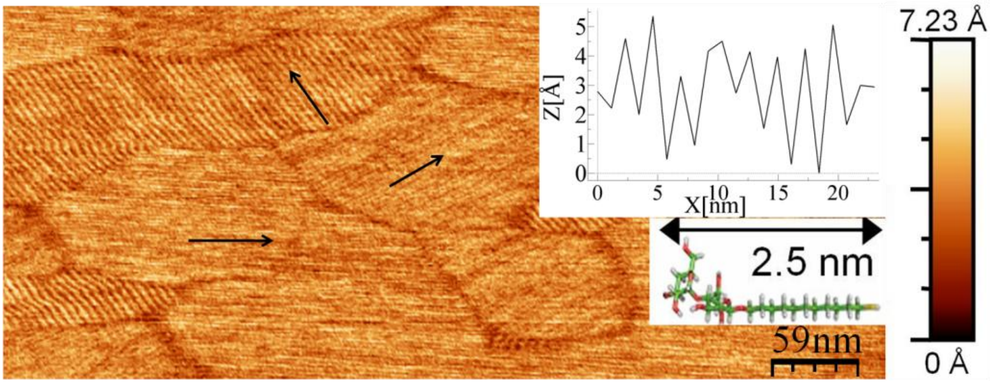


Figure 3. Dynamic atomic force microscopy topographic image of self-assembled maltoside neoglicoconjugate islands adsorbed on HOPG, obtained by means of magnetostrictive drive with the sample immersed in water. The organic molecules adsorb flat on graphite following the preferential crystallographic directions of the HOPG hexagonal symmetry. The black arrows guide the eye in the identification of the different domain arrangements. The profile in the inset corresponds to the white profile drawn in the image. A periodic pattern of 2.5 nm is observed (17.23 nm between the two points shown/seven peaks), which corresponds to the length of the molecule.

Ultrasonic Force Microscopy characterization of a new scaffold formed of polyelectrolyte complexes

Oscar Valdés[1] and **M. Teresa Cuberes[2]**

[1] Centro de Biomateriales, Universidad de La Habana, Ave. Universidad e/ G y Ronda, CP 10400, Ciudad de La Habana (Cuba).
oscarv@biomat.uh.cu

[2] Laboratorio de Nanotecnología, Universidad de Castilla-La Mancha, Plaza Manuel de Meca 1, 13400 Almadén (Spain).
teresa.cuberes@uclm.es

Ultrasonic Force Microscopy (UFM) belongs to a novel family of Scanning Probe Microscopy techniques based on the use of Atomic Force Microscopy (AFM) with ultrasound excitation, initially developed to implement a near-field probe to emulate the Acoustic Microscope with nanoscale resolution [1]. The UFM procedure is based on the mechanical-diode effect [1, 2] which occurs due to the net force acting upon the AFM cantilever tip during each ultrasonic cycle because of the non-linearity of the tip-sample interaction force. A mechanical-diode response can also be detected in liquid environments [3]. UFM has been successfully applied to investigate the nanoscale distribution of elastic phases in polymer gels in ambient conditions [4], and in lipid bilayers in aqueous solution [3]. A unique advantage of the ultrasonic-AFM techniques is their ability to map nanoscale subsurface elastic inhomogeneities [1, 5].

Here, we apply UFM to image the elasticity of a biopolymer network within polyelectrolyte complexes [6]. Poly(acryloxyethyl-trimethylammonium chloride-co-2-hydroxyethyl methacrylate) [poly(Q-co-H)] / sodium alginate gel (Ca2+) [AlgNa] / poly-l-lysine [PLL] films were prepared on a mica surface. AFM / UFM allows us to study the structural arrangement and elasticity of the polyelectrolyte complexes with nanoscale resolution.

Fig. 1 shows the topography (a) and the UFM image (b) on the surface of the AlgNa gel/PLL/mica system. The elastic contrast on the AlgNa surface is indicative of the formation of a biopolymer network. On the AlgNa film, the surface morphology is mostly characterized by areas with rounded beads (≈150 nm in diameter) and polymer strands. Alginate is obtained from the Phaeophyceae brown seaweeds as a linear non-branched polymer containing 1, 4 - β - D-mannuronic acid (M) and 1, 4 - α - L - guluronic acid (G) residues. It gelifies in the presence of bivalent ions such as Ca2+. In the UFM contrast, guluronic residues with Ca2+ crosslinks in the alginate gel are identified as stiffer regions than the adjacent polymer formed by mannuronic or unreacted guluronic parts. Flatter, more homogenous surface regions are also present, presumably related to outdiffused PLL.

Incorporation of the poly (Q-co-H) layer results in an increased compactness of the film, and an enhancement of the previous AlgNa topographic features. Fig. 2 corresponds to the topography and UFM image recorded on the surface of the Poly(Q-co-H)/AgNa gel/PLL/ mica The unique subsurface sensitivity provided by UFM reveals the elastic bonding distribution in the buried biopolymer network by imaging from the poly(Q-co-H) overlayer.

Provided the biocompatibility of the resulting polyelectrolyte complex film, we propose this system as a novel scaffold for bioengineering applications. The results we present demonstrate the potential of UFM to get insight in the elastic behavior of encapsulated bionetworks.

References

[1] M. T. Cuberes in "Applied Scanning Probe Methods XI", B. Bhushan, H. Fuchs (ed.), Springer-Verlag Berlin Heidelberg (2009) 39-71.
[2] J. J. Martínez and M. T. Cuberes, in Nanoscale Tribology—Impact for Materials and Devices, edited by Y. Ando, R. Bennewitz, R.W. Carpick, W.G. Sawyer, Mater. Res. Soc. Symp. Proc. Volume 1085E, Warrendale, PA (2008).
[3] M. T. Cuberes, J. of Physics: Conf. Ser., 100 (2008) 052014.
[4] B. Talavera, J. J. Martínez, F. Santiago, and M. T. Cuberes, in Nanoscale Tribology—Impact for Materials and Devices, edited by Y. Ando, R. Bennewitz, R.W. Carpick, W.G. Sawyer, Mater. Res. Soc. Symp. Proc. Volume 1085E, Warrendale, PA (2008).
[5] M. T. Cuberes et al., J. Phys. D: Appl. Phys **33** (2000) 2347-2355; L. Tetard, A. Passian, et al. Nature Nanotechnology **3** (2008) 501-505.
[6] O. Valdés and M. T. Cuberes, J. Biomed. Nanotechnol **5** (2009) 716-721

Figure 1

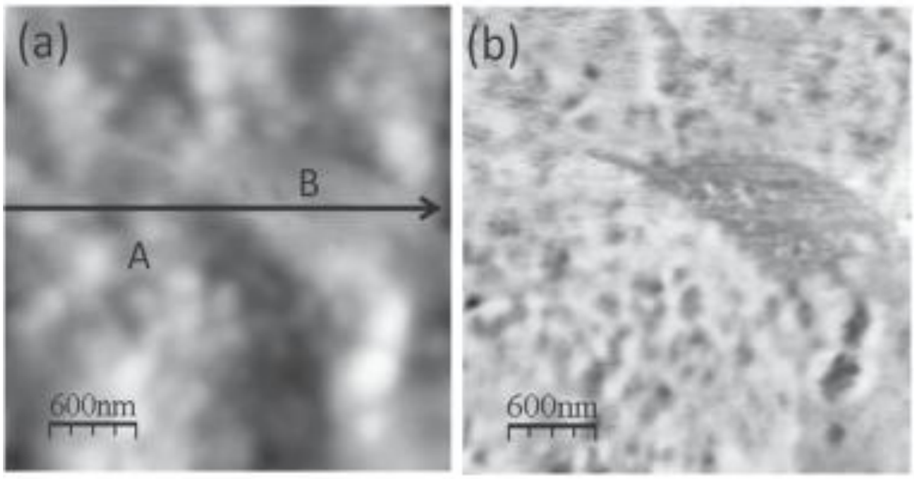
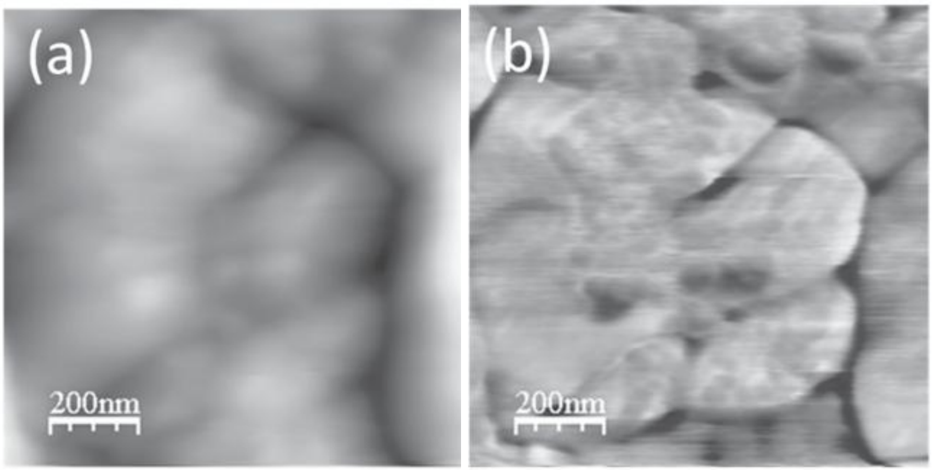


Figure 2



Electronic excitations in thin metallic films

V. Despoja,[1,2] J.P. Echeverry,[1,2] E.V. Chulkov,[1,2,3] V.M. Silkin[1,3,4]

[1]Donostia International Physics Center (DIPC), P. Manuel Lardizabal 4, 20018 San Sebastián, Spain
[2]Centro de Física de Materiales CFM-MPC, Centro Mixto CSIC-UPV/EHU, 20018 San Sebastián, Spain
[3]Depto. de Física de Materiales, Facultad de Quimica, Universidad del País Vasco, Apto. 1072, 20080 San Sebastián, Spain
[4]Ikerbasque, Basque Foundation for Science, 48011 Bilbao, Spain

Confinement of valence electrons in metallic films of thickness comparable with the electron Fermi wavelength results in discrete quantum well states, which are the origin of quantum size effects in the properties of the system. Most theoretical studies have focused on the electronic structure of these systems and less attention has been paid to study of the electronic excitations.

At the same time, investigation of how the collective and single-particle electronic excitations evolve with the change of the film thickness present interesting problem, especially at the range of film thicknesses a few atomic layers. Recently this was investigated within framework of a jellium model [1]. In particular, there was demonstrated how size effects, i.e. discrete electronic spectrum in the direction perpendicular to the film surface influences excitations spectra. In present contribution we perform investigation of the evolution of the electronic excitations in thin Ag(111) films as a function of thickness considering its electronic band structure on a more realistic basis in comparison with the jellium model. For this we employ a model potential proposed in Ref. [2]. This potential mimics the atomic structure of the Ag(111) in the direction z perpendicular to the surface, and correctly reproduces the experimental Ag(111) work function, the projected bulk band structure, the surface and first image-potential states. With the use of this model potential we have performed self-consistent calculations of the surface response function of the Ag slabs of 1-10 monolayer thickness. For comparison, we also performed similar calculations using the energy band structure obtained whitin a conventional jellium model. The comparison of these two sets of data reveals striking differences in the excitation spectra of Ag films. The origin of these differences resides in the different band structures of two models. As an example, in Fig. 1 we demonstrate differences in the band structure for 4 ML slabs obtained in the two models. Thus, even for very thin films, in the case of 1D model potential one can observe two states (whose wave functions are mainly localized in vicinity of the surface atomic layers) with energies close to the Fermi energy (surface states) whereas the jellium model does not allow appearance of this kind of states. These differences in band structures are translated to the excitation spectra of these two models. As an example, in Figs. 2 and 3 we present excitation spectra for the 4 ML slab for the jellium and model potentials, respectively. The most pronounced differences correspond to interband transitions. A dispersive peak around 1eV in Fig. 3 corresponds to transitions between the partially occupied even and the empty odd surface states. An intraband region is qualitatively similar in both models. In this regaions the sharp linearly dispersing peaks correspond to Acustic Surface Plasmon (ASP) [3]. Small differences in their dispersion are dictated by the band structure (at the q=0 point) and different effective masses which influence the Fermi velocities. For example, in Fig.1 the deepest occupied states have almost the same energies and effective masses which cause the similarity in the higher energy ASP branches in two models. On the other hand, for the higher occupied model potential states the effective masses are smaller unity that produces differences between the lower-energy ASP branches.

Note that upon increase of the slab thickness all the quantum size effects in the excitation spectra gradually vanish in the two models. However, the acoustic surface plasmon related to the Ag(111) surface state survives as was demonstrated previously [4].

References

[1] L. Marusic, V. Despoja, M, Sunjic, J. Phys.: Condens. Matter, **18** (2006) 4253.
[2] E.V. Chulkov, V.M. Silkin, P.M. Echenique, Surf. Sci., **437** (1999) 330.
[3] V.M. Silkin, A. Garcia-Lekue, J.M. Pitarke, E.V. Chulkov, E. Zaremba, P.M. Echenique, Europhys. Lett., **66** (2004) 260.
[4] V.M. Silkin, J.M. Pitarke, E.V. Chulkov, P.M. Echenique, Phys. Rev. B, **72** (2005) 115435.

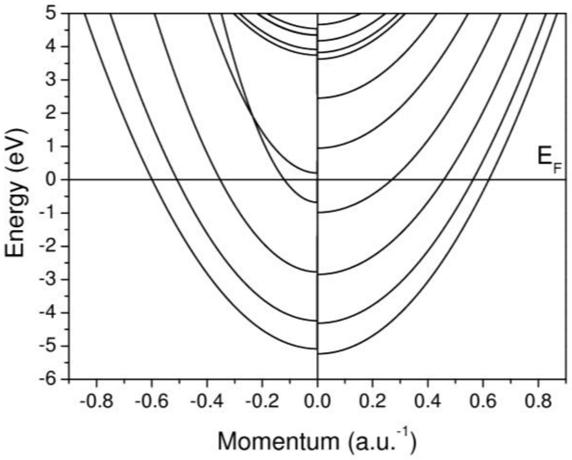


Figure 1. Normalized Left side: Band structure for the 4ML Ag(111) film calculated by using the model potential of Ref. [1]. Effective masses from bottom to top are m*=0.96, 0.83, 0.61, 0.29, 0.44, 1.0, 1.0, 1.0, 1.0. Right side: Band structure for the 4ML thick Ag film calculated by using the jellium model. Effective masses for all the bands are set to unity.

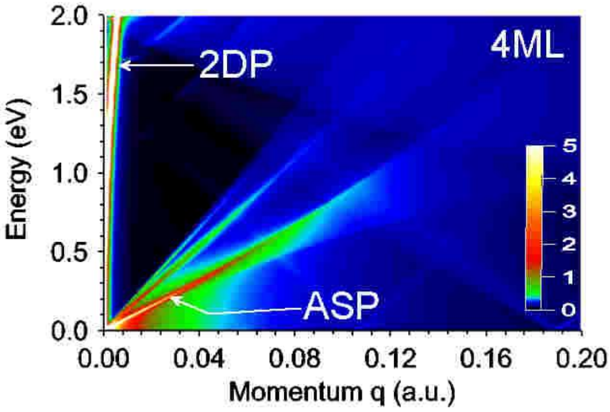


Figure 2. Normalized surface loss function, Im[g(q,ω)]/qω, for the 4ML thick Ag film calculated by using the jellium model.

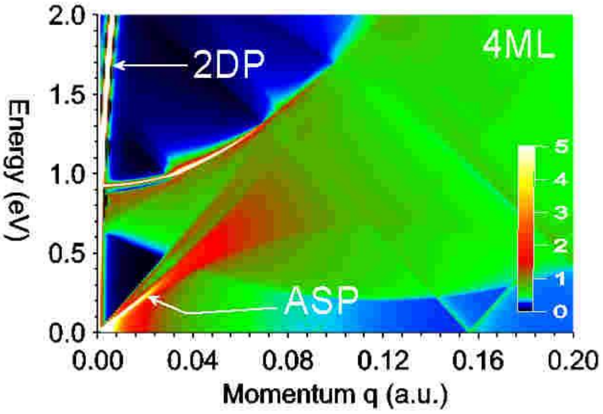


Figure 3. Normalized ormalized surface loss function, Im[g(q,ω)]/qω, for the 4ML thick Ag film calculated by using the model model.

Multifunctional Ferritin Nanoparticles for Multimodal MRI-OI-SPECT Imaging

José M. Domínguez-Vera, Elsa Valero, Belén Fernández, Purificación Sánchez, Rafael Cuesta and Natividad Gálvez

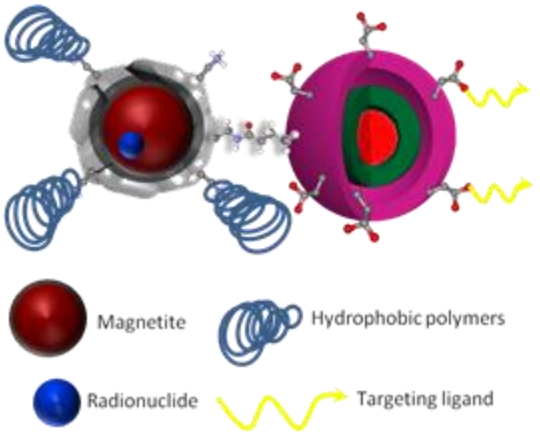
Ferritin Nanoparticles Group, Departamento de Química Inorgánica, Universidad de Granada, Spain

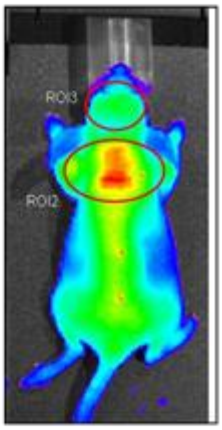
josema@ugr.es

Medical Imaging has made great progress due to advances in imaging devices and chemical probes. Several modalities such as Magnetic Resonances Imaging (MRI), Optical Imaging (OI), radionuclide imaging using Single Photon and Positrons (SPECT and PET) are currently being used. Each imaging modality has its merits and limitations but strong points of some of them can be combined by the use of a single nanoprobe. In this sense, one of the most exciting challenges in this field is to create more and more powerful nanoprobes capable of getting parallel detection by several modalities for an early diagnosis, if possible at molecular level.

We have developed a flexible method for the preparation of magnetic-fluorescent nanostructures by covalent coupling two nanobuilding blocks: a magnetic ferritin and a quantum dot (QD), through the reaction between lysines and carboxylic groups at the external shells of ferritin and QD, respectively [1]. The resulting nanostructure can serve as a platform for the addition of other functional chemical species, including hydrophobic polymers and targeting ligands. In addition, the inorganic material inside the ferritin cavity can be doped with some “non inocent” anions, such as phosphate or $^{99m}TcO_4^-$.

We can create therefore, a library of nanostructures simultaneously containing: i) a doped magnetite nanoblock (for MRI), ii) a quantum dot or eventually a dye (for OI), iii) a radionuclide such as ^{99m}Tc (for SPECT), iv) some hydrophobic polymers (for improving plasma half life) and v) a targeting ligand (“à la carte”) [2].





The in vivo OI study on nude mice shows that whereas free QD is mainly located at the liver, our multifunctional nanostructure is preferentially accumulated at the lungs. This different biodistribution points out that whereas the QD is detected and removed from the bloodstream by the reticulo-endothelial system, the full ferritin-QD nanostructure has a longer blood circulation time, thus improving the probability of attaining the desired target.

References

[1] B. Fernández, N. Gálvez, R. Cuesta, A. B. Hungría, J. J. Calvino and José M. Domínguez-Vera. ***Adv. Funct. Mater***. **2008**, 18, 3931-35.

[2] José M. Domínguez-Vera, N. Gálvez, B. Fernández, E. Valero, B. Federico, L. Calderan, P. Marzola, J. J. Calvino, A. B. Hungría, R. Cuesta. Patent ES1634.24B. José M. Domínguez-Vera, N. Gálvez, E. Valero, P. Sánchez. Patent ES1634.24C.

Observation of enhanced optical gain in photonic crystals

R. Sapienza[1],M. Leonetti[2,3], **L. S. Froufe-Pérez** [2], J. Galisteo-López[2], C. Conti[4], and C. López[2].

[1]ICFO - Institut de Ciències Fotòniques. Parc Mediterrani de la Tecnologia, Castelldefels 08860 Barcelona, Spain.
[2]Instituto de Ciencia de Materiales de Madrid (CSIC) and Unidad Asociada CSIC-UVigo, Cantoblanco, 28049 Madrid, Spain.
[3]Dipartimento di Fisica, Universitá di Roma La Sapienza, I-00185, Roma, Italy.
[4]Research Center INFM-CNR, c/o Universitá di Roma Sapienza, I-00185, Roma Italy

luis.froufe@icmm.csic.es

We present the measurement of gain length in photonic crystals doped with laser dye. A gain enhancement is experimentally observed for light propagating along the Γ-K symmetry direction in reciprocal space, while a strong inhibition is measured for directions characterized by a lower degree of crystal symmetry. These results are theoretically explained by comparing the optical gain to the calculated density of states along the crystal directions.

We find a six-fold increase of the gain in opal photonic crystal, as compared to the homogeneous film, and a more than 20-fold variation between Γ-K and less symmetrical directions, in the same photonic crystal. This enhancement is due to a large increase of the density of the available modes around the Γ-K direction. Large variation of the gain in photonic crystal show the impact of the tailored density of states on light generation and amplification and open the way to enhancement of other phenomena like non-linear wave mixing and harmonic generation. Our result show how nanostructured media could be at the basis of the development of novel lasing sources with exceptional tunability, directionality and efficiency while being plastic photonics CMOS compatible, and candidates for in-board interconnections for future generation computers.

Magnetism in oxide nanoparticles: Surface effects

M. A. Garcia

Instituto de Cerámica y Vidrio, Consejo Superior de Investigaciones Científicas, Spain

magarcia@icv.csic.es

It has been recently reported that some non-magnetic materials in bulk state exhibit magnetic behavior at the nanoscale (nanoparticles and thin films) due to surface and size effects. Most of the results have been observed in oxides. Some of these effects are not reproducible and seem related to experimental difficulties when measuring very small signals inherent to the nano scale [1]. Common handling and measurement procedures may induce spurious signals that are not important when dealing with traditional macroscopic bulk magnetic materials.

On the other hand some results are reproducible and have been reproduced by different groups. Some of these reliable observations can be explained with the well established theories of magnetism applied to surfaces and interfaces [2-5]. In particular oxides containing magnetic ions (as Mn, Co, Fe) with paramagnetic and antiferromagnetic interactions may exhibit ferromagnetic-like behavior due to surface modifications induced by the local order modifications due to the presence of other materials.

Finally, there are some results that can not be explained within the current framework of magnetism and suggest the existence of new magnetic ordering mechanisms at the nanoscale [6].

References

[1] M. A. Garcia, E. Fernandez Pinel, J. de la Venta , A. Quesada, V. Bouzas, J. F. Fernández, J. J. Romero, M. S. Martín González, J. L. Costa-Krämer, J. Appl. Phys, **105** (2009) 0139205

[2]. J. L. Costa-Krämer, F. Briones, J. F. Fernandez, A. C. Caballero, M. Villegas, M. Diaz, M. A. García and A. Hernando, Nanotechnology **16**, (2005) 214

[3] M. A. García, M. L. Ruiz-González, A. Quesada, J. L. Costa-Krämer, J. F. Fernández, S. J. Khatib, A.Wennberg, A. C. Caballero, M. S. Martín-González, M. Villegas, F. Briones, J. M. González-Calbet, A. Hernando, Phys. Rev. Lett. **94** (2005) 217206

[4] A. Serrano, E. Fernandez Pinel, A. Quesada, I. Lorite, M. Plaza, L. Pérez, F. Jiménez-Villacorta, J. de la Venta, M. S. Martín-González, J. L. Costa-Krämer, J. F. Fernandez, J. Llopis, M. A. García, Phys. Rev. B,**79** (2009) 144405

[5] M. S. Martin-González, M. A. García,I. Lorite, José L. Costa-Krämer, Fernando Rubio-Marcos N. Carmona and José F. Fernández. J. of the Electrochem. Soc., **157** (2010) E31

[6] M. A. Garcia, J. M. Merino, E. Fernández Pinel, A. Quesada, J. de la Venta, M. L. Ruíz González, G. Castro, P. Crespo, J. Llopis, J. M. González-Calbet, A. Hernando. Nano Letters **7** (2007) 1489.

Tailoring the modulation depth in Au/Co/Au magnetoplasmonic switches

D. Martín-Becerra, **M. U. González**, V. V. Temnov, A. García-Martín, J. B. González-Díaz, A. Cebollada, T. Thomay, A. Leitenstorfer, R. Bratschitsch, G. Armelles

Instituto de Microelectrónica de Madrid, IMM (CNM-CSIC), Tres Cantos, Madrid, Spain
Department of Chemistry, Massachusetts Institute of Technology, Cambridge (MA), USA
Department of Physics and Center for Applied Photonics, University of Konstanz, Germany

mugonzalez@imm.cnm.csic.es

The ability of surface plasmon polaritons (SPP) to confine optical fields beyond the diffraction limit makes them very attractive for the development of miniaturized optical devices. Several passive plasmonics systems have been successfully demonstrated in the last decade, but the achievement of nanophotonic devices with advanced functionalities requires the implementation of active configurations. This needs the capability to manipulate the surface plasmon polaritons with an external agent. Among the different control agents considered so far, the magnetic field holds a robust promise since it is able to directly modify the dispersion relation of SPP [1]. This modulation lies on the non-diagonal elements of the dielectric tensor, ε_{ij}. For noble metals, the ones typically used in plasmonics, these elements are unfortunately very small at field values reasonable for developing applications. Ferromagnetic metals have sizeable ε_{ij} values at small magnetic fields (proportional to their magnetization), but are optically too absorbent. A smart system to develop magnetic field sensitive plasmonic devices is the use of multilayers of noble and ferromagnetic metals [2, 3].

Based on these hybrid multilayers, a magnetoplasmonic switch has been recently demonstrated [4]. The switch has been implemented through a micro-interferometer consisting on a slit paired with a tilted groove (see figure 1). Illumination with a *p*-polarized laser beam at normal incidence results in the excitation of SPPs at the groove, which propagates towards the slit, where they are reconverted into free-space radiation (I_{SP}) and interfere with light directly transmitted through the slit (I_r). The interference term is given by $\sqrt{I_{SP}}\sqrt{I_r}$ cos ($k_{SP}\, d+\phi_0$), with k_{SP} the SPP wavevector and *d* the groove-slit distance. In our tilted groove configuration, *d* varies for each slit position, creating a pattern of maxima and minima in the light transmitted through the slit (optical interferogram, see image in fig. 1). When we apply an external periodic magnetic field high enough to saturate the sample (about 20 mT) in the direction parallel to the slit axis, k_{SP} is modified therefore shifting the interference pattern. Thus, at each slit position we detect a variation of the intensity synchronous with the applied magnetic field (magnetoplasmonic interferogram, see graph in fig. 1). The analysis of both interferograms allows us to extract the SPP wavevector modulation, Δk. The full intensity modulation depth of the system is given by the product $\Delta k \times d$.

The modulation obtained in this basic configuration of the magnetoplasmonic switch, Au/Co/Au multilayers in air, is $\Delta k \sim 0.5\text{x}10^{-3}\ \mu\text{m}^{-1}$ for a wavelength of λ_0 = 800 nm, reasonable although slightly low for practical applications. Optimization of the geometrical parameters to achieve the maximum possible modulation of the surface plasmon wavevector will provide a higher flexibility in the design of the magneto-plasmonic optical switches. A straightforward approach consists on the coverage of the metallic multilayer with a dielectric media with high ε_d, since the modulation Δk is proportional to $(\varepsilon_d)^2$ [4]. We have then covered our magnetoplasmonic switches with a thin layer of PMMA (ε_d = 2.22). Figure 2 shows the measured Δk for systems with 60 nm PMMA at λ_0 = 633 nm as compared to identical reference samples without PMMA. A fourfold enhancement of the modulation, in excellent agreement with the theoretical predictions, has been obtained. Nevertheless, the propagation distance of the plasmon decreases with the addition of overlayers, which will prevent the use of interferometers with large *d* and the intensity modulation depth will then be limited. Thus, a compromise between the modulation enhancement and the propagation distance of the SPP has to be achieved. A detailed analysis of the behaviour of the magnetoplasmonic switches when covered with dielectric overlayers, both in terms of modulation enhancement and propagation distance, will be presented.

References

[1] R. F. Wallis, J. J. Brion, E. Burstein, and A. Hartstein, Phys. Rev. B **9** (1974) 3424.
[2] J. B. González-Díaz, A. García-Martín, G. Armelles, J. M. García-Martín, C. Clavero, A. Cebollada, R. A. Lukaszew, J. R. Skuza, D. P. Kumah and R. Clarke, Phys. Rev. B **76** (2007) 153402.

[3] E. Ferreiro-Vila, J. B. González-Díaz, R. Fermento, M. U. González, A. García-Martín, J. M. García-Martín, A. Cebollada, G. Armelles, D. Meneses-Rodríguez and E. Muñoz-Sandoval, Phys. Rev. B **80** (2009) 125132.
[4] V. V. Temnov, G. Armelles, U. Woggon, D. Guzatov, A. Cebollada, A. Garcia-Martin, J. Garcia-Martin, T. Thomay, A. Leitenstorfer, and R. Bratschitsch, Nat. Photonics **4** (2010) 107.

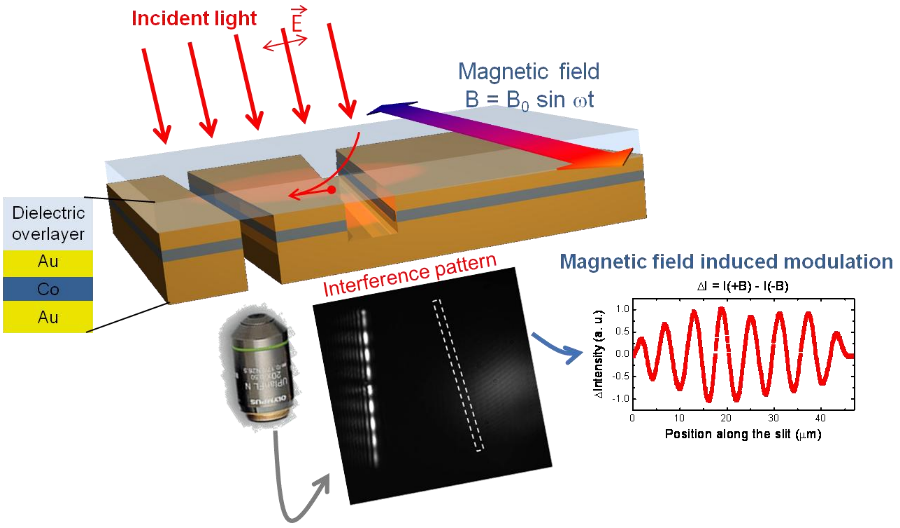


Figure 1. Sketch of the magneto-plasmonic micro-interferometer.

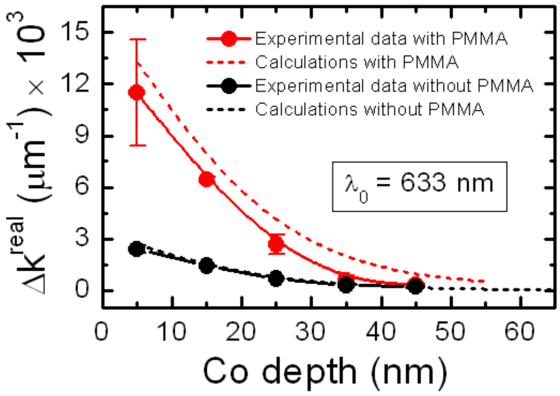


Figure 2. Comparison of the SPP wavevector modulation as a function of the Co layer position for Au/Co/Au micro-interferometers without dielectric overlayer and with 60 nm PMMA overlayer. The values correspond to λ_0 = 633 nm.

New highly active and selective nanostructured oxide catalysts

M.O. Guerrero Pérez[1], R. López Medina[2], M.A. Bañares[2]

[1]Departamento de Ingeniería Química, Escuela de Ingenierías, Universidad de Málaga, E-29071-Málaga.
[2]Instituto de Catálisis y Petroleoquímica (CSIC), Marie Curie, 2, E-28049-Madrid (Spain)

oguerrero@uma.es

Nanostructured catalysts present valuable advantages from both industrial and academic points of view. Active nanostrucured catalytic oxides can be supported on a non-expensive material that acts as support, such as alumina, to prevent sinterization. Thus, the amount of active phase required for a satisfactory catalytic performance can be minimized. In addition, the use of nano-scaled oxide phases maximizes the surface-to-volume ratio allowing a better insight on the nature of the active phase [1]. For instance, we have shown that nanoscaled Sb-V-O supported catalysts can perform even better than the corresponding bulk oxide catalysts [2] and the nature of the actual working phase uncovered [3]. Thus, presenting this work, we prepare nanoscaled molybdenum oxide based catalysts, well known as selective for propane partial oxidation reactions.

Two Mo-V-Nb-Te nanoscaled oxide catalysts have been prepared supported on γ-Al_2O_3, one with a low surface coverage (4 atoms/nm^2 of support, submonolayer) and the other with high coverage (12 atoms/nm^2, above monolayer). For comparative purposes, a conventional bulk MoVNbTeO oxide has also been prepared. Figure 1 shows the XRD patterns of these samples and Figure 2, the Raman spectra under dehydrated conditions. The rutile-like active phase can be identified by its XRD shoulder near 36.8º and the features near 80.3º. for the remaining peaks overlap with those of MoO_2 phase and also Raman spectra further confirm the presence of the rutile structure (broad Raman band near 820-840 cm^{-1}) [2,3]; this band overlaps with those near 821 and 459 cm^{-1} at high coverage, these bands are observed in catalysts containing the so-called M1 phase, which is active and selective; these bands could also be assigned to the stretching mode of bridging Mo-O-M (M= Mo,V) bonds of $Te_2M_{20}O_{57}$ in highly distorted surface on alumina [4]. The band near 990 cm^{-1} is characteristic of the stretching modes of Mo=O and/or V=O bonds whereas the band near 370 cm^{-1} corresponds to a molybdenum containing phase.

High-Resolution Transmission Electron Microscopy (HRTEM) can be used to directly image nanoparticles at scales approaching a single atom. The HRTEM analysis (Figure 3) of nanoscaled catalyst thermally treated in inert gas at 600ºC reveal the presence of M1 ($Te_2M_{20}O_{57}$; M= Mo, V, Nb) phase, as indicated by the regular particle morphologies. Inside the pentagonal rings are assumed to have Nb centers that edge-share oxygen with adjacent Mo sites; these Mo sites connect to one another by corner-sharing oxygen of the octahedral suggesting that Te and Nb are highly important for the structural order in M1 phase [5].

The results show that the rutile and M1 active phases for propane partial oxidation reaction have been prepared on the alumina support. Activity results (Table 1) confirm that higher loading sample ($12Mo_5V_4Nb_{0.5}Te_{0.5}$) presents higher conversion and higher acrylic acid selectivity than the bulk counterpart. Thus, a cheaper catalyst that performs better than the corresponding bulk material can be obtained by the use of nanoscaled catalysts.

Table 1. Catalytic results obtained in the propane partial oxidation reaction, AA sel. to Acrylic acid, and ACR to acrolein. Reaction conditions: total flow 40 ml/min feed gas (% vol) $C_3/O_2/H_2O/He$ = 12.5/20.4/15.9/51.2, 200 mg, GHSV = 4800 h^{-1}, T = 400ºC.

Catalyst	**S_{BET} (m^2/g)**	**% Conversion**	**% S_{AA}**	**% S_{ACR}**	**% S_{C3H6}**	**% S_{COx}**	**% Y_{AA}**
γ-Al_2O_3	193	6.0	0	0	30.0	70.0	0
MoVNbTe rutile	26	32.1	50.2	6.3	20.2	23.3	16.1
$4Mo_5V_4Nb_{0.5}Te_{0.5}$	159	27.5	37.0	20.5	30.7	11.3	10.2
$12Mo_5V_4Nb_{0.5}Te_{0.5}$	74	51.0	44.7	9.5	12.4	31.5	22.8

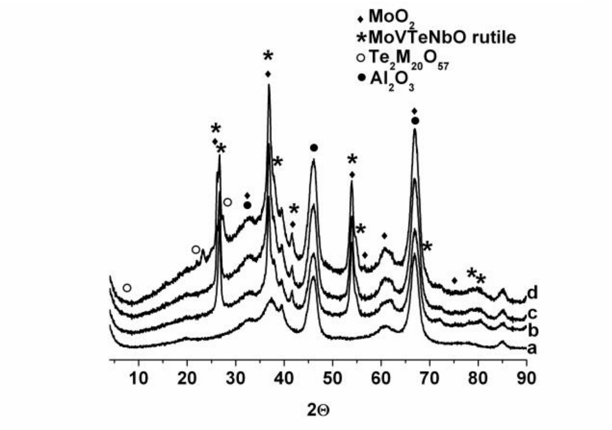


Figure 1. XRD of a) γ-Al_2O_3 support, b) nanoscaled MVNbTeO rutile-type phase, and c) $4Mo_5V_4Nb_{0.5}Te_{0.5}$, d) $12Mo_5V_4Nb_{0.5}Te_{0.5}$ supported catalysts.

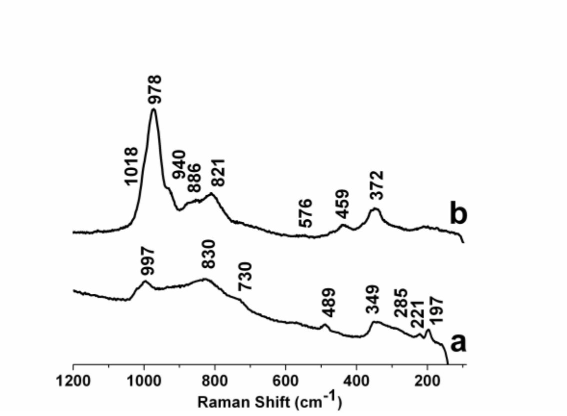


Figure 2. In situ Raman spectra under dehydrated conditions of a) $4Mo_5V_4Nb_{0.5}Te_{0.5}$, and b) $12Mo_5V_4Nb_{0.5}Te_{0.5}$ supported catalysts.

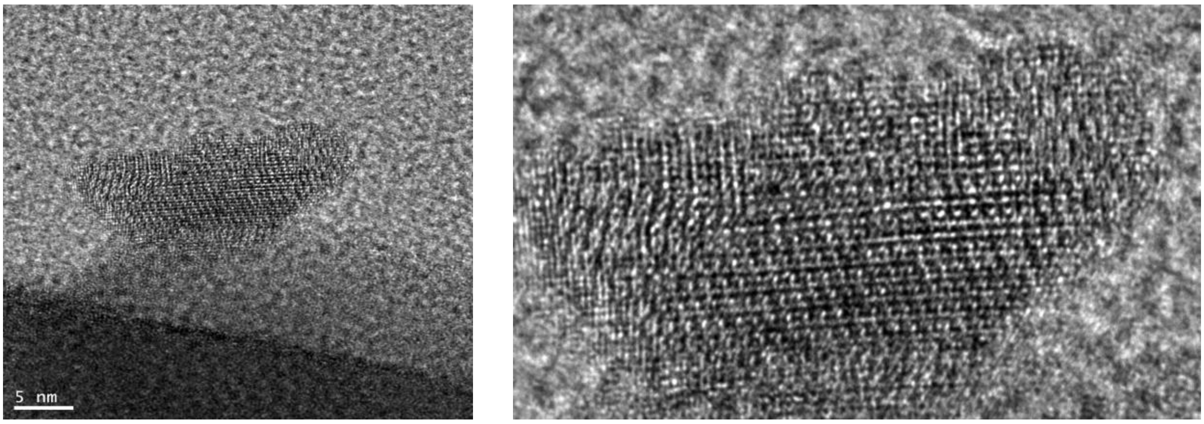


Figure 3. High Resolution TEM images showing the projection of the distortioned M1 phase supported with occupied heptagonal channels for Nb cations in $12Mo_5V_4Nb_{0.5}Te_{0.5}$ catalyst.

Acknowledgements

The Spanish Ministry of Science and Innovation (Grant No. CTQ2008/02461/PPQ) is acknowledged for the financial support. R.L.M. thanks MAEC-AECID (Spain) for his pre-doctoral fellowship. Authors thank Elizabeth Rojas García (ICP-CSIC) for her help with catalytic tests and to Olaf Torno (SASOL Germany GmbH) for providing alumina support.

References

[1] M.A. Bañares, G. Mestl, Adv. Catal. **52** (2009) 43.
[2] M.O. Guerrero-Pérez, J.L.G. Fierro, M.A. Bañares, Top. Catal. **41** (2006) 43
[3] M.O. Guerrero-Pérez, M.A. Bañares, Chem. Commun. (2002)1292
[4] L. Yuan, V.V. Guliants, M.A. Bañares, S.J. Khatib, Top. Catal. **49** (2008) 268
[5] P. Korovchenko, N.R. Shiju, A.K. Dozier, U.M. Graham, M.O. Guerrero Pérez, V.V. Guliants, **50** (2008) 43

Ultrafast laser inscribed near field lenses in Lithium Niobate crystals

Jorge Lamela, Jorge Barrios, Airán Ródenas, **Daniel Jaque**, Ginés Lifante, Francisco Jaque, Guangyong Zhou, and Min Gu

Departamento Fisica de Materiales, F. Ciencias, Universidad Autonoma de Madrid, 28049 Madrid, Spain
Centre for Micro-Photonics and Centre for Ultrahigh-bandwidth Devices for Optical Systems, Faculty of Engineering and Industrial Sciences, P. O. Box 218, Hawthorn, Victoria 3122, Australia

Daniel.jaque@uam.es

The possibility of creating controlled periodic nanostructures at the surface of ferroelectric nonlinear lithium niobate (LN) crystals is nowadays attracting much attention because of its numerous applications including the fabrication of two-dimensional (2D) photonic crystals [1], micro-diffraction elements [2], 2D phononic crystals [3], and novel focusing structures when combined with metallic coatings [4]. Among the different techniques capable of controlled surface structuring in LN crystals at the sub-micrometric scale (such as focused ion beam milling, ion beam enhanced etching, or mask assisted plasma etching), femtosecond laser ablation (FLA) is of special relevance because its simplicity, reduced processing times and absence of sample preparation requirements. [5] Nevertheless, for most of the above mentioned applications (especially those involving visible light control) reduced hole sizes are required. The possibility of using high-NA (NA > 1) optics has been already demonstrated in several materials (including glasses and self-assembled monolayers) [6,7], but its potential application in LN crystals for beating the 200 nm limit is still unexplored. In addition to the above mentioned practical applications, the creation of sub-200 nm surface structures in a high refractive-index nonlinear medium such as LN (n ~ 2.2 - 2.4) is also interesting from a fundamental point of view since they could open the avenue novel fundamental effects, such as extraordinarily high transmission or polarization-sensitivity effects [8].

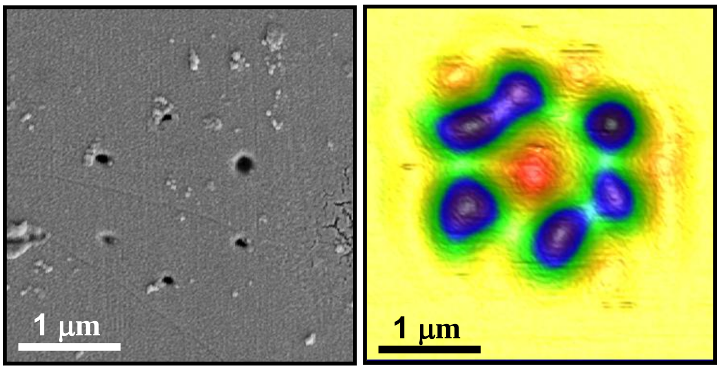


Figure 1. Scanning electron microscopy (SEM) of a six nano-hole array fabricated by fs pulses in LN crystal (left). The Near Field transmited intensity as measured with a SNOM (right).

In this work we report on the femtosecond laser fabrication of orderes arrays of sub-λ/4 holes in a LN crystal by multi-pulse ablation, with a full control over the hole diameter in the 80-200 nm range. We demonstrate that the presence of the fabricated nano-holes strongly modulates the near-field optical transmission of the LN surface. We show that the near-field transmitted intensity almost vanishes at hole´s central position, whereas a significant near-field enhancement is produced at its surroundings. The increment observed in the near field intensity in the surroundings of the nano-holes has been found to be weak for single nano-holes but of relevance in the case of ordered arrays of nanoholes. By comparing the measured and 3D FDTD simulated NSOM images we found nanometric surface relief in combination with cooperative multiple-scattering as the key factors for the optical contrast mechanisms.
As an exciting example we provide above the results obtained from a six-nanohole ordered array fabricated by fs laser inscription in a LN surface as well as the near field transmission intensity distribution experimentally observed with our SNOM. In this Figure it is more than evident the strong light concentration caused at the geometrical center of the array (in excess of 60%).
In this talk we will explain the fundamentals of such phenomena as well as the new windows that it opens in modern nano-photonics.

References

[1] S. Diziain, J. Amet, F. I. Baida, and P. M. Bernal. Appl. Phys. Lett. 93, 261103 (2008).

[2] G. A. Torchia, C. Mendez, I. Arias, L. Roso, A. Rodenas, D. Jaque. Appl. Phys. B. 83, 559 (2006).

[3] K. Kokkonen, M. Kaivola, S. Benchabane, A. Khelif, and V. Laude. Appl. Phys. Lett. 91, 083517 (2007).

[4] M. Merano, G. Boyer, A. Trisorio, G. Chériaux, and G. Mourou. Opt. Lett. 32, 2239 (2007).

[5] F. Korte, J. Serbin, J. Koch, A. Egbert, C. Fallnich, A. Ostendorf and B. N. Chichkov. Appl. Phys. A. 77, 229 (2003).

[6] Y. V. White, X. Li, Z. Sikorski, L. M. Davis and W. Hofmeister. Opt. Express 16, 14411 (2008).

[7] N. Hartmann, S. Franzka, J. Koch, A. Ostendorf and B. N. Chichkov. Appl. Phys. Lett. 92, 223111 (2008).

[8] 8.- A. Battula, S. Chen, Y. Lu, R. J. Knize and K. Reinhardt. Opt. Lett. 32, 2692 (2007).

Magnetic Glyconanoparticles as MRI Probes

Marco Marradi, Isabel García, Juan Gallo, Ainhoa Irure, and Soledad Penadés

Laboratorio de GlicoNanotecnología, CIC biomaGUNE/CIBER-BBN, Parque Tecnológico de San Sebastián,
Pº de Miramón 182, 20009 San Sebastián

mmarradi@cicbiomagune.es

The construction of novel multifunctional bionanomaterials that can help in better understanding life processes at the nanoscale and with potential applications in medicine is a key challenge of nanotechnology. Our group has experience in preparing gold and magnetic nanoclusters, and semiconductor nanocrystals functionalized with different types of carbohydrates (glyconanoparticles). [1]

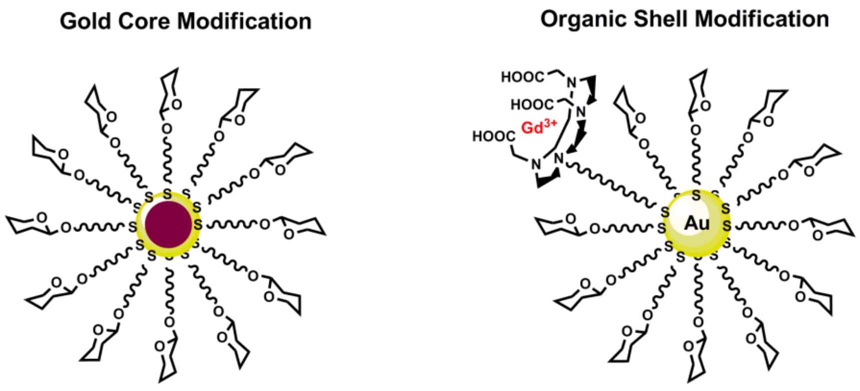
The aim of this talk is to present our results on the preparation, characterization and applications of magnetic glyconanoparticles as biocompatible, biofunctional and water-soluble probes for Magnetic Resonance Imaging (MRI). In the area of MRI, magnetic nanoparticles have demonstrated to be highly sensitive and target-specific contrast agents for observing biological events both at cellular and molecular level. [2]

For engineering magnetic glyconanoparticles, we have designed two approaches (Figure 1). The first approach is based on the development of novel core@shell bimetallic ferrites (Fe, Mn, Co, Au) coated with amphiphilic carbohydrate derivatives as superparamagnetic T_2-contrast agents. These biocompatible nanomaterials are superparamagnetic at room temperature and present similar, or higher, transversal relaxivities (r_2) than commercial contrast agents currently in clinical use as Resovist® and Endorem®. By further functionalization of the organic shell with antibodies, contrast agents for selective labelling and tracking specific cells have been obtained.

The second approach converts gold glyconanoparticles into paramagnetic probes (T_1-contrast agents) by modifying the organic shell through insertion of Gd(III) chelates (Figure 1). In this way, it was possible to obtain biocompatible paramagnetic glyconanoparticles which present similar, or higher, longitudinal relaxivities (r_1) than commercial contrast agents currently in clinical use as Dotarem® and Magnevist®. [3] Their application in the detection of glioma in murine models in vivo will be presented.

References

[1] For a leading review, see: J. M. de la Fuente and S. Penadés, *BBA-Gen. Subjects*, **1760** (2006) 636.
[2] Y. W. Jun, J. H. Lee and J. Cheon, Chemical design of nanoparticle probes for high-performance magnetic resonance imaging, *Angew. Chem. Int. Ed. Engl.*, 47 (2008) 5122.
[3] M. Marradi, D. Alcántara, J. M. de la Fuente, M. L. García-Martín, S. Cerdán and S. Penadés, Chem. Commun., **26** (2009) 3922.



Gold Core Modification

Fe_3O_4@Au core/shell
Superparamagnetic GNPs
(T_2-Agents)

Organic Shell Modification

Gd-Based Au
Paramagnetic GNPs
(T_1-Agents)

Figure 1. Schematic representation of prepared magnetic glyco-ferrites and Gd-based glyconanoparticles as MRI probes.

Towards the development of biomimetic optical devices

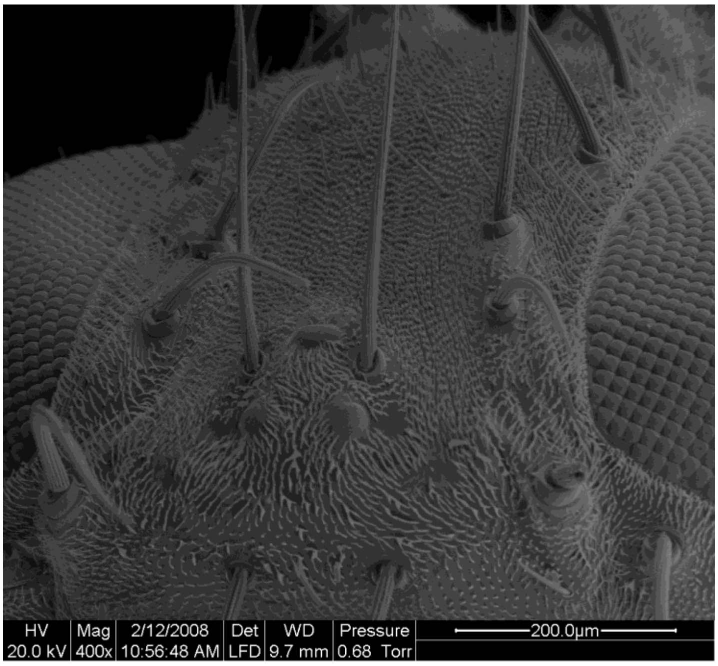
D.P. Pulsifer, A. Lakhtakia, and **R.J. Martín-Palma**

Materials Research Institute and Department of Engineering Science and Mechanics, The
Pennsylvania State University, University Park, Pa, 16802, USA
Departamento de Física Aplicada, Universidad Autónoma de Madrid, 28049 Cantoblanco, Madrid,
Spain

rauljose.martin@uam.es

The implementation of concepts from nature in different technoscientific fields is called biomimetics. The new feature of biomimetics is the ability to design and produce micro- and nano-scaled features and devices. Motivated by the idea of biomimetic optical devices, the conformal evaporated-film-by-rotation (CEFR) technique was devised to fabricate inorganic replicas of biotemplates with high reliability and fidelity at the micro- and nano-scales. The CEFR technique is particularly well suited for bioreplication as the temperatures involved during deposition are sufficiently low and the replication process occurs in a non-corrosive environment, thereby avoiding damage to the underlying biotemplate.

The compound eyes of insects are attractive candidates for bioreplication as they present a desirable optical scheme for imaging with a very wide field of view. In this regard, using the CEFR technique, we have successfully created replicas of the eyes of flies, finding that there is neither a distortion of the original structure nor any observable new structure created by the replication technique. We have experimentally determined that a similar optical response in the visible and near-infrared frequency regimes is observed before and after replication, thereby indicating that the structure of the biotemplate was replicated with high fidelity, preserving the original optical functionality. Replicate devices could serve to enhance light collection for solar energy collectors, optical communication systems or microcameras.



We have also used the CEFR technique to replicate wings of butterflies. The butterfly wing has a photonic band-gap structure that provides its particular color as well as additional functionalities, including aerodynamics, light weight, mimicry, and camouflage. The wing is composed of thousands of scales. These are intricately shaped with stratification, voids, and grooves of complex shapes that result in several optical effects, such as interference, scattering, and diffraction. Since the morphology of the butterfly wing makes it a very efficient diffuser of light, the replica could be used as an antireflection structure for increased photon trapping or as an optical diffuser.

References

[1] R.J. Martín-Palma, C.G. Pantano and A. Lakhtakia, Applied Physics Letters **93** (2008) 083901.
[2] R.J. Martín-Palma, C.G. Pantano and A. Lakhtakia, Nanotechnology **19** (2008) 355704.
[3] A. Lakhtakia, R.J. Martín-Palma, M.A. Motyka, and C.G. Pantano, Bioinspiration & Biomimetics **4** (2009) 034001.
[4] D.P. Pulsifer, A. Lakhtakia, and R.J. Martín-Palma, Applied Physics Letters **95** (2009) 193701.

Metalorganic Nanostructures with a pure coordination bond

Javier Méndez*, Lucía Álvarez, Samuel Peláez, M.F. López, Pedro Serena, J.A. Martín-Gago

Instituto de Ciencia de Materiales de Madrid, ICMM-CSIC, Spain

*jmendez@icmm.csic.es

Metalorganic networks and nanostructures have become an interesting research subject (see for example the reviews [1-5]), due to the potential applications as nano-templates for adsorbates with catalytical properties or for the study of their low dimensional properties. Among these systems, many have been named as the result of a non-covalent coordination interaction [4-5], where a dehydrogenation of the organic molecules takes place [6].

Here we present our work in the formation of metalorganic nanostructures based on the iron and PTCDA coordination on a gold surface. By means of scanning tunnelling microscopy/spectroscopy (STM-STS) [7], X-ray photoemission spectroscopy (XPS), and ab-initio theoretical calculations, we complete a view of this pure coordination system.

STM images show different metalorganic nanostructures depending on the preparation procedure (coverage, ratio and temperature): from 0D nanodots obtained at low coverages, to 1D chains after 360-380K annealing, and 2D coverage when the 1:1 ratio is observed. XPS spectras for the C1s and O1s peaks show how the coordination between the iron and the molecule induce a redistribution of the charge in the organic molecule, stronger at the carboxylic group. At the same time the Fe peak shows no significant change for the metalorganic structures, with the iron atoms keeping their metallic state Fe^0, as expected for a pure coordination bond.

Finally the theoretical calculations show the stability of the proposed models and how the HOMO – LUMO orbitals at the 2D nanostructures are located at different molecules (in figure b). This last is the reason for the strong difference observed at these structures in the STM images measured at both polarities.

References

[1] J.V. Barth, G. Costantini, and K. Kern, "Engineering atomic and molecular nanostructures at surfaces.," Nature, vol. 437, 2005, pp. 671-9.

[2] T. Kudernac, S. Lei, J.a. Elemans, and S. De Feyter, "Two-dimensional supramolecular self-assembly: nanoporous networks on surfaces.," Chemical Society reviews, vol. 38, 2009, pp. 402-21.

[3] H. Liang, Y. He, Y. Ye, X. Xu, F. Cheng, W. Sun, X. Shao, Y. Wang, J. Li, and K. Wu, "Two-dimensional molecular porous networks constructed by surface assembling," Coordination Chemistry Reviews, vol. 253, 2009, pp. 2959-2979.

[4] J.V. Barth, "Molecular architectonic on metal surfaces.," Annual review of physical chemistry, vol. 58, 2007, pp. 375-407.

[5] J.V. Barth, "Fresh perspectives for surface coordination chemistry," Surface Science, vol. 603, 2009, pp. 1533-1541.

[6] S.L. Tait, Y. Wang, G. Costantini, N. Lin, A. Baraldi, F. Esch, L. Petaccia, S. Lizzit, and K. Kern, "Metal-organic coordination interactions in Fe-terephthalic acid networks on Cu(100).," *Journal of the American Chemical Society*, vol. 130, 2008, pp. 2108-13.

[7] J. Méndez, R. Caillard, G. Otero, N. Nicoara, and J. Martín-Gago, "Nanostructured Organic Material: From Molecular Chains to Organic Nanodots," Advanced Materials, vol. 18, 2006, pp. 2048-2052.

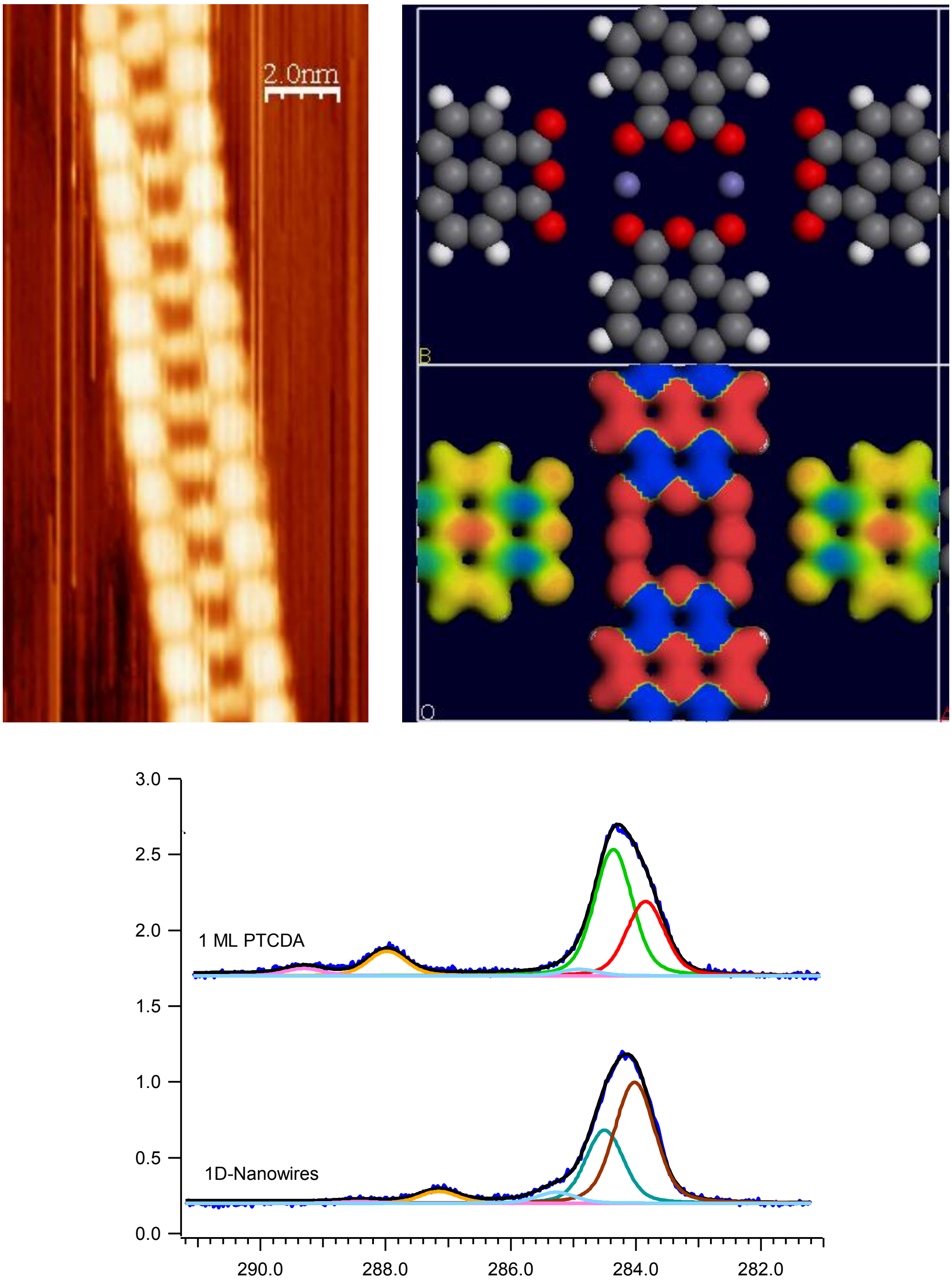


Figure. a) STM image of a “ladder-like” structure made of PTCDA molecules and iron atoms. b) Relaxed model of a periodic metalorganic network and the calculated HOMO – LUMO orbitals. c) C1s photoemission spectra for a PTCDA monolayer on gold and for a gold substrate covered with 1D metalorganic chains.

2-D Confined Hydrogen Bonded Networks of Polychlorotriphenylmethyl Radicals on Au(111) Surfaces

Veronica Mugnaini[1], Federico Grillo[2], Malena Oliveros[1], Steve Francis[2], Neville Richardson[2] and
Jaume Veciana[1]
[1] Institut de Ciencia de Materials de Barcelona (ICMAB-CSIC)/Networking Research Center on
Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), Campus Universitari de Bellaterra, Bellaterra,
(Spain)
[2] School of Chemistry, Univeristy of St. Andrews, St. Andrews, (UK)
vmugnaini@icmab.es

Functionalization of surfaces with multifunctional molecules assembled into multidimensional networks is nowadays one of the challenges of nanotechnology, towards the preparation of devices.[1] In the frame of this stimulating research field, of great interest is the family of multifunctional open-shell molecules, namely polychlorinated triphenylmethyl (PTM) radicals, whose paramagnetic character can be switched off by electrochemical reduction to the anionic species.[2] These molecules have been successfully grafted onto surfaces by chemisorption [3] and coordination chemistry,[4] demonstrating in all cases the preservation of their open-shell electronic configuration.

Recently, we successfully achieved the deposition of the tri-carboxy PTM derivative **1** (Fig.1) on Au(111) under UHV conditions. As shown by room temperature scanning tunnelling microscopy images (Fig. 2), these non-planar molecules self-assemble into a two-dimensional surface confined network driven by the formation of hydrogen bonding between the carboxylic functions.

Nevertheless, due to the electro activity of **1**, its low reduction potential value, and to its close contact to the gold metallic surface, its radical character could be lost after deposition forming the corresponding anionic derivative of **1**, with the obtaining of a diamagnetic surface. To characterize the functionalized Au(111) and assess its robustness, we made use of many different techniques, such as EPR, XPS and Ellipsometry. The obtained results, that will be the object of this contribution, evidence the persistent paramagnetic character of the PTM derivative **1** after UHV deposition onto gold. These results pave the way towards the preparation of multifunctional hybrid surface confined open frameworks using PTM radicals as ligands of transition metal ions.

References

[1] Bonifazi, D., Mohnani, S., Llanes-Pallas, A., Chem. Eur. J., **15**, (2009), 7004-7025
[2] N. Crivillers, M. Mas-Torrent, S. Perruchas, N. Roques, J. Vidal-Gancedo, J. Veciana, C. Rovira, L. Basabe-Desmonts, B. J. Ravoo, M. Crego-Calama, D. N. Reinhoudt, Angew. Chem. Int. Ed., **46**, (2007), 2215-2219
[3] Mas-Torrent, M, Crivillers, N., Mugnaini, V., Ratera, I., Rovira, C., Veciana, J., J. Mater. Chem., **19,** (2009), 1691-1695
[4] Shekhah, O., Roques, N., Mugnaini, V., Munuera, C., Ocal, C., Veciana, J., Wöll, C., Langmuir, **24**(13), (2008), 6640-6648.

Figures

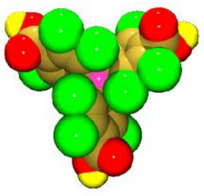


Figure 1: Molecular structure of the tri-carboxy PTM derivative 1. In green the chlorine atoms; in red the oxygen atoms. In pink the carbon center bearing the unpaired electron.

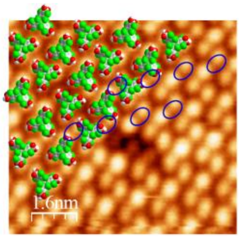


Figure 2: Room Temperature STM image of derivative 1 on Au(111). The molecule is modeled on top of the image. The circles indicate the H-bond formation.

Parallel Alignment of Nanowires for Fast Fabrication of Nanowire Based Gas Sensors

R. Jimenez-Diaz[a], **J. Daniel Prades[a]**, F. Hernandez-Ramirez[b,c], J. Santander[d], C. Calaza[d], L. Fonseca[d], C. Cané[d], A. Romano-Rodriguez[a]

[a] MIND/IN2-UB, Departamento de Electrónica, Universidad de Barcelona, c/ Marti I Franques 1 08028, Barcelona, Spain
[b] M-2E, Institut de Recerca en Energia de Catalunya (IREC), Barcelona, Spain
[c] XaRMAE, Departament d'Electrònica, Universitat de Barcelona, Barcelona, Spain
[d] Instituto de Microelectrónica de Barcelona, IMB-CNM-CSIC, E-08193 Bellaterra, Spain

dprades@el.ub.es

Nanowires have emerged as potential blocks for future electronic devices [1]. However, significant requirements arise from the use of elements with dimensions in the nanoscale: large scale synthesis of structures with homogeneous properties and reliable, affordable and fast contact fabrication, among others. In this work, a methodology for the fabrication of gas sensors based on individual metal oxide nanowires (NWs) is presented. Dielectrophoretic (DEP) alignment is used in combination with Focused Ion Beam (FIB) lithography for the deposition of contacts to obtain reliable and reproducible gas sensors, reducing the time necessary for their fabrication.

First of all, monocrystalline SnO_2 nanowires were dispersed on ethanol, making solutions with different concentrations. Afterwards, their manipulation was carried out by spreading a droplet of the solution (~10 µl) onto a SiO2 / Si wafer with pre-patterned microelectrodes, while an AC voltage of controlled frequency between these microelectrodes was applied. These experimental conditions were kept constant until the complete evaporation of the suspension was reached. Efficiency of DEP alignment process with different nanowire concentrations and frequency of the AC voltage applied was analyzed by means of SEM inspection. This step allowed determining the optimal experimental conditions to perform the DEP alignment process with SnO2 nanowires. To guarantee the formation of good electrical contacts between pre-patterned microelectrodes and nanowires, Electron Beam Assisted Deposition and Ion Beam Assisted Deposition processes were performed. These nanowires were electrically contacted using a FEI Strata 235 dual beam instrument equipped with an injector to deposit Pt. The details of this fabrication method were explained in detail elsewhere [2]. Finally, two- and four-probe dc electrical measurements were done using a Keithley 2602 Source Measure Unit, enabling the estimation of the key-parameters of these nanowires. On the other hand, some of these nanowires were also tested as gas sensors, using well-controlled environmental conditions. For this objective, some nanowires were placed onto suspended microhotplates which contained integrated microheaters. This kind of measuring platform enables an optimal control of the working temperature allowing fast and reproducible modulation of the temperature up to 600 K. The obtained results demonstrated the huge potential of nanowires as building-blocks of a new generation of devices with improved performances. It is noteworthy that DEP-aligned nanowires did not exhibit any significant difference in their electrical response than those reported with non-aligned nanowires [3]. For this reason DEP-based technologies are a promising approach for the fabrication of nanosensors in a scalable process which fulfill the requirements to become industrialized.

References

[1] E. Comini, Anal. Chim. Acta 568 (2006) 28-40.
[2] F. Hernandez-Ramirez, A. Tarancon, O. Casals, J. Rodriguez, A. Romano-Rodriguez, J. R. Morante, S. Barth, S. Mathur, T. Y. Choi, D. Poulikakos, V. Callegari and P. M. Nellen, Nanotechnology 17 (2006) 5577-5583.
[3] F. Hernandez-Ramirez, J. Rodriguez, O. Casals, E. Russinyol, A. Vila, A. Romano-Rodriguez, J.R. Morante, M. Abid, Sens. Actuators, B, Chem 118 (2006) 198–203.

Acknowledgments

Work partially funded by the Spanish projects MAGASENS, CROMINA and ISIS. RJ is indebted to the Spanish MEC for the FPU grant. This work has been developed partially using the capacities of ICTS Clean room of micro & nano fabricacion of IMB-CNM (CSIC).

Nanometrology, nano-eco-toxicology and standardization

Emilio Prieto

Centro Español de Metrología (CEM), C/Alfar 2, Tres Cantos (Madrid), Spain
Chairman of the AENOR GET 15 Committee on Standardization on Nanotechnologies, AENOR, Génova, 6, 28004 Madrid, Spain

eprieto@cem.mityc.es

Nanotechnologies enable scientists to manipulate matter at the nanoscale (size range from approximately 1 nm to 100 nm) [1]. Within this size region, materials can exhibit new and unusual properties, such as altered chemical reactivity, or changed electronic, optical or magnetic behaviour. Such materials have applications across a breadth of sectors, ranging from healthcare to construction and electronics.

Quantitative determination of properties of micro and nanostructures is essential in R&D and a pre-requisite for quality assurance and control of industrial processes. The determination of critical dimensions of nanostructures is important because the linking to many other physical and chemical properties depending on such dimensions. To get quantitative measurements is essential to count with accurate and traced measuring instruments, together with validated measurement procedures widely accepted [2].

Geometric features decisive for nanotechnology applications include 3D objects like large molecules (e.g. DNA), clusters of atoms (e. g. bucky balls), nanoparticles (like TiO_2 particles added to products to improve reflectivity), nanowires (like carbon nanotubes (CNT), single-walled CNT (SWCNT), multi-walled CNT (MWCNT)), surfaces structures (super-hydrophobic surfaces, riblets) and thin films covering large surfaces (hardness, scratch-resistance, reflectivity, wetting properties …) [3].

So, nanometrology, the science of measurement applied to the nanoscale plays a key role in the production of nanomaterials and nanometre devices. But most of the today's efforts in Research are not successful and they won't be if there is no transfer to industrial applications. In fact, nanotechnology has not yet emerged as massive production due to both the difficulty of developing a solid nanometrology infrastructure and the lack of awareness about it by researchers, product developers and R&D funders.

Instruments and techniques used today at the nanoscale are many and varied: exploration probes, ion beams, electronic beams, optical means, X-ray, electromagnetic means, mechanical techniques, etc. New instruments offer every day better capabilities but such equipments should be correctly calibrated in order to maintain their metrological capabilities (traceability, accuracy) so guarantying the reliability of the results, something crucial in R&D and industrial production.

Creation of metrological infrastructure and means has been intended for years by National Metrology Institutes (NMIs) by using specific tools, as the European Metrology Research Programme (EMRP)(www.emrponline.eu), the NanoScale series of Conferences (www.nanoscale.de/) where, since 1995, the main developments on quantitative measurements at the nanoscale have taken place, the Coordination of Nanometrology Initiative (www.co-nanomet.eu), funded under the European Commission FP 7 and others.

But apart of potential benefits to consumers, nanotechnologies may also present new risks it is necessary to study, as a result of their novel properties. A report by the European Union Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) published in 2009, listed a number of physical and chemical properties which affect the risk associated with nanomaterials [4], among them size, shape, solubility and persistence, chemical and catalytic reactivity, anti-microbial effects or aggregation and agglomeration. This is particularly important in the Food Sector. The European Union has provided €40 million in funding for nanomaterials safety research in the last three years, along with another €10 million in 2009. Studies on nano-eco-toxicology, together with standardization issues, are then important and urgent matters today at international level.

A forum where international coordination is taking place is the OECD which, at the present time, plays a central role in the coordination of research efforts for the development of test methodologies for risk assessment which will underpin the regulation of nanotechnologies. Some of the OECD Committees and Working Groups related to nanotechnology are: the Working Party on Chemicals, Pesticides and Biotechnology, the Working Party on Manufactured Nanomaterials, and the Working Party on Nanotechnology.

REACH—European Community legislation concerned with chemicals and their safe use—plays also a role, albeit limited, in regulating nanomaterials. The general opinion today is that REACH can adequately regulate nanomaterials, but there is a need for future revisions of REACH to move the focus of regulation from the size/shape of nanomaterials to also their functionality [5].

Finally, there is also a key role for standardization related to measurement and characterization, and testing of the characteristics and behaviour of nanomaterials and the exposure assessment, complementing the work being carried out in the framework of the OECD and in the context of the implementation of REACH. The European Commission therefore requests CEN, CENELEC and ETSI to develop standardization deliverables applicable to a) Characterization and exposure assessment of nanomaterials and b) Health, Safety & Environment.

Spain is participating actively in the works of ISO/TC 229, CEN/TC 352 and IEC/TC 113 Committees through the AENOR GET 15 Committee on Nanotechnologies. Matter under study is divided into four main fields: 1) Terminology and Nomenclature, 2) Measurement and Characterization, 3) Health, Safety and Environment and 4) Material Specifications. About 40 technical specifications and international standards are today under production for the ulterior benefit of all stakeholders (R&D, industries, citizens, …). Some of them are already appearing in Spanish as UNE-CEN ISO Standards.

On this talk a general view of all these activities and aspects of nanotechnologies is presented, highlighting the importance of all of them for the industrial development of nanotechnologies and the protection (health and safety) of citizens and the environment.

References

[1] ISO TS 27687:2008, *Nanotechnologies – Terminology and definitions for nano-objects – Nanoparticle, nanofibre and nanoplate*, 1st ed., 15-08-2008.

[2] *Nanoscale Metrology*, Editorial, Meas. Sci. Technol. 18 (2007).

[3] Scanning Probe Microscopy, Scanning Electron Microscopy and Critical Dimension: Nanometrology: Status and Future Needs within Europe, European Nanometrology Discussion Papers, Co-Nanomet, November 2009.

[4] SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks), *Risk assessment of products of nanotechnologies*, 19 January 2009, pp 15-16.

[5] Royal Commission on Environmental Pollution (RCEP), UK, Novel Materials in the Environment: The case of nanotechnology, p 64, Nov. 2008.

Production of glass nanofibres by a novel technique: Laser Spinning

F. Quintero, O. Dieste, J. Pou, R. Comesaña, F. Lusquiños, A. Riveiro

Dpto. Física Aplicada, Universidad de Vigo, ETSI Industriales, c/ Maxwell, 36310 Vigo, Spain

fquintero@uvigo.es

New applications of one dimensional nanostructured materials are quickly evolving [1]. We have developed a new method, Laser Spinning, for the production of ultralong amorphous ceramic nanofibers with lengths up to several centimetres. This technique allows large quantities of nanofibres to be made with specific, controllable chemical compositions. Furthermore, the production of amorphous nanofibres of non-ready glass former materials was demonstrated. This will potentially open up a whole new range of applications for the fibres.

The fundamentals of the technique will be outlined. It employs a laser to melt a small volume of a solid precursor material while a high pressure gas jet drags it. Thus, the molten material forms glass fibres as a result of its viscous elongation by the drag force and rapid cooling by the convective heat transfer promoted by the gas jet. Figure 1.a exhibits a SEM micrograph showing the typical morphology of the fibres. They form a disordered mesh of intertwined fibres with different diameters, typically in the range from tens of nanometres up to several microns. Each fibre has a uniform well-defined cylindrical morphology of near constant diameter with smooth surface, as can be observed in the TEM picture presented in Fig. 1.b. Because of the speed of the cooling the final structure is amorphous as the diffraction pattern in the inset of TEM micrograph demonstrates.

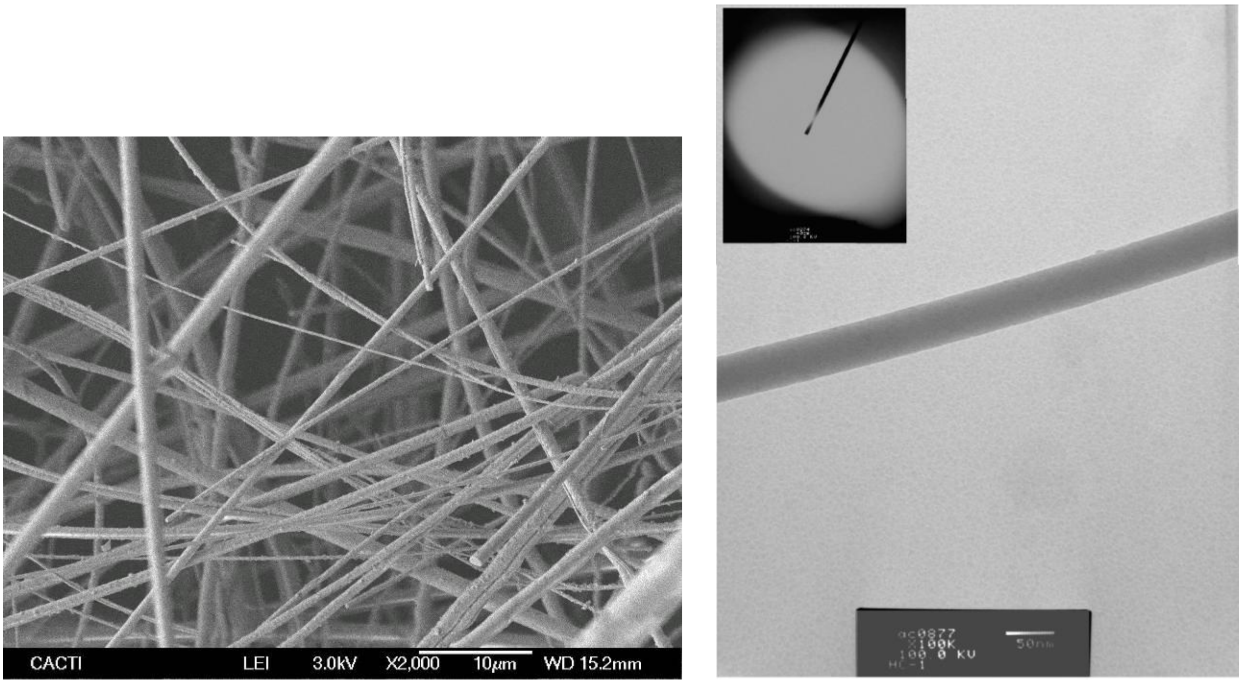
In this presentation experimental evidence on the mechanism of formation of the nanofibers will be shown using a high speed camera to record the formation of microfibers in some milliseconds by elongation of the viscous molten material during Laser Spinning. This process of fibre formation is mathematically modelled by applying the basic theories of elongational flows to the specific case of uniaxial stretching during melt blowing. The fundamentals of the model and the key parameters controlling the process will be outlined. The mathematical model allows to extrapolate the experimental evidences obtained for the production of microfibres to explain the formation of the nanofibres in a matter of microseconds. The dimensions and temperature of the molten volume together with its viscosity to surface tension ratio are revealed to be the controlling factors in determining the formation of the nanofibres [2, 3].

A crucial point question with regard to the composition of the fibres is to verify if they keep exactly the same chemical composition than the precursor material. The most likely alteration on the composition might be a depletion in the most volatile species due to the high temperatures of the melt and variations of composition among the fibres. For this reason we performed several experiments and analyses of the resulting fibres. In order to compare the composition of the precursor material with that of the fibres, a series of homogeneous glass plates were prepared and processed to obtain the nanofibres. Then, both series of samples were analyzed by X-Ray Fluorescence (XRF) and compared with corresponding pairs, demonstrating a good correlation of the chemical composition. Furthermore, a study of the compositional homogeneity of the fibres was performed analyzing the composition mapping of a set of fibres by Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS). These analyses proved that Laser Spinning can be used to produce nanofibres with homogeneous and controlled chemical composition [4].

Finally, some of the promising applications of the glass nanofibers will be outlined, ranging from the production of Bioglass® nanofibres for tissue engineering [5], to the design of nanofibres with new compositions for special functional textiles or carbon capture.

References:

[1] S.V.N.T. Kuchibhatla, A.S. Karakoti, D. Bera and S. Seal, Prog. Mater. Sci. **52** (2007) 699.
[2] F. Quintero, A.B. Mann, J. Pou, F. Lusquiños, and A. Riveiro, Appl. Phys. Lett. **90** (2007) 153109.
[3] F. Quintero, O. Dieste, J. Pou, F. Lusquiños, and A. Riveiro, J. Phys. D: Appl. Phys. **42** (2009) 065501.
[4] F. Quintero, J. Pou, F. Lusquiños, and A. Riveiro, Appl Surf. Sci. **254 (**2007) 1042.
[5] F. Quintero, J. Pou, R. Comesaña, F. Lusquiños, A. Riveiro, A.B. Mann, R.G. Hill, Z.Y. Wu, and J.R. Jones, Adv. Funct. Mater. 1**9** (2009) 3084.



a)

b)

Figure 1. a) The SEM micrograph presents the typical appearance of the micro- and nanofibres produced by means of the Laser Spinning technique. b) The TEM micrograph shows a detail of a nanofibre with a diameter of 35 nm and the inset shows its amorphous structure.

Quantum dot-based time-resolved adhesion assay for cell co-cultures

Pilar Rivera Gil[1,*], Fang Yang[1], Heidi Thomas[2], Andreas Terfort[2] and Wolfgang J. Parak[1]

[1]Dr. P. Rivera Gil, Fang Yang and Prof. W. J. Parak, Fachbereich Physik und Wissenschaftliches Zentrum für Materialwissenschaften (WZMW), Philipps Universität Marburg, Renthof 7, 35037 Marburg, Germany.
[2]Dr. H. Thomas and Prof. A. Terfort, Institut for Inorganic and Analytic Chemistry, Goethe-Universität Frankfurt, Max-von-Laue-Str. 7, 60438 Frankfurt am Main and Fachbereich Chemie, Philipps-Universität Marburg, Hans-Meerwein-Strasse, 35043 Marburg, Germany.

* E-mail: pilar.riveragil@physik.uni-marburg.de

Colloidal inorganic semi-conductor nanocrystals – commonly known as Quantum dots (QDs) – are prepared as fluorescent probes in biological staining. Compared with conventional fluorophores, QDs have a narrow, tunable (depending on the size), symetric emission spectrum and are photochemically stable [1]. The bright fluorescence allows for sensitive detection, the reduced photo-bleaching [2] permit measurements over long periods of time, and enable live cell imaging. Due to their narrow emission peaks they are suitable for multiplexing, in which multiple colors can be obtained in parallel from single excitation sources. Furthermore, QDs are spontaneously ingested by living cells [3], are confined in the cell and are only transferred to daughter cells upon cellular division. According to the advantageous characteristic of QDs, one of the main applications in cell biology is the use of QDs as marker for cell lineage. In this work, a QD label-based time resolved adhesion assay for co-cultures is presented. This is a novel technique, which allows for quantifying the adhesion properties of cell co-cultures on one substrate. Two different cell lineages were labeled with fluorescent QDs of two different colors and were grown within a co-culture onto different substrates. Due to the high contrast and the low brightness variations of the background, a software was developed to count the cells automatically. The adhesion of one against the other cell type was quantified by the ratio of the different colors. With this technique, the effect of different nano- and micro-structured surfaces on the adhesion behavior within co-cultures can be quantified.

References

[1] Bruchez, M. Jr., et al., *Science*, 281: 2013-2016 (1998)

[2] Wu, X., et al., *Nature Biotechnology*, 21(1): 41-46 (2003)

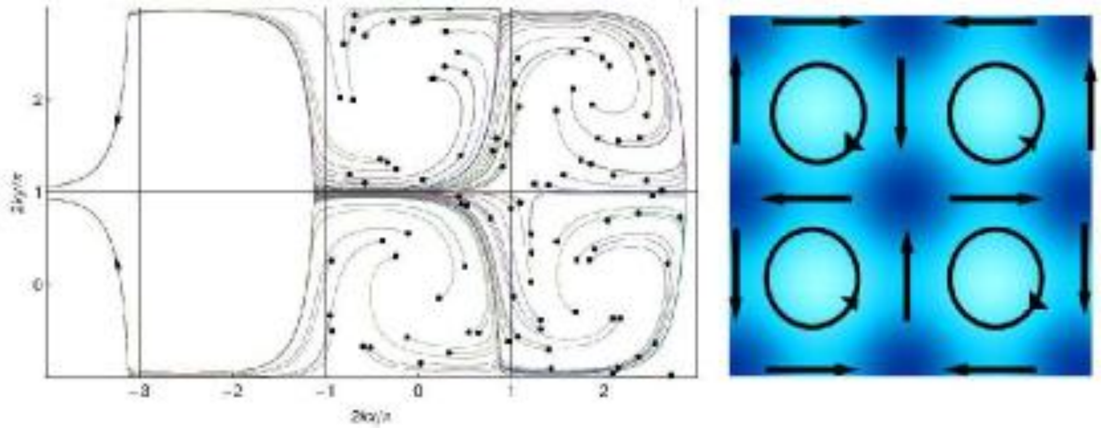
[3] Pellegrino, T., et al., *SMALL* 1, 48-63 (2005).

Particle Dynamics in Non-Conservative Optical Vortex Fields

S. Albaladejo[1], I. Zapata[2], M. I. Marques[1], M. Laroche[3], J.M. Parrondo[4],
F. Scheffold[5], F. Sols[2] and **J.J. Saenz[1]**

[1] Moving Light and Electrons (Mole) Group, Univ. Autónoma de Madrid, (Spain)
[2] Dpto. Fisica de Materiales, Universidad Complutense de Madrid, (Spain)
[3] Institut d´Optique, CNRS, Université Paris-Sud, (France)
[4] Dpto. Física Atómica y Molecular, Universidad Complutense de Madrid, (Spain)
[5] Department of Physics, University of Fribourg, (Switzerland)

Light forces on small (Rayleigh) particles are usually described as the sum of two terms: the dipolar or gradient force and the scattering or radiation pressure force. The scattering force is traditionally considered proportional to the Poynting vector, which gives the direction and magnitude of the momentum flow. However, as we will show, when the light field has a non-uniform spatial distribution of spin angular momentum, an additional scattering force arises as a reaction of the particle against the rotation of the spin. This non-conservative force term is proportional to the curl of the spin angular momentum of the light field [1] .We will illustrate the relevance of the spin force in the particular simple case of a 2D field geometry arising in the intersection region of two standing waves [2]
We will also discuss the peculiar particle dynamics in the non-conservative force field of an optical vortex lattice [3]. Radiation pressure in the whirllight field (arising in the intersection region of two crossed optical standing waves [2]) plays an active role spinning the particles out of the whirls sites leading to a giant acceleration of free diffusion. Interestingly, we show that a simple combination of null-average conservative and nonconservative steady forces can rectify the flow of damped particles. We propose a "deterministic ratchet" stemming from purely stationary forces [4] that represents a novel concept in dynamics with considerable potential for fundamental and practical implications.



References

[1] S. Albaladejo, M. Laroche, M. Marques, J.J. Saenz, Phys.Rev.Lett. 102 , 113602 (2009)
[2] A. Hemmerich, T.W. Hansch, Phys. Rev. Lett. 68, 1492 (1992).
[3] S. Albaladejo, M.I. Marques, F. Scheffold, J.J. Saenz, Nano Letters, September 1 (2009).
[4] I. Zapata, S. Albaladejo, J.M. Parrondo, J.J. Saenz, F. Sols, Phys. Rev. Lett. (2009)

AlN-actuated piezoelectric MEMS/NEMS resonators

J.L. Sanchez-Rojas[1], J.Hernando1, A.Donoso[1], J.C. Bellido[1], A. Ababneh[2], H. Seidel[2] and U. Schmid[3]

[1]University of Castilla-La Mancha, ETSI Industriales, 13071 Ciudad Real, (Spain)
[2] Chair of Micromechanics, Microfluidics/-actuators, Saarland University, 66123 Saarbruecken, (Germany)
[3] Dept. Microsystems Technology, Vienna University of Technology, Floragasse 7, 1040 Vienna, (Austria)

JoseLuis.SanchezRojas@uclm.es

Piezoelectric MEMS/NEMS resonators have a great potential for a wide range of applications in fields such as telecommunications or biotechnology. In these two areas, devices like film bulk acoustic wave resonators, microplate resonators, microcantilevers and microbridges have been studied in detail [1-3]. High Q-factor and efficient electromechanical coupling are desirable figures of merit, which may be achieved in higher order modes [4]. Very often, piezoelectric films sandwiched between rectangular electrodes, on top of a deformable silicon layer, are used to excite these resonances.

In this work, we demonstrate an advanced design procedure to fabricate piezoelectric resonators based on flexible plates. Two design strategies are followed: i) optimized response (actuation or sensing) in a given mode; ii) filtering by excitation of a particular mode independently. Our procedure is based on the pioneering concept of modal sensors/actuators to control the vibrations of flexible piezoelectric laminates [5]. Excitation and detection by geometrically shaping the electrodes has been described previously, but it was restricted to one-dimension [5,6]. We have designed resonant piezoelectric sensors/actuators based on two-dimensional microplates by optimizing the surface electrode shape in both dimensions. A numerical finite element procedure, which considers the effective surface electrode covering the piezoelectric film as a binary function on each element, has been developed as in [7]. For the optimization goal, this binary function is assumed to be 1 (0) if covered (not covered) by the electrode; for modal filtering, a binary function accounts for differential excitation of different parts of the plate. Our calculations allowed us to predict, for a given mode in a plate with arbitrary boundary condition, the top electrode layout reaching higher displacement (and hence larger change in admittance) in resonance than any other electrode design for the same structure.

Fig. 1 shows three examples resulting from our calculations for a) optimization of a higher order mode in a microcantilever, b) filtering a torsional mode in a microcantilever and c) filtering a fundamental mode in a microbridge. In the case of optimization, the black part corresponds to the top metallization, whereas for filtering, both black and white areas have to be excited with opposite phase voltages. This ideal spatial distribution of the exciting signal, resulting from the FEM calculation, has to be implemented satisfying certain design rules, such as a minimum gap between metal areas. As an example, Fig. 2 shows some of the devices fabricated, in particular, those corresponding to filtering in Fig. 1; a conservative metal-metal gap of 5 µm has been used and the edges of the fabricated patterns, although close, do not perfectly match those deduced with the model. The AlN driven cantilevers and bridges (640 µm x 200 µm) were fabricated on p-doped (100) silicon substrate which served as bottom electrode. They were backside patterned down to a thickness of about 20 µm. Aluminium nitride, 1000 nm thick, was sputter-deposited and 500 nm thick Al electrode layer was placed on top, with the layout specified by the design goal and the optimization procedure.

The devices have been characterized by laser Doppler vibrometry and impedance measurements up to 6 MHz, to determine the resonant frequencies and out-of-plane displacements, and the corresponding admittance change for the first twenty modes. Fig. 3 shows the displacement spectrum measured on the bride-shaped structure of Fig. 2, designed to filter the fundamental mode (denoted as mode 2_0). Also included in this figure is the response of a reference microbridge, with exactly the same layers and geometry, except for the top electrode, which has two simple square electrodes. Although the filtering is not perfect in this particular device (some leak-through from other modes is present), a significant reduction of the response in the higher order modes, up to more than twenty resonances above the fundamental mode, can be demonstrated, showing that the implemented designs can suppress the contributions of different modes simply by shaping the surface electrodes.

References

[1] G. Piazza, P.J. Stephanou, A.P. Pisano, “Piezoelectric, Aluminum Nitride vibrating contour-mode MEMS resonators”, *J. Microelectromech. Syst.*, vol. 15, pp. 1406-1418, 2006.

[2] G. Wingqvist, J. Bjurström, L. Liljeholm, V. Yantchev, I. Katardjiev, “Shear mode AlN thin film electro-acoustic resonant sensor operation in viscous media” *Sensors and Actuators B* 123. pp. 466–473. 2007.

[3] P Sanz, J Hernando, J Vazquez, J L Sanchez-Rojas. “Laser vibrometry and impedance characterization of piezoelectric microcantilevers”, *J. Micromech. Microeng*. 17 pp. 931–937, 2007.

[4] Mustafa U. Demirci and Clark T.-C. Nguyen, “Higher-Mode Free-Free Beam Micromechanical Resonators”, in *Proceedings of the 2003 IEEE International Frequency Control Symposium*, 2003, pp.810-818.

[5] C.-K. Lee, F.C. Moon, “Modal Sensors/Actuators” *Transactions of the ASME”*, Vol. 57, pp. 434-441, 1990.

[6] A. Prak, M. Elwenspoek, and J. H.J. Fluitman, “Selective Mode Excitation and Detection of Micromachined Resonators”, *J. Microelectromech. Syst.*, vol. I, pp. 179-186, 1992.

[7] A. Donoso, J.C. Bellido, “Systematic design of distributed piezoelectric modal sensors/actuators for rectangular plates by optimizing the polarization profile. *Strutural and Multidisplinary Optimization*. doi:10.1007/s00158-008-0279-7. 2008.

Figures

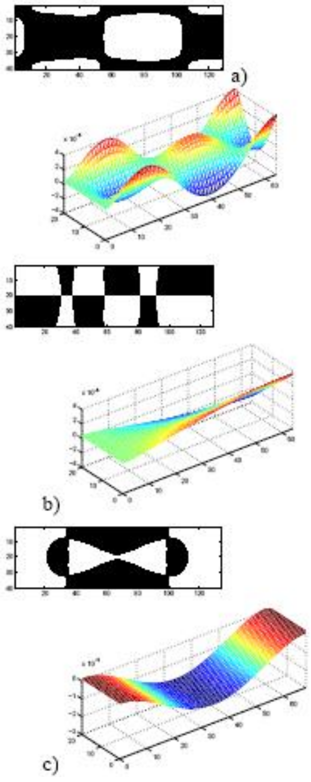


Figure 1. Calculated electrode shapes for a) optimization of a higher order mode in a microcantilever, b) filtering first torsional mode in a microcantilever and c) filtering fundamental mode of a microbridge.

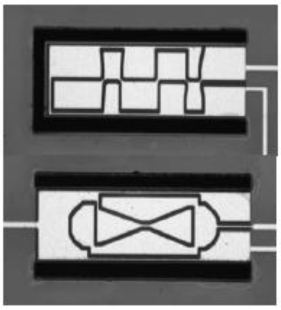


Figure 2. Implementation of the designs in figures 1 b) and c).

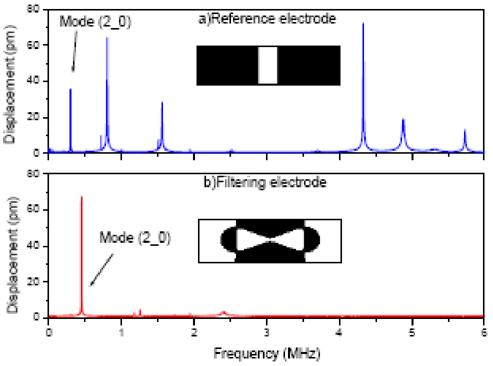


Figure 3. Displacements versus frequency for the same excitation in two microbridges differing only in the top metallization, a) with two lateral rectangular electrodes, and b) with tailored electrode layout.

Choline Dendrimers As Versatile Tools For The Development Of New Antibiotics And Tissue Imaging

Víctor M. Hernández-Rocamora[1], Beatriz Maestro[1,2], Sanne W. A. Reulen[3], Bas de Waal[3], María Morales[4], Pedro García[4], E.W. Meijer[3], Maarten Merkx[3] and **Jesús M. Sanz[1]**

[1]Instituto de Biología Molecular y Celular. Univ. Miguel Hernández. 03202- Elche (Spain)
[2] Instituto de Electroquímica. Universidad de Alicante. 03080-Alicante (Spain)
[3] Laboratory for Chemical Biology. Eindhoven Univ. of Technology. 5600MB-Eindhoven (The Netherlands)
[4] Dep. de Microbiología Molecular. Centro de Investigaciones Biológicas, CSIC, and CIBER de Enfermedades Respiratorias (CibeRes). 28040-Madrid (Spain)

jmsanz@umh.es

Dendrimers are non-linear, branched polymers that display multiple copies of a single ligand on its surface. They are regular, monodisperse macromolecules of well-defined structure that can be easily functionalized and employed for the efficient molecular recognition of proteins. The multiple applications of these molecules range from *in vivo* drugdelivery to imaging agents [1,2].

Streptococcus pneumoniae (pneumococcus) is a major human pathogen [3] that contains multiple copies of the aminoalcohol choline (Fig 1A). These multivalent architectures serve as attachment sites for a variety of surface-exposed choline-binding proteins (CBPs) that are involved in essential processes for virulence such as cell-wall separation, the release of bacterial toxins and adhesion to the host [4]. All CBPs contain a characteristic choline-binding module (CBM) that directs the adsorption of the protein to the bacterium surface (Fig 1B). In order to mimic the structure of the pneumococcal cell wall we synthetized choline-functionalized poly(propileneimine) (PPI) dendrimers [5] (Fig 2A) that increased their affinity to the CBMs about 10 000-fold compared to free choline. Concomitantly, the dendrimers also turned out to be very efficient inhibitors of the enzymatic activity of CBPs *in vitro* (by competing with the cell walls for binding to the enzyme), and arrested separation of daughter cells after cell division when assayed in liquid cultures of *S. pneumoniae* (Fig 2B). Therefore choline dendrimers constitute a promising starting point for the development of new antibiotics against pneumococcal diseases.

Taking advantage of the strength and specificity of the interaction choline dendrimers and CBPs, we have constructed a fusion protein containing the choline-binding module C-LytA and the collagen-binding protein CNA35 from *Staphylococcus aureus* [6]. The protein bound to fluorescein-labeled choline dendrimers with micromolar affinity. This non-covalent protein-dendrimer complex was used to specifically label collagen tissue samples that were subsequently visualized by fluorescence microscopy (Fig 3).

Our results therefore show that choline dendrimers can be used for specific, noncovalent, high affinity binding of fusion proteins containing choline-binding modules. These molecules may constitute attractive tools for a variety of biotechnological and biomedical applications.

References

[1] Svenson, S. and Tomalia, D.A.. Adv. Drug Delivery Reviews **57** (2005), 2106– 2129.
[2] Heegaard, P.M.H. and Boas, U. Recent Pat Anti-Infective Drug Discov.**1** (2006), 333-351.
[3] Maestro, B. and Sanz, J.M. Recent Pat Anti-Infective Drug. Discov., **2** (2007), 188-196.
[4] Bergmann, S. y Hammerschmidt, S. Microbiology, **152** (2006), 295–303.
[5] Hernández-Rocamora, V.M., Maestro, B., De Waal, B., Morales, M., García, P., Meijer, E.W., Merkx, M. and Sanz, J.M. Angew. Chem. Int. Ed. **48** (2009), 948-951.
[6] Patti, J. M., Boles, J. O. and Hook, M. Biochemistry **32** (1993), 11428-11435.

Figures

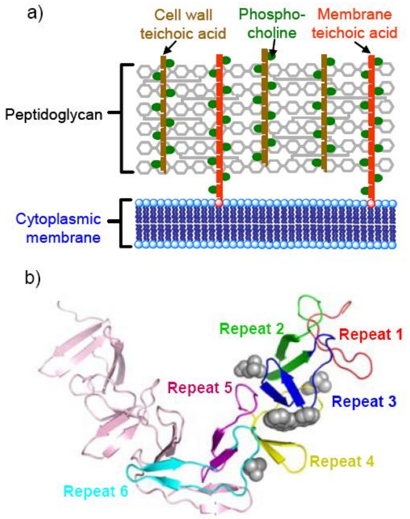


Figure 1. a) Representation of cholinecontaining cell wall from S. pneumoniae. b) Structure of choline binding module C-LytA

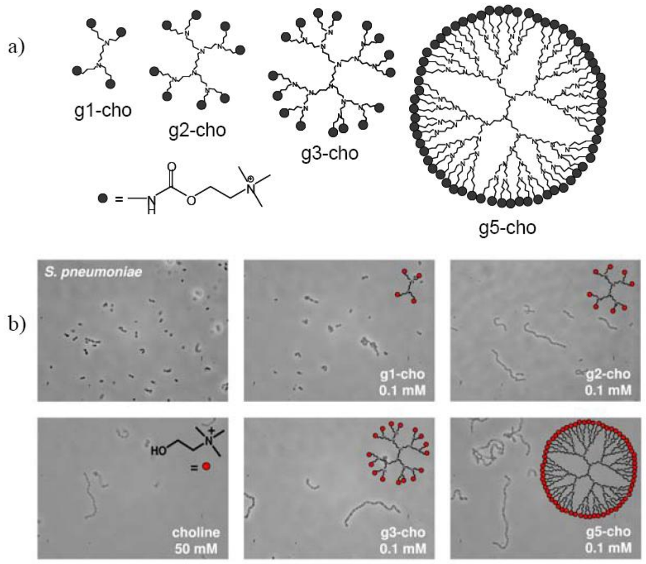


Figure 2. a) Scheme of different generations of choline dendrimers. b) Inhibition of pneumococcal cell separation by dendrimers

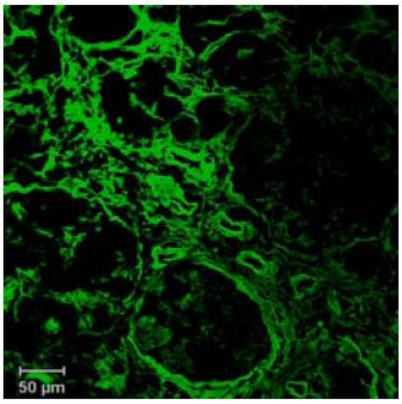


Figure 3. Collagen fibers visualization in human kidney tissue with C-LytCNA35 fusion protein and g5-cho/FITC choline dendrimers.

New paradigms and New Devices based on Nanomechanics for Ultrasensitive Biological detection

Javier Tamayo, Johann Mertens, Priscila M. Kosaka, Eduardo Gil, Montserrat Calleja

Bionanomechanics Lab-Instituto de Microelectrónica de Madrid- CSIC, Isaac Newton 8 (PTM),
Tres Cantos 28760, Madrid, (Spain)

jtamayo@imm.cnm.csic.es

The goal of discovering new devices and new transduction concepts for biological detection remains of paramount importance. Nanotechnology based approaches are promising candidates for providing portable and low cost nanosensor devices, capable of analyzing tiny amounts of sample, and specifically disease markers from patients. We present here recent advancements in the development of novel MEMS/NEMS devices and new sensing paradigms to achieve the ultimate limits in biological detection based on nanomechanics. The presented results are divided in the following battle fronts,

- Multifunctional nanomechanical systems for highly selective and sensitive biological detection.

We propose the combination of multiple nanomechanical structures in arrays in order to detect multiple signatures of adsorbed biomolecules such as the mass, the mechanical properties and the surface stress [1]. A prototype device is shown in Fig. 1. The nanomechanical arrays provide a double flavour of the adsorbed molecules: the added mass reported by the cantilevers with the Au area at the tip and the nanoscale elasticity reported by the cantilevers with the Au area at the clamp. The devices in Fig. 1 were applied for DNA detection based on Watson-Crick pairing rules. The proposed design for nanomechanical resonators provides higher specificity for DNA sensing in comparison with conventional single cantilevers.

- Ultrasensitive mass detection based on single silicon nanowire resonators

Silicon nanowires together carbon nanotubes represent the ultimate limit in the minituarization of nanomechanical resonators. Silicon nanowires present resonance frequencies of 10-1000 MHz, quality factors 10^3-10^5 and active masses of 10 femtograms. It is expected that these devices can be applied for ultrasensitive mass sensing at the subzeptogram level and for mass spectroscopy of single biomolecules. However, the achievement of the optimal performance of these devices requires a detailed understanding of the nanomechanical response and a major development of the optical instrumentation for the detection of the picometer scale vibrations. We have developed advanced optical instrumentation and in depth models of the nanomechanical response of the silicon nanowire vibrations.

- Arrays of coupled nanomechanical resonators for ultrasensitive mass sensing

The elastic coupling of identical nanomechanical resonators via overhangs offers a new paradigm for biosensing. Firstly, the vibrational energy of the system is found delocalized in both, nanomechanical resonators and vibration eigenmodes. However, the landing of a minute mass on one of the resonant structures produces a large perturbation in the vibration localization that can be exploited for ultrasensitive mass sensing. The intrinsic common mode rejection of these devices allows quantification of the differential mass between coupled resonators. We have modelled the response of coupled nanomechanical resonators and we have experimentally characterized the response of coupled resonators to controlled adsorbed masses [2]. A picture of two coupled cantilevers used in this work is shown in Fig. 2.

References

[1] D. Ramos, M. Arroyo-Hernandez, E. Gil Santos, H. Duy Tong, C. van Rijn, M. Calleja, J.Tamayo, Analytical Chemistry 81 (2009) 2274
[2] E. Gil Santos, D. Ramos, A. Jana, M. Calleja, A. Raman, J. Tamayo, Nano Letters 9 (2009) 4122

Figures

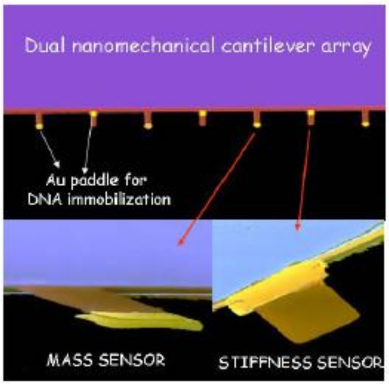


Figure 1. Optical (top) and scanning electron microscopy (bottom) images of a nanomechanical system consisting of cantilevers with a gold area at the tip and cantilever with a gold area at the base. The gold area confines the immobilization of bioreceptors tethered with a thiol linker. The cantilever length, width and thickness are 15 µm, 6 µm and 100 nm, respectively. The operation principle of this device is that the resonance frequency of the cantilevers with the Au area on the tip is sensitive to the adsorbed mass whereas the resonance frequency of the cantilevers with the Au area at the clamp are sensitive to the mechanical properties of the adsorbate.

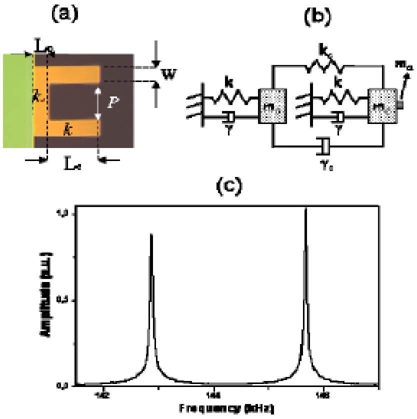


Figure 2. Optical micrograph of an array of two identical silicon nitride microcantilevers coupled via an overhang. Each cantilever has a length Lc = 25 µm, width b = 10 µm and thickness h =0.1 µm. The gap between the cantilevers is P=20 µm and the overhang length is Lo = 7 µm. (b) Simple model based on the harmonic oscillator theory. (c). Thermomechanical spectra of one of the cantilevers that shows two vibration modes. The first resonant peak is related to the two cantilevers vibrating in phase, whereas the second peak is related to the cantilevers vibrating in antiphase.

Revealing the role of anchoring groups in the electrical conduction through single-molecule junctions

Linda Angela Zotti, Thomas Kirchner, Juan-Carlos Cuevas, Fabian Pauly, Thomas Huhn,
Elke Scheer and Artur Erbe

Departamento de física teórica de la materia condensada,
Universidad Autonoma de Madrid, 28049 Madrid, (Spain)

linda.zotti@uam.esl

Great effort has been devoted recently to understand the role of the anchoring groups in the transport properties of single-molecule junctions [1,2]. However, these studies have been largely based on the analysis of the low-bias conductance, which does not allow to elucidate the exact influence of the terminal groups in both the electronic structure and transport characteristics of the junctions.

In this work we present a combined theoretical and experimental study of the transport properties of ethyne single molecules chemically modified by the introducing thiol, nitro and cyano terminal groups. The measurements were performed using the mechanically controllable break-junction (MCBJ) technique. We show that the observed I-V curves can be accurately fitted with a single-level resonant tunneling model. From the fits, we are able to extract both the width of the resonant level that dominates the transport, which is a measure of the strength of the metal-molecule coupling, and the position of this level. Thus, we are able for the first time to establish quantitatively how different end groups determine the metal-molecule coupling and to show how these groups affect the internal electronic structure of the molecules.

We have performed first principles calculations of the transport properties of these molecules using a combination of density functional theory and non-equilibrium Green's function techniques [3]. Our computational results show that for all molecules the conductance is dominated by a single level, the closest one to the gold Fermi level. The strength of the coupling and the molecular level energy position were extracted from the first principles calculations and they were found to be in good agreement with our experimental results. We find that the coupling strength is similar for thiol, amino ending groups, while it is much lower for cyano and nitro groups. Moreover, for thiol- and amino-terminated molecules the current proceeds through the highest occupied molecular orbital (HOMO), while in the case of nitro- and cyano-terminated molecules, the conductance was found to be dominated by the lowest unoccupied molecular orbital (LUMO), in agreement with the findings of recent thermopower experiments [4]. These results demonstrate that end groups not only determine the metal-molecule coupling, but they also strongly modified the internal electronic structure of the molecules, changing in turn the nature of the electrical conduction.

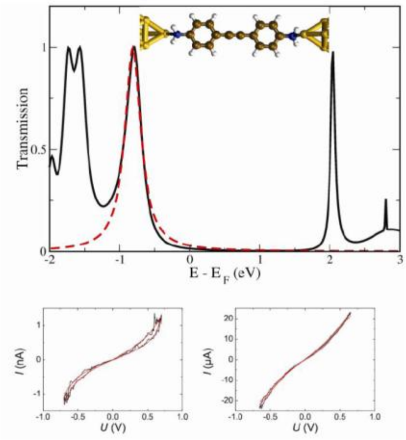


Figure 1: Upper: First principle calculations of the transmission through the Au|1,2-bis(4-aminophenyl)ethyne|Au junction. Lower: Experimental I-V curves of junctions formed with thiol and nitro terminated molecules

References

[1] X. Li, J. He, J. Hihath, B. Xu, S. M. Lindsay, and N. Tao, J. Am. Chem. Soc. **128**, (2006) 2135
[2] Y. S. Park, A. C. Whalley, M. Kamenetska, M.L. Steigerwald, M. S. Hybertsen, C. Nuckolls, L. Venkataraman, J. Am. Chem. Soc. **129**, (2007) 15768
[3] F. Pauly, J.K. Viljas, U. Huniar, M. Häfner, S. Wohlthat, M. Bürkle, J.C. Cuevas, Gerd Schön, New J. Phys. **10**, (2008) 125019.
[4] K. Baheti, J.A. Malen, P. Doak, P. Reddy, S-Y. Jang, T.D. Tilley, A. Majumdar, R.A. Segalman, Nano Letters **8**, (2008) 715

INVITED SPEAKERS

CNANO GSO SESSION

How to coat plant viruses

Abid Ali Khan[1], Thales de Oliveira[1], Dr. Sachin Shah[1], Dr. Nadja Amsharov[2], Dr. Anan Kadri[3], Dr. Christina Wege[3], Zhenyu Wu[4], Chenchen Ma[4], Prof. Carl Krill III[4], **Dr. Alexander Bittner**[1,2]

[1]CIC nanogune, Self-Assembly group, Tolosa Hiribidea 76, 20018 Donostia, (Spain)
[2]MPI-FKF Nanoscale Science, Heisenbergstr. 1, 70569 Stuttgart, (Germany)
[3]Universität Stuttgart, Biologisches Institut, Pfaffenwaldring 57, 70550 Stuttgart, (Germany)
[4]Ulm University, Institute of Micro and Nanomaterials, Albert-Einstein-Allee 47, 89081 Ulm, (Germany)

The Tobacco mosaic virus (TMV) can be metallized in aqueous suspension, resulting in unique dumbbell-, rod- and tube-shaped deposits with diameters down to 3 nm and lengths up to micrometers [1,2]. The coating process is based on the adsorption of noble metal cations followed by autocatalytic electroless deposition. In practical terms, the virus suspension is simply mixed with an aqueous solution of the metal ions and a reductant; in the same way, oxide coatings are possible [3]. Strategies for selective deposition inside the 4 nm channel [4] or on the outer coat are based on changing TMV's colloidal properties by:

- adsorption of ions from solutions
- mutations of the coat proteins to change the local chemistry
- attachment of material to RNA, which can be partially liberated from TMV [1]
- polymer coatings.

All four methods are useful as primers for further coating by oxides or metals. When the coating is ferromagnetic, the rods or tubes form the basis for novel ferrofluids. The shear-induced decrease in viscosity that is usually observed in ferrofluids can be suppressed when virus-based composites replace conventional spherical particles. The coatings have been analyzed by a range of methods, including TEM, SEM and SQUID magnetometry.

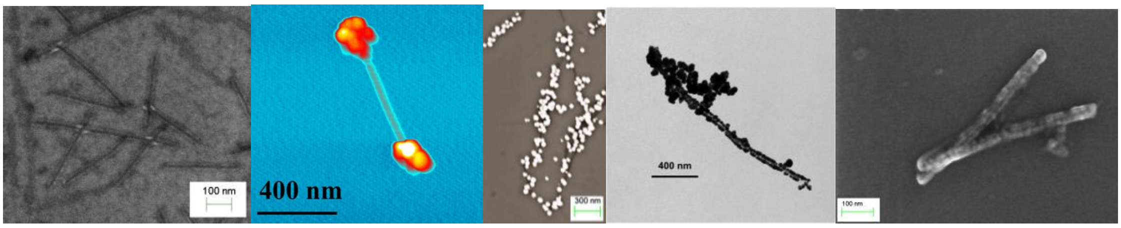


Figure 1: SEM of polyaniline-coated Tobacco mosaic viruses (TMVs); Au-TMV-TMV-Au dumbbell (AFM) [1]; TMV with Ni dots (SEM); TMV-histidine mutants coated by Ni (TEM); TMV coated with Fe_xO_y (SEM)

References

[1] S. Balci et al., Angew. Chemie Int. Ed. 46 (2007) 3149-3151, “Self-Assembly of Metal-Virus Nanodumbbells”
[2] S. Balci et al., Adv. Mater. 20 (2008) 2195-2200, “Printing and Aligning Mesoscale Patterns of Tobacco Mosaic Viruses on Surfaces”
[3] S. Balci et al., Electrochim. Acta 54 (2009), 5149-5154, “Catalytic coating of virus particles with zinc oxide”
[4] A.M. Bittner et al., Surf. Sci 603 (2009), 1922-1925, “Biomolecules as Soft Matter Surfaces”

Carbon Nanotube Electromechanical Resonators for Ultra Sensitive Mass/Force Sensing.

B. Lassagne[1], M. Respaud[1], A. Bachtold[2]

[1]Université de Toulouse ; Laboratoire de Physique et de Chimie des Nano-Objets (LPCNO CNRS-INSA-UPS) ; UMR 5215 ; Toulouse, France.
[2]Centre d'Investigacio en Nanociencia i Nanotechnologia (CIN2) Barcelona, Spain.

Shrinking electro-mechanical systems down to sub micrometer dimensions has opened new avenues for both very sensitive mass/force/charge sensing and fundamental issues in physics. I will show here that scaling the dimensions of mechanical resonators down to the nanometer by using carbon nanotubes (CNTs) allows to go further than previous micro fabricated devices and to reach unprecedented capabilities for ultrasensitive sensing.

Very recently, important results have highlighted the exceptional potential of CNTs. First, three independent research groups have demonstrated that CNT resonators are the most sensitive nanomechanical balance made so far [1, 2]. Thanks to their very low active mass and their very high and widely tuneable frequencies, CNTs have a mass sensitivity of few atoms.

Second, we have demonstrated how to improve considerably the CNT electromechanical performances. Indeed, when the electronic transport in the CNT is governed by a Coulomb blockade regime, we have demonstrated the possibility to widely tune the mechanical properties of the CNT [3]. Specifically, the resonance frequency, the quality factor and the nonlinear dynamic of the motion can be widely modified using the gate voltage. This surprising phenomenon, coming from the strong coupling between the electron motion into the CNT and its mechanical motion, allows one to considerably increase in the non-linear regime the quality factor of the CNT. It is a crucial point to improve the performances for sensing.

To conclude, I will present how a CNT electro mechanical resonator can be used for ultrasensitive magnetometry. The principle is to chemically graft onto the CNT a very small magnetic nanoparticle (~1 nm) or a molecular magnet. Then, the CNT is used as a force sensor in order to measure the interaction between the magnetic object and an external magnetic field. Some preliminary calculations predict that CNT would have sensitivity of the order of the Bohr magneton in a large range of temperature and magnetic field. It is the ultimate limit to study the fundamental magnetic properties of very small nano-objects.

References

[1] K. Jensen & al Nature Nanotechnology, 3, 533 (2008).
[2] B.Lassagne & al Nanoletters, 8, 3735 (2008).
[3] B.Lassagne & al Science, 325, 1107 (2009).

Malaga [Spain] · March 23>26
NANOSPAIN
CONF2010

ORAL CONTRIBUTIONS

CNANO GSO SESSION

The rise of Thermo-plasmonics

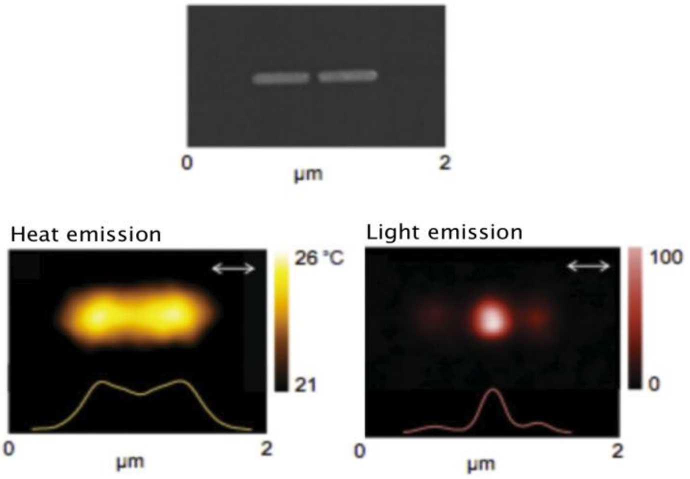
Guillaume Baffou, J. Donner, Mark P. Kreuzer, C. Girard, F. J. García de Abajo, Romain Quidant

ICFO – The Institute of Photonic Sciences, Mediterranean Technology Park, 08860 Castelldefels, Barcelona

Temperature control at the nanoscale is a promising field of Nanotechnology that could have unprecedented applications in physics, chemistry and biology. For now, this field remains at its infancy, mainly because of the lack of efficient thermal microscopy techniques and controllable nano-sources of heat.

Plasmonic nanostructures have already shown their ability to shape the optical field at the nanoscale, which led to all kind of exciting applications in nano-optics. In the same manner, one can wonder if plasmonic nanoparticles can be used as nano-sources of heat to shape the temperature at the nanoscale.

In this presentation, we propose an insight into the emerging field of nanotechnology named thermo-plasmonics. We first described new numerical techniques that we developed to understand the heat generation and model the temperature distribution in plasmonic nanostructures. Based on these numerical tools, we discuss the ability of plasmonic nanoparticles assembly to structure and control the temperature at the nanoscale. In a second part, we present a novel thermal microscopy technique that we applied to map for the first time the temperature around plasmonic structures. Unexpectedly, we found that the spatial origin of heat does not match the spatial origin of light around plasmonic structures. Based on this observation, we explain in details the physics of heat generation in plasmonics. We finally show how this temperature mapping technique can be used in biology to map for the first time the temperature distribution in single living cells in which plasmonic nanoparticles have been internalized.



Thermal vs optical near fields of a gap-antenna gold nanostructure showing that the spatial origin of heat does not match the spatial origin of light. This turns out the be a very general rule in plasmonics.

References

[1] G. Baffou, M. P. Kreuzer, F. Kulzer, R. Quidant, Optics Express **17**, 3291 (2009)
[2] G. Baffou, R. Quidant, C. Girard, Applied Physics Letters **94**, 153109 (2009)
[3] G. Baffou, C. Girard, R. Quidant, Phys. Rev. Lett. *Submitted* (2010)
[4] G. Baffou, R. Quidant, F. J. García de Abajo, ACSnano **4**, 709 (2010)

Cadherin-mediated cell adhesion:
From nanomechanical measurements between single molecules to living cells

S. Chevalier, O. Courjean, H. Feracci*

Université Bordeaux 1, CNRS UPR 8641, Centre de Recherche Paul Pascal, 115 Avenue Dr Schweitzer,
33600 Pessac (France)

Corresponding author, e-mail: feracci@crpp-bordeaux.cnrs.fr

Classical cadherins are transmembrane adhesive receptors that play essential roles in the initiation and stabilization of junctional structures, named adherens junctions in epithelial tissues. Interactions between cadherin extracellular domains (EC1-5) from adjacent cells mediate Ca^{2+}-dependent specific adhesion. The cadherin intracellular domain facilitates adhesion through linkage to cytoskeletal networks, which imparts resistance to mechanical stress and enables concerted motions required in morphogenetic processes.

Whereas it is widely accepted that the specificity of cadherin adhesive interactions is localized to the N-terminal domain, the mechanism of the recognition process is still poorly understood. Structural studies have shown that the adhesive interface consists of the β-strand exchange between the first extracellular cadherin domains (EC1) of partner cadherins from neighboring cells. This binding mode is common to classical type I and type II cadherins. In order to elucidate the details of the dynamics of these adhesive interactions, we have focused on E-cadherin (epithelial) and cadherin-11 (mesenchymal), chosen as type I and type II prototypes, respectively. Since NH_2-terminal domains are crucial for the adhesive function of cadherins, we recombinantly expressed the two outermost domains of both cadherins. Trypsin sensitivity and CD spectroscopy have been used to evaluate the correct folding as well as structural changes upon calcium binding of these fragments. Individual cadherin trans interactions have then been analyzed using a biophysical approach, the *Laminar Flow Chamber*, together with beads/cells assays. Transient tethers had second order kinetics, suggesting a multistate interaction. Point mutations have been introduced in the protein sequence to identify the amino acid residues involved in this mechanism. Our observations provide novel and detailed insights into the structural elements involved in regulating cell-cell interactions.

This work was supported by grants from the Association pour la Recherche sur le Cancer, the Fondation pour la Recherche Médicale, Ligue Contre le Cancer Dordogne, and the Région Aquitaine. S. Chevalier is supported by the Région Aquitaine.

References

E. Perret, A. M. Benoliel, P. Nassoy, A. Pierres, V. Delmas, J. P. Thiery, P. Bongrand, H. Feracci, EMBO J 2002, 21, 2537.

E. Perret, A. Leung, H. Feracci, E. Evans, Proc Natl Acad Sci U S A 2004, 101, 16472.

O. Courjean, G. Chevreux, E. Perret, A. Morel, S. Sanglier, N. Potier, J. Engel, A. van Dorsselaer, H. Feracci, Biochemistry 2008, 47, 2339.

L. Raptis, R. Arulanandam, A. Vultur, M. Geletu, S. Chevalier, H. Feracci, Biochem. Cell. Biol. 2009, 87, 835.

Decorating DNA origamis with gold nanoparticles

Juan Elezgaray(1), Jean Michel Arbona(1), Jean-Pierre Aimé(1), Sebastien Bidault(2), Françoise Argoul(3), Lotfi Berguiga(3) and Thibault Roland(3)

(1)CBMN, UMR 5248, 33600 Pessac, France
(2) UMR 7587 CNRS, ESPCI ParisTech, France
(3) ENS Lyon, LJC and Physics Lab, 46 Allée d'Italie, 69364 Lyon Cedex 07 France

Synthetic strategies to produce gold nanostructures around DNA templates have been developed over the last decade after the pioneering works of C. A. Mirkin and coworkers (Mirkin, 1996) and A. P. Alivisatos and coworkers (Alisivatos 1996). In particular, it is possible to obtain well-defined NP grouping geometries by controlling precisely the number of DNA single strands grafted on each gold particle through electrophoretic purification (Zanchet 2001, Zanchet 2002). This allows combining gold particles with other nano-objects (such as quantum dots) on the same template or producing symmetric 1D (Deng 2005) or 2D (Zheng 2006) NP lattices. However there are three major difficulties when producing DNA templated NP groupings for SERS applications : obtaining short particle spacings to enable large field enhancements ; using a rigid DNA scaffold to control precisely the grouping geometry ; introducing specific binding sites on electromagnetic hot-spots.
S. Bidault and coll. recently demonstrated that reproducible ~1nm NP spacings could be obtained in groupings of 5, 8 or 18 nm diameter particles using two DNA double strands (Bidault, 2008). Using several particles of different sizes allows optimizing field enhancement effects at one specific position of the structure (at the surface of the smallest NP) (Li, 2003). This geometry still presents two drawbacks : it is not possible to tune the spacing lengths and the three particles cannot be properly aligned to optimize field enhancements (Li,2003).

DNA origamis (Rothemund 2006) are good candidates to overcome the last two issues : controlling precisely the nanostructure geometry and introducing specific binding sites.

In this communication, we will discuss several issues, both theoretical and experimental, concerning the arrangement of gold nanobeads on such DNA constructions. In particular, we will focus on the possible optimizations that are possible as a function of the relative position of the beads or the bending of the DNA origami. We will also consider the use of surface scanning plasmon microscopy (Berguiga 2007) as a tool to characterize, by purely optical methods, the distribution of an origami deposit.

References

[Alisivatos 1996] A. P. Alivisatos, K. P. Johnsson, X. G. Peng, et al., Nature **382** (1996) 609.
[Berguiga 2007] L. Berguiga, S.J. Zhang, J. Elezgaray & F. Argoul., Optics Lett. **32** (2007) 509.
[Bidault 2008] S. Bidault, F. J. G. de Abajo, and A. Polman, JACS **130** (2008) 2750
[Deng 2005] Z. X. Deng, Y. Tian, S. H. Lee, et al., Angewandte Chemie-International Edition **44** (2005) 3582.
[Li 2003] K. R. Li, M. I. Stockman, and D. J. Bergman, Physical Review Letters 91 (2003).
[Mirkin 1996] C. A. Mirkin, R. L. Letsinger, R. C. Mucic, et al., Nature **382** (1996) 607.
[Rothemund 2006] Rothemund, P. W. K. Nature **440** (2006), 297-302.
[Zanchet 2001] D. Zanchet, C. M. Micheel, W. J. Parak, et al., Nano Letters **1** (2001) 32.
[Zanchet 2002] D. Zanchet, C. M. Micheel, W. J. Parak, et al., Journal of Physical Chemistry B **106**, 11758 (2002).
[Zheng 2006] J. W. Zheng, P. E. Constantinou, C. Micheel, et al., Nano Letters **6** (2006) 1502.

Coordination polymer nanoparticles for biomedical applications

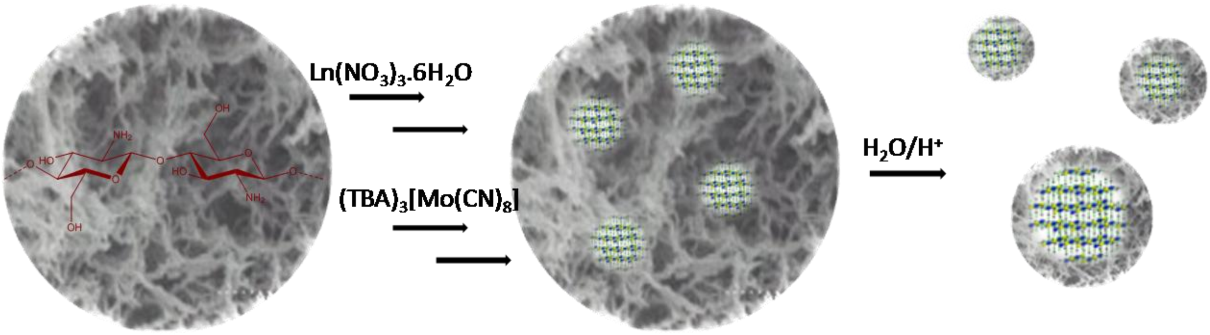
Joulia Larionova, Yannick Guari, Christian Guérin

Institut Charles Gerhardt, Equipe Chimie Moléculaire et Organisation du Solide (CMOS), UMR
5253, Université Montpellier II, Place E. Bataillon, 34095 Montpellier cedex 5, France

Fax: +33 4 67 14 38 52, e-mail: joulia.larionova@univ-montp2.fr

The development of nanoparticles as new probes for biomedical imaging is a research highly developed because of strong societal demand in this area. Metal oxides and metallic nanoparticles of various compositions have been intensively investigated and several types of such nanoparticles have ben applicated in clinical practice. Very recently, nanoparticles of molecule-based materials as a new type of inorganic nanoparticles were explored for such purpose. In this presentation, we present our recent investigations on the synthesis and properties of cyano-bridged coordination polymer nanoparticles $Ln^{3+}/[Mo(CN)_8]^{3-}$ (with Ln = Eu, Tb) and $Eu_{0.5}{}^{3+}Gd_{0.5}{}^{3+}/[Mo(CN)_8]^{3-}$ designed from octacyanometallates building block and lanthanides ions and enwrapped with the natural water-soluble biopolymer, chitosan (Fig.1). Depending on their composition, these nanoparticles may show high longitudinal/transverse relaxivity and/or luminescence and maybe considered as a new family of multifunctional contrast agents for Magnetic Resonance Imaging and biolabeling. The internalization of these nanoparticles into human cancer cells and their lack of cytotoxicity *in vitro* both on human cancer and normal cell lines were investigated.

Figure1. Schematic representation of a step-by-step approach used for the synthesis of coordination polymer nanoparticles enwrapped by chitosan shell.



Liquid nanodispensing:
molecules deposition and manipulation of ultrasmall droplets

Thierry Ondarçuhu, Erik Dujardin, Laure Fabié and Aiping Fang

Nanosciences group, CEMES-CNRS, 29, rue Jeanne Marvig,
31055 Toulouse cedex4 (France)

ondar@cemes.fr

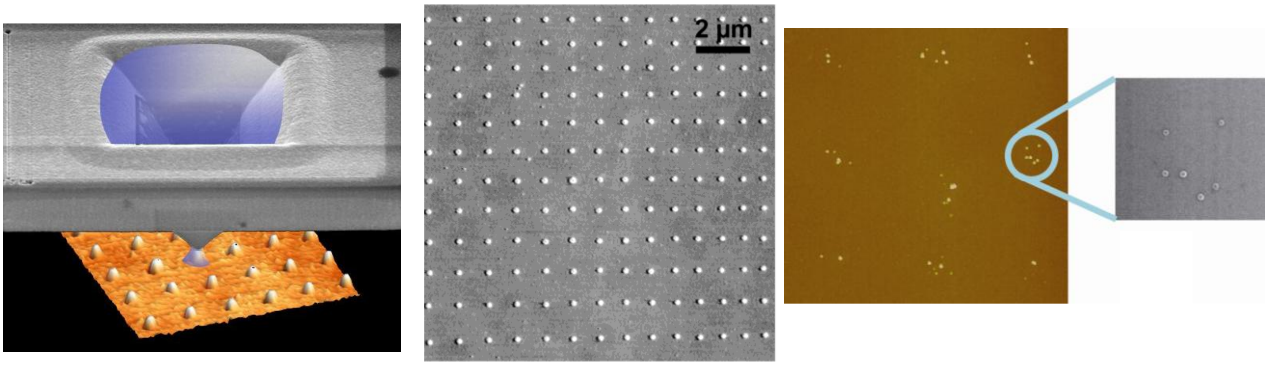
Controlled deposition of individual molecules on a surface is an important challenge in many studies in nanosciences. We present an AFM-based method for dispensing and manipulation of liquid nanodroplets on a surface. This newly developed nanoscale dispensing system (NADIS) is based on the direct transfer of liquid from a hollow AFM tip through a small aperture at its apex to the substrate by simple contact [1]. With an ink supplied from an on-tip reservoir, we can transport droplets onto a substrate in the femtoliter to attoliter range with a high droplets density (figure 1). We explored the liquid transfer mechanism from the tip to the substrate and showed that the size of dispensed droplets can be accurately and reproductively controlled by parameters such as the aperture size on the probe, the surface energy of both the tip outer wall and the sample surface [2]. By scaling down this method, we were able to deposit arrays of droplets with a diameter as small as 70 nm, which for standard dilutions contains only few molecules. Direct patterning of proteins or nanoparticles demonstrated the versatility of the method. An original deposition set-up including two AFM tips was also developed [3] in order to position the droplets on predefined structures on the surface (figure 2), a crucial point for many applications.

Due to the small dimensions of the manipulated droplets, it becomes important to address the problem of wetting and capillarity at nanometer scale, a question which remains largely unanswered. By its ability to manipulate femto- to atto-liter droplets, NADIS is a unique technique to tackle this issue, as demonstrated by the studies of capillary forces during dispensing [4] (figure 3), evaporation of femtoliter sessile droplets [5] or spreading dynamics at sub-micron scale.

References

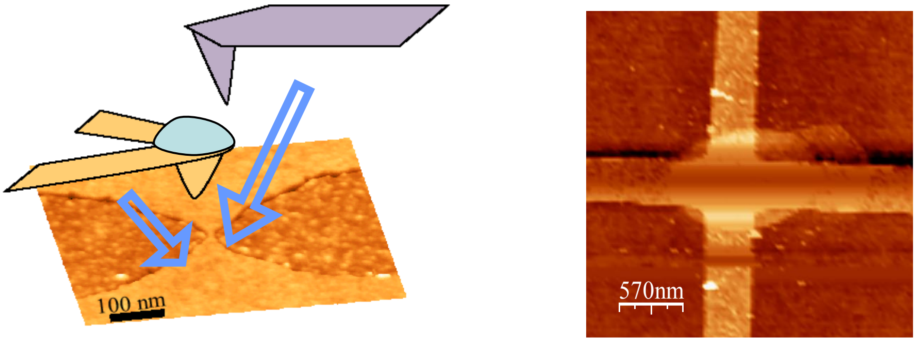
[1] A.Meister, M. Liley, J. Brugger, R. Pugin, H. Heinzelmann, Appl. Phys. Lett. 85 (2004) 6260.
[2] A.Fang, E. Dujardin, T.Ondarçuhu, NanoLett. **6** (2006) 2368.
[3] T. Ondarçuhu, L. Nicu, S. Cholet, C. Bergaud, S. Gerdes, C. Joachim, Rev. Sci. Instr. **71** (2000) 2087.
[4] L. Fabié, H. Durou, T. Ondarçuhu, Langmuir, **26** (2010) 1870.
[5] J. Arcamone, E. Dujardin, G. Rius, F. Pérez-Murano, T. Ondarçuhu, J.Phys.Chem.B, **111** (2007) 13020.

Figures



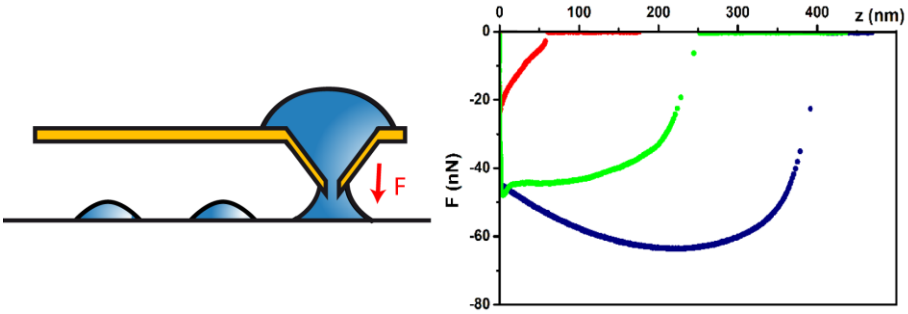
(a) (b) (c)

Figure 1. (a) Sketch of the liquid nanodispensing technique; (b) Array of deposited molecules spots with diameter 200 nm; (c) AFM image of an array of spots of polystyrene nanoparticules and SEM image of one spot. Each spot contains a small number of objects.



(a) (b)

Figure 2: (a) Schematic representation of the nanopositioning set-up including two tips: one NADIS tip for deposition and one AFM Tapping tip for imaging; (b) Example of droplet deposited on predefined electrodes.



(a) (b)

Figure 3: (a) Schematic representation of the capillary force exerted by the meniscus during the dispensing process; (b) Examples of measured force curves in various conditions: hydrophilic tip with 200 nm aperture (blue), same tip made hydrophobic (green), hydrophobic tip with 35 nm aperture.

Raman spectroscopy of long isolated graphene ribbons grown on the C face of 6H-SiC

Antoine Tiberj, Jean-Roch Huntzinger, Benoit Jouault, Bilal Jabakhanji and Jean Camassel
GES – UMR 5650 Université Montpellier 2/CNRS, 34095 Montpellier cedex 5, France

Nicolas Camara, Gemma Rius,Alessandra Caboni, Francesc Pérez-Murano and PhilippeGodignon
CNM-IMB-CSIC – Campus UAB 08193 Bellaterra, Barcelona, Spain

Narcis Mestres
ICMAB-CSIC – Campus UAB 08193 Bellaterra, Barcelona, Spain

antoine.tiberj@univ-montp2.fr

Graphene has emerged recently as a new material with outstanding electronic properties [1]. This includes mass-less Dirac fermions, ballistic transport properties at room temperature and good compatibility with silicon planar technology [2]. Different techniques have been developed in the last six years to fabricate mono or bi-layer graphene. They range from exfoliated graphite, either mechanically1 or in a liquid-phase solution [3] to chemical vapor deposition on a metalsurface [4], and, more recently, to substrate-free synthesis when passing ethanol into an argon plasma [5]. The method investigated in this work consists in a controlled sublimation of few atomic layers of Si from a single crystal SiC substrate [6]. Such epitaxial growth of grapheme (EG) seems to be the most suitable option for industrial applications but, for easy control, it necessitates either a large and homogeneous sheet of monolayer graphene (MLG) or few layers graphene (FLG) covering the full wafer surface.

Basically, on both the Si and C faces of any SiC substrate, graphene grows selectively on some reconstructed parts of the surface. Controlling the growth means then controlling locally the surface reconstruction. At low pressure conditions (below 10-6 Torr), it remains challenging to grow FLG with homogeneous domains larger than few hundred nanometers on both faces [7]. The homogeneity can be increased by lowering the sublimation rate. It has been demonstrated on the Si face by working at high pressure under a noble gas atmosphere such as argon [8,9]. In this work [10], the surface reconstruction of the C face during the Si sublimation is modified by covering the SiC substrate with a graphite cap. It leads to a strongly step-bunched morphology with on few selected terraces the growth of long anisotropic graphene ribbons (5 µm wide and up to 600 µm long).

Since the Raman fingerprint of Bernal stacked FLG depends strongly of the number of graphene layers [11] and the absorbtance of FLG is almost independent of the wavelength and proportional to the number of graphene layers [12], we combine micro-Raman spectroscopy with micro-transmission measurements to study the quality and thickness uniformity of these ribbons. We find that most of these ribbons are homogeneous monolayers or bilayers of graphene and that the thermal stress between the graphene layer and the 6H-SiC substrate is relaxed by the formation of wrinkles. This combination of techniques is especially useful to discriminate without any ambiguity between a monolayer graphene and a misoriented bilayer because their Raman fingerprint are identical. The spectra and extinction coefficient of a monolayer, a Bernal stacked bilayer noted AB, and a misoriented bilayer noted AA' are shown in Figure 1.

References

[1] K.S. Novoselov, A.K. Geim, S.V. Morozov, D.Jiang, Y.Zhang, S.V. Dubonos, I.V. Grigorieva and A. A. Firsov, Science 306 (5696), (2004) 666-669.
[2] A.H. Castro-Netto, F. Guinea, N.M.R. Peres, K.S. Novoselov, and A.K. Geim, Rev. Mod. Phys. **81**, (2009) 109.
[3] Y. Hernandez, V. Nicolosi, M. Lotya, F.M. Blighe, Z. Sun, S. De, I.T. McGovern, B. Holland, M. Byrne, Y.K. Gun'Ko, J.J. Boland, P. Niraj, G. Duesberg, S. Krishnamurthy, R. Goodhue, J. Hutchison, V. Scardaci, A.C. Ferrari and J.N. Coleman, Nature Nano. **3**, (2008) 563.
[4] P.W. Sutter, J.I. Flege, and E.A. Sutter, Nat. Mater. **7**, (2008) 406.
[5] A. Dato, V. Radmilovic, Z.H. Lee, J. Phillips and M. Frenklach, Nano Lett. **8**, (2008) 2012.
[6] C. Berger, Z.M. Song, X.B. Li, X.S. Wu, N. Brown, C. Naud, D. Mayo, T.B. Li, J. Hass, A.N. Marchenkov, E.H. Conrad, P.N. First, and W.A. de Heer, Science **312 (5777)**, (2006) 1191.
[7] J. Hass, R. Feng, J.E. Millan-Otoya, X. Li, M. Sprinkle, P.N. First, W.A. de Heer, E.H. Conrad and C. Berger, Phys. Rev. B **75**, (2007) 214109.

[8] K.V. Emtsev, A. Bostwick, K. Horn, J. Jobst, G.L. Kellogg, L. Ley, J.L. McChesney, T. Ohta, S.A. Reshanov, E. Rotenberg, A.K. Schmid, D. Waldmann, H.B. Weber and T. Seyller, Nature Mat. **8**, (2009) 203.
[9] C. Virojanadara, M. Syvajarvi, R. Yakimova, L. I. Johansson, A. A. Zakharov and T. Balasubramanian, Phys. Rev. B **78**, (2008) 245403.
[10] N.Camara, J.R. Huntzinger, G. Rius, A. Tiberj, N. Mestres, F. Perez-Murano, P. Godignon and J. Camassel, Phys. Rev. B **80**, (2009) 125410.
[11] A.C. Ferrari, J.C. Meyer, V. Scardaci, C. Casiraghi, M. Lazzeri, F. Mauri, S. Piscanec, D. Jiang, K.S. Novoselov, S. Roth and A.K. Geim, Physical Review Letters **97 (18)**, (2006) 187401.
[12] R. R. Nair, P. Blake, A. N. Grigorenko, K. S. Novoselov, T. J. Booth, T. Stauber, N. M. R. Peres, and A. K. Geim, Science **320**, (2008) 1308.

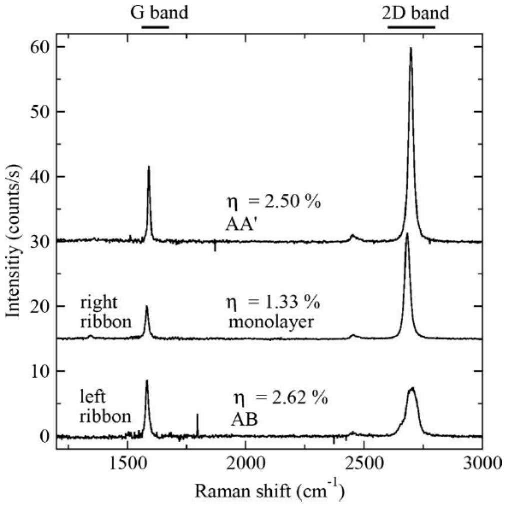


Figure 1: Raman spectra collected in the middle of different graphene ribbons with the corresponding relative extinction coefficient η=ΔT/T0. From top to bottom a misoriented bilayer (AA'), a monolayer and a Bernal stacked bilayer (AB) from [10].

KEYNOTE SPEAKERS

PARALLEL SESSIONS

Acute toxicity of Cobalt Ferrite and Gold nanoparticles: *in vitro* and *in vivo* study

Miquel Borràs[1], Constança Porredon[1], Leire Goikoetxea[2], Judith Sendra[3], Nerea Briz[2], Joaquin de Lapuente[1], Noelia Alvarez[2] and Ainhoa Egizabal[2]

[1] Unitat de Toxicologia Experimental i Ecotoxicologia, Parc Científic de Barcelona, (Spain)
[2] INASMET TECNALIA, Donostia, (Spain)
[3] ENDOR Nanotechnologies, Barcelona, (Spain)

Men are in contact with natural NPs through the environment. Moreover, engineered NPs are increasingly becoming a significant part of everyday life and in the biomedical field they are very promising tools to be used as drug delivery and diagnostic systems.

A reduction of toxic effects is one of the general goals of nanotechnology in the biomedical field. Indeed, the possibility of administering lower equipotent doses and the improved targeted delivery may lead to this end. However, due to its distinctive physicochemical and kinetic characteristics, the ability of NPs to cross barriers and to reach less accessible targets, and the fact that their mechanisms of interaction with cells are largely unknown, their toxic effects must be established, but its assessment present special challenges. Its behaviour toward biological systems is influenced by many factors including shape, coatings and their inherent heterogeneous size distribution. On the other hand, in NPs the internalization process becomes a crucial event and should be carefully characterized. In that complex context toxicological methods adapted to these new materials should be developed.

NANOSOST is a Singular Project of the Spanish Ministry of Science and Innovation that address the safety of nanoparticles, its production and its different industrial uses with a broad scope.

Within the frame of NANOSOST, we have tested the toxicity of 3 kinds of nanoparticles (NPs): gold (AuNP), gold coated by hyaluronic acid (AuNP coated by HA) and cobalt ferrite ($CoFe_2O_4$ NP). The diameters of these NPs were 10,45nm, 30nm and 17nm, respectively.

We studied the acute toxicity in rats by intraperitoneal (IP) administration. The specific aim of the study was to determine a DL_{50} by the Up&Down protocol and compare these results with the values obtained in parallel for gold (III) chloride (HAuCl4) and $CoFe_2O_4$ in solution. Toxicity was studied by clinical signs, necropsy, hematological parameters and histopathological exam of kidney, liver, spleen and lung. At the same time, biodistribution by TEM (liver, spleen, kidney and lung) and ICP-MS of different tissues (liver, spleen, pancreas, lymph node, kidney, lung and brain) at 14 days from the administration was assessed.

On the other hand, the aforementioned nanoparticles were tested in vitro for cytotoxicity and mutagenicity. The cytotoxicity was assessed in LLC-PK1 and Hep2 (representing potential target organs following systemic administration) by means of WST-1 and LDH methods. Bacterial mutagenicity was assessed in 4 *Salmonella thyphimurium* and 1 *Escherichia coli* strain with and without metabolic activation according to Ames protocol. Additionally, the uptake of the NPs by cells was studied by fluorescence microscopy and ICP-MS.

The results of these studies are presented, and the pitfalls of the classical methods when dealing with NPs are discussed.

Microcavity-mediated coupling of two distant semiconductor quantum dots

J.M. Calleja

Universidad Autónoma de Madrid-Física de Materiales (Spain)

Long distance (1,4 μm) interaction of two InAs/GaAs quantum dots (QD) in a photonic crystal microcavity is observed. Individual and simultaneous coupling of the QDs to the cavity mode is probed by Purcell effect as well as by changes in emission intensity and polarization upon detuning Δ. For one of the QDs the polarization angle Φ continuously rotates from perpendicular to parallel to the cavity mode upon changing its detuning. It follows the empirical law $\Phi = \text{atan}(\Delta/b)$, reversing sign for negative detuning. Inter-QD coupling is demonstrated by resonant optical excitation in the p-states of any of the quantum dots, which results in an increase of the s-state emission of both quantum dots and the cavity mode. The cavity-mediated coupling can be controlled by varying the excitation intensity. These results represent an experimental step towards the realization of quantum logic operations using distant solid state qubits.

Molecular Biradicals: Towards Functional Nano-Scale Biradicals

Juan Casado, Juan T. López Navarrete

Department of Physical Chemistry, University of Málaga,
Campus de Teatinos s/n, Málaga, Spain
casado@uma.es

Molecular radicals and biradicals have been largely understood in chemistry as reactive intermediates in chemical reactions (i.e., organic and electrochemical processes, polymerization initiators, etc.). Many examples however exist in the recent literature concerning molecular stable radical units used as the basic components of organic-based magnetic materials[1]. A requirement for these substrates to be active as magnets is ferromagnetic coupling between the basic molecules bearing the unpaired electrons: through space magnetic exchange is the most common mechanism of spin alignment giving rise to the ferromagnetic materials[2]. These exchange interactions are usually small and a strong temperature dependence of the macroscopic magnetic property is observed. Often low temperature magnets are obtained and only a few of these are still active at room temperature. Another exigent quest for magnetic molecules is the ability to combine electron conduction and spin transport, two requirements needed for spintronics [3]. For the advance of this field, it would be necessary to conceive relative large conjugated radicals capable of stabilizing the injected charge and facilitate electron transport. At this point molecularly stable biradicals with aligned spins, or triplets, might offer reliable alternatives for spintronic substrates, since the net spin of the triplet resides in large conjugated units very favourable for electron migration.

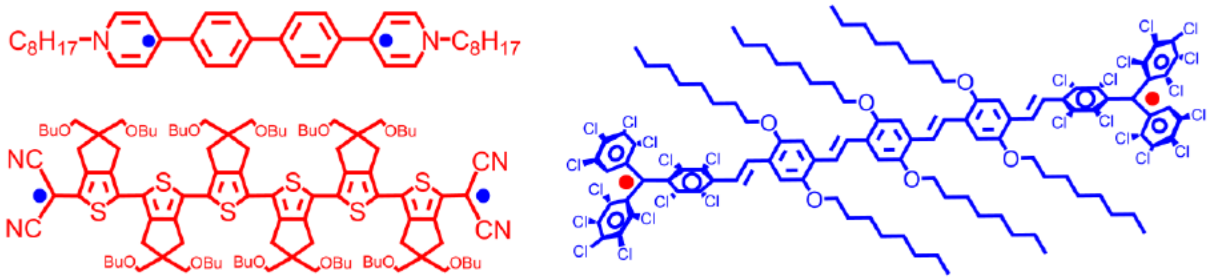


Figure 1. Triplet species residing either in the ground (blue) or in very low lying energy excited states (red).

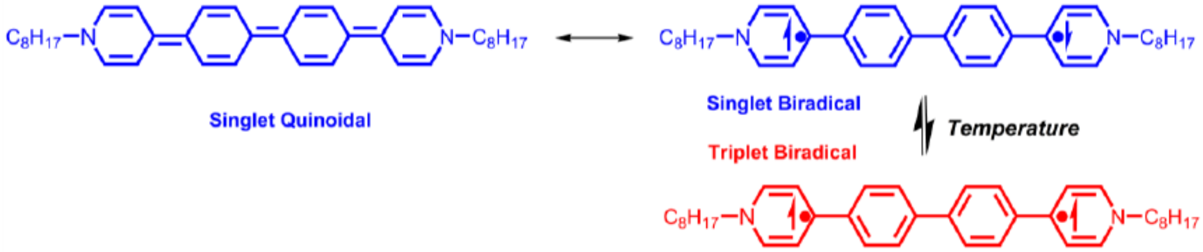


Figure 2. Closed and open shell forms of the singlet ground state in equilibrium with the triplet of the viologens.

In this keynote, a few concepts and examples of large-size conjugated molecules having an active triplet species either as the ground electronic state or as the lowest lying energy excited state are described together with their thermal interconversion. In Figure 1, the molecular structures of these examples are depicted. In the first two cases, based on quinoidal viologens and oligothiophenes, the triplet states are the first lowest lying excited states and are in thermal equilibrium with the singlet biradical ground electronic states. The thermal modulation between the low and high spin states allows the thermal switching between an "on" and an "off" magnetic state. The concepts exploited in these two cases are the pro-aromatic character of the quinoidal platforms for which, given a certain number of pro-aromatic units, the system "prefers" to break a double bond generating two unpaired electrons being the promoters of the magnetically active triplets such as depicted in Figure 2. The third example represents the opposite situation.

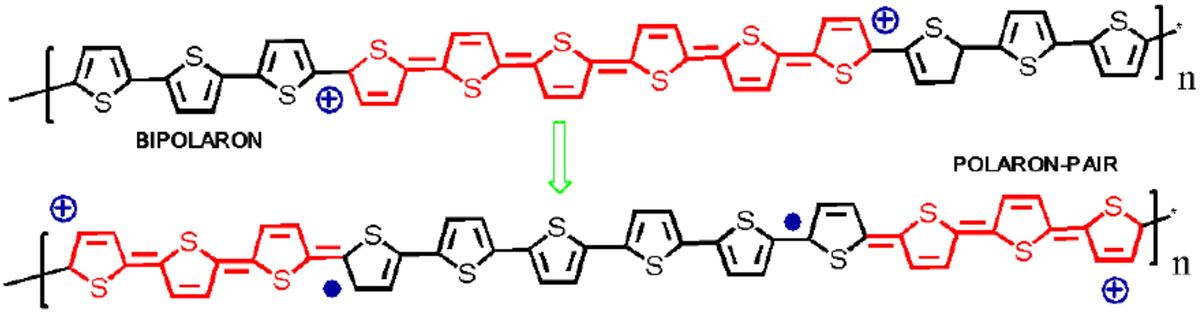


Figure 3. Bipolaron to polaron-pair balance in long oligothiophene dications.

In the last example of this keynote, our interest turns to the charge carrier determination in heavily doped (i.e., oxidized) polythiophene. Here it will present new Raman spectroscopic data in a twelve-thiophene model dication and that are in line with the existence of well separated two polarons instead of a confined bipolaron, or polaron-pair. In addition, it is proved that these are not two independent polarons or radical cations but their spins are coupled giving rise to a singlet biradical and, much more interesting, to a triplet biradical with exploitable magnetic properties. These Raman data are extended to the case of the conducting polythiophene where the possible presence of thermal magnetism would confer to the polymer an additional property complementing its electrical conductivity.

In summary, four examples of long conjugated molecules having a biradical structure acting on it have been described based on their spectroscopic properties, mainly Raman vibrational spectroscopy. The search of these species supposes the description of nano-sized spin bearing molecules which can act as building blocks for nano-structures with potential applications in a variety of multifunctional devices, single molecules devices among many others.

References:

[1] E. Coronado, F. Palacios, J. Veciana, Ang. Chem. Int. Ed. **42** (2003) 2570. V. Mereacre, M. Nakano, J. Gómez, I. Imaz, C. Sporer, K. Wurst, J. Veciana, C. Turta, D. Ruiz-Molina, P. Jaitner, Chem. Eur. J. **12** (2006) 9238-9254.
[2] V. Barone, A. di Matteo, F. Mele, Iberio de P. R. Moreira, F. Illas, Chem. Phys. Lett. **302** (1999) 240.
[3] S. A. Wolf et al., Science **294** (2001) 1488.
[4] J. Casado, S. Patchkowskii, M. Z. Zgierski, L. Hermosilla, C. Sieiro, M. Moreno Oliva, J.T. López Navarrete, Angew. Chem. Int. Ed. **47** (2008) 1443.
[5] R. Ponce Ortiz, J. Casado, V. Hernández, J.T. López Navarrete, P.M. Viruela, E. Ortí, K. Takimiya, T. Otsubo, Angew. Chem. Int. Ed., **46** (2007) 9057.
[6] J. Casado, K. Takimiya, T. Otsubo, F.J. Ramírez, J.J. Quirante, R. Ponce Ortiz, S.R. González, M. Moreno Oliva, J.T. López Navarrete, J. Am. Chem. Soc. **130** (2008) 14028.
[7] Y. Ie, A. Han, T. Otsubo, Y. Aso, Chem. Commun., (2009), 3020.

Governance of nanotechnologies: some socio-legal impacts

Garcia Hom, Anna
Moles i Plaza, Ramon-Jordi

GRISC (Governance of Risk Research Centre), Vila Universitària, Edifici Blanc. Campus de la UAB.
Bellaterra (Cerdanyola del Vallès), Spain
Anna.garcia@uab.cat
Ramon.moles@uab.cat

Nanotechnologies constitute an emerging area of knowledge with an enormous capacity for impact on the world economy and on science itself. Current research and activities related to nanotechnologies will undoubtedly have a massive social impact (McDonald, 2004). In fact, they constitute one of the areas of scientific research that has experienced the largest growth over the last few decades. The need to address social concerns in the early stages of research and development has been recognised as fundamental, especially in the light of recent controversy on the possible risks associated with certain types of technology (EU, 2004). Examples such as GMOs, nuclear energy and mobile phone masts are phenomena that have led to rejection and conflict simultaneously with their introduction (Walls, et al, 2005). Due to the extremely broad range of potential applications available using nanotechnology and the wide range of characteristics offered by manufactured nanomaterials, research is necessary into public opinion that either facilitates or places obstacles in the path of the development of these technologies in society according to perceptions of the benefits or risks associated with them. In this context, the surge in public debate on the health, technological, regulatory and social implications of nanotechnologies has intensified in recent years. Therefore, in the context of an emerging technology that is partially characterised by uncertainty, two questions and/or hypotheses stand out as being inevitable: the relevance of public opinion in the introduction and development of emerging technologies in general, and nanotechnologies in particular, which are mainly the result of the perceptions and knowledge that people have about them, and on the other hand, the problems that the different regulatory procedures have posed to date in some legislation Regulation of the use and applications of nanosciences and nanoapplications have therefore become a growing focus for attention in the European Area insofar as there are many questions still to be answered in this field concerning potential risks for health and the environment. In a regulatory sense the challenge here is to account for the potential benefits of N+N, minimising the risks through high level protection of health, safety and the environment in fields where nanomaterials are used. To achieve this there is an urgent need to analyse the need for adaptation of Spanish legislation to the proposals of the European Commission. These demand a Spanish regulatory framework for N+N, detailed knowledge of both NNG (materials nanogroups, products and applications based on N+N) which may be the object of regulation in Spain, and the current Spanish regulatory framework in order to identify where the inefficiencies in it lie.

Characterization of MMX polymers by conductance AFM: a new type of molecular wires.

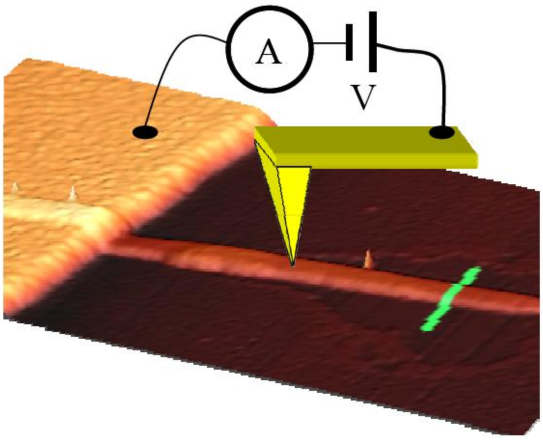
J. Gómez-Herrero L. Welte1, A. Calzolari, R. di Felice and F. Zamora
Universidad Autónoma de Madrid
Julio.gomez@uam.es

Conductance atomic force microscope (CAFM) is a powerful tool to characterize the electrical conductivity of nanowires [1,2]. In particular CAFM has been extensively used to measure the electrical transport properties of carbon nanotubes [3,4,5], DNA [6] . Carbon nanotubes present outstanding electrical transport properties however it is difficult to envision how to selforganize them on surfaces, a basic requirement for molecular circuitry.

We present a new candidate to molecular wire based on a particular type of coordination polymer known as MMX [7. These polymers are usually obtained as crystals and can be described as an infinite sequence of dimetalic units linked by a ligand (usually a halogen), the chains interact through weak van der Waal forces. In the talk I will address the method to produce highly conductive nanometer bundles of a platinum based MMX [8] polymer on insulating surfaces with a detailed description of the CAFM technique used to characterize the wires.

References

[1] C. Gómez-Navarro, P.J. de Pablo, J. Gómez-Herrero, B. Biel, F.J. García Vidal, A. Rubio and F. Flores. Nature Materials 4, 534 (2005)
[2] X. D. Cui, A. Primak, X. Zarate, J. Tomfohr, O. F. Sankey, A. L. Moore, T. A. Moore, D. Gust, G. Harris, and S. M. Lindsay. Science 294, 571, (2001)
[3] P.J. de Pablo, C. Gomez-Navarro, J. Colchero, P.A. Serena, J. Gomez-Herrero, A.M. Baro. Phys. Rev. Lett. 88, 36804-36808 (2002)
[4] Mc. Euen J.Y. Park, S. Rosenblatt, Y. Yaish, V. Sazonova, H. Ustunel, S. Braig, T.A. Arias, P.W. Brouwer, P.L. McEuen. Nano Letters, 4, 517, (2004)
[5] P. Sundqvist, F.J. Garcia-Vidal, F. Flores, M. Moreno-Moreno, C. Gomez-Navarro , J.S. Bunch, J. Gomez-Herrero. Nano Lett., 7, 2568. (2007)
[6] P. J. de Pablo, F. Moreno-Herrero, J. Colchero, J. Gómez Herrero P. Herrero, A.M. Baró, Pablo Ordejón, Jose M. Soler and Emilio Artacho. Phys. Rev, Lett .85, 4992 (2000)
[7] L. Welte, A. Calzolari, R. di Felice, F. Zamora and J. Gomez-Herrero.. Nature Nanotechnology 5, 110, (2010).
[8] L. Welte, U. García-Couceiro, O. Castillo, D. Olea, C. Polop, A. Guijarro, A. Luque, J. M. Gómez-Rodríguez, J. Gómez-Herrero, Félix Zamora. Adv. Mat., 21, 2025, (2009)



Biocompatibility and immune response to nanoparticles: a key issue.

África González-Fernández[1], Belén Díaz Freitas[1], Christian Sánchez-Espinel[1], Andrea Hernández[1],
Mercedes Peleteiro[1], Tamara Lozano[1], Isabel Pastoriza[2], Luis Liz-Marzán[2], Jesus M de la Fuente[3], Valeria Grazú[3], Angela Franca[1].

[1]Inmunología y Unidad Compartida con Complejo Hospitalario Universitario de Vigo and
[2]Dept. Química Física and Unidad Asociada CSIC, University of Vigo,
Campus As Lagoas Marcosende, Vigo 36310, Spain
[3]Biofunctional Nanoparticles and surfaces group, Aragon Nanoscience Institute (INA), University of Zaragoza,
Pedro Cerbuna 12, 50009 Zaragoza, Spain

africa@uvigo.es

Nanotechnology is finding growing applications in industry, biology, and medicine. Nanoparticles (NPs) can offer many advantages over traditional drug design and delivery, as well as toward medical diagnostics. The use of nanostructures in biomedical applications could show clear benefits, but some issues such as **toxicity and immunogenicity** must be carefully considered. In addition, as with any medical device or pharmaceutical drug intended to be used for *in vivo* biomedical application, NPs must be **sterile** and several changes can be produced during lyophilisation (Figure 1) or depending on the method of sterilization (Figure 2).

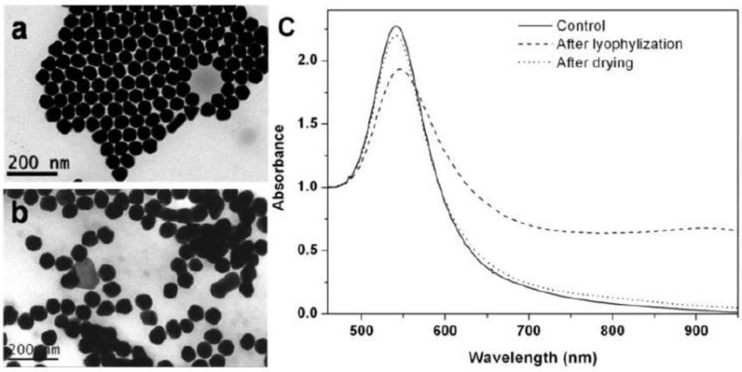


Figure 1 TEM images of Au@PEG NPs before (a) and after (b) lyophilisation. UV-visible spectra (c) of Au@PEG NPs in PBS solution of control (solid line), after lyophilisation (dashed line) and drying (dotted line).

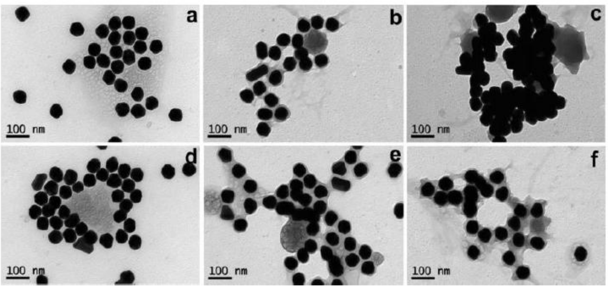
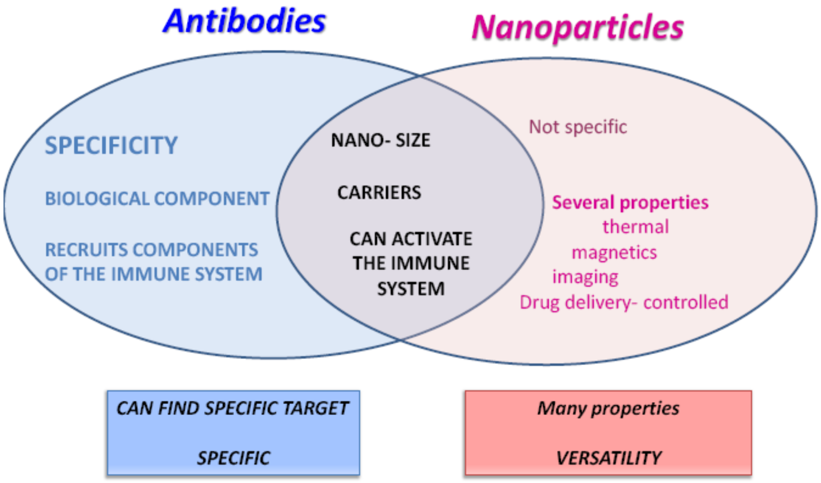


Figure 2 Representative TEM images showing the effect of the different sterilization procedures on Au@PEG NPs: a) control, b) UV, c) gas plasma, d) ethylene oxide, e) formaldehyde and f) autoclave.

Immunogeniciy is another important issue. Nanoparticles can induce inflammation (complement activation, cytokine secretion, production of reactive oxigen species), actívate phagocytosis and immune responses (allergy, antibody production) that it should be correctly addressed before their use *in vivo*. Finally, the conjugation of antibodies to nanoparticles can generate a product that combines the properties of both, showing versatility and specificity, but also can increase their immunogenicity.

What antibodies can offer to NPs and what NPs can offer to Abs



Open Innovation in Russia and CIS

Albert Gozal

ISTC, Krasnoproletarskaya 32, Moscow, Russia
gozal@istc.ru

The International Science and Technology Center (ISTC) is an intergovernmental organization dedicated to international scientific cooperation. Founded on the basis of an international agreement signed by the European Union, Japan, Russian Federation, and the United States of America in 1994, and in 2004 by Canada, ISTC coordinates the efforts of numerous governments, international organizations and private sector organizations, providing scientists from Russia, Georgia and other countries of the Commonwealth of Independent States (CIS) opportunities towards meeting the technological and R&D demands of international business and industry.

Objectives: Support the transition to market-based economies; Contribute to solving national and global technological problems; Encourage the integration of Russian, Georgian and CIS scientists into the international scientific community; Support basic and applied research.

The International Science and Technology Center (ISTC) based in Moscow, works with both governmental and commercial organizations to source highly skilled scientists and research project teams and promotes high-tech innovation developments. ISTC also offers full project management services that take forward R&D projects and partnerships. EU private companies, government agencies and nongovernmental organizations can access the services of ISTC by applying to become an ISTC Partner through a no-cost application procedure.

EU's Role in the ISTC: EU is one of the main contributors to the ISTC since its establishment. EU directly supports the operation of the Moscow-based ISTC Secretariat, including EU staff. Since 1994, EU has contributed over M$ 238.5 to support scientists through the ISTC and has funded over 965 projects involving more than 41570 scientists with a number of private organizations, institutions and individuals acting as non-funding collaborators. Moreover, EU has over 55 private and governmental Partners at the ISTC which funded 115 R&D projects managed by ISTC in Moscow for an amount of M$40.9.

What ISTC offers to EU organizations?

Cost-Free Technology Searches – With a network of over 900 prestigious institutes and more than 70,000 expert scientists, ISTC provides a cost-free service to assist EU business and research community to identify appropriate research teams and potential R&D partners in Russia, Georgia and CIS

Specialist Project Teams – ISTC can assemble expert project teams to identify and develop near-to market technologies of interest to EU business and research community.

Introduction and Travel Support – ISTC, can support scientists travel to meet potential EU business and research community partners in order to develop Partner Projects, provides bilingual staff to assist Partners with meeting arrangements, visa support and access to specialist research institutes as appropriate. On request ISTC can organize match-making meetings, thematic workshops and seminars.

Professional Project Management – ISTC offers full in-country project management services for R&D projects at 5% of total project cost **(0% up to end 2010)** and low-cost R&D incentives

Up to €30,000 Project Preparation Funding Support – EU Partners of the ISTC can apply for funding of up to 50 per cent (to a maximum of €30,000) towards a first-time R&D Partner Project Preparation. This is a new initiative supported by the EU, via ISTC

Further Benefits include – Customs and duty-free imports of equipment used in projects, direct and tax-free payments of grants to scientists working on EU partner projects, full on-site project monitoring by ISTC professional staff and the ISTC Partner has complete control of all project funds.

As an **example** I shall speak briefly of some ongoing research in Russia in the field of nanotoxicology,

1-Toxicological and medical and hygienic aspects of nanoproducts manufacturing and application (Boris N. Filatov,*Research Institute of Hygiene, Toxicology and Occupational Pathology, Volgograd, Russia)*

Nanotechnology is _the ability to create products with a pre-set atomic structure_ by atomic and molecular manipulation. Behavior of nanomaterials entering human organism depends on materials' chemical composition, molecular size and shape, surface charge, amount, and solubility. Bioaccumulation and stability may also affect nanoparticles' behavior. Nanoparticles' characteristics and those of atoms used in synthesis may differ.

Some significant gaps in nanotoxicological assessment data, mainly in occupational safety standards development and emerging nanoproducts application, should be outlined.

Most of nanotoxicological investigations have been performed in vitro using cell cultures; in case of lab animals only preliminary studies have been carried out. In point of nanotechnology safety hygienic standards, no adequate studies have been carried out related to working area and environment hazard assessment and product hazard assessment.
There is a requirement of comprehensive nanotechnology and nanoproducts toxicometric research used for development of occupational safety hygienic standards related to chemical industry and toxicological drug testing. From experience to date, it is clear that critical overview of the available data as well as new and highly designed research conducting are required to evaluate nanoparticles' ecotoxicity and the distinctions between nanoparticle properties and those of the same substance bulk formulations. The Institute has entered on case study with the toxicological assessment of gold nanoparticles.

2- Zinc Nanoparticles Toxicity And Biological Properties (Skalny A.V., Glushchenko N.N., *Institute of Toxicology, Russian Federation, Saint-Peterburg, Russian Federation and Institute of Energy Problems of Chemical Physics – Russian Academy of Sciences, Moscow, Russian Federation)*

At present the nanotechnology allows to obtain metal nanoparticles with given physicochemical and biological properties. However during the development of new drugs with metal nanoparticles the assessment of nanoparticles toxicity becomes task of primary importance. We studied the toxicity of zinc nanoparticles: MPD (maximum permissible dose), LD50, LD100. We have shown that in the range of doses 0.05-100 mg/kg zinc nanoparticles exert biotic action i.e. accelerate metabolic processes, in the range of doses 100-450 mg/kg there's a safety zone, doses more than 450 mg/kg are toxic ones. LD50 of zinc sulfate is 28 times lower comparing with LD50 of zinc nanoparticles. We have also shown that the introduction of zinc nanoparticles reduces voluntary alcohol use and reduces by 40% the animal mortality after alcohol intoxication. The mechanism of protecting action of zinc nanoparticles has been studied.

3-Estimation of genotoxic effect of nanomaterials (L.P.Sycheva, Y.A.Revazova, V.S.Zhurkov, A.N. Sysin Research Institute of Human Ecology and Environmental Health of Russian Academy of Medical Science, Moscow)

Nanomaterials (NM) are characterized by a number of features, which demand an estimation of suitability and sufficiency of existing approaches of a studying of toxicity and genotoxicity of chemicals. So, the NM are characterized by high permeability in bodies, organs, tissues and cells; an induction of free radicals, including active forms of oxygen and nitrogen; damage of cell structure; ability of some NM to penetrate through karyolemma to nucleus; conjugation with DNA; structure of some NM including atoms of chemicals, possessing cancerogenic action, for example, cadmium or arsenic; similarity in a structure of some NM with asbestos fibers which are genotoxic and cancerogenic. The analysis of the literature shows, that NM genotoxic activity is not studied almost. Available data are received on the limited quantity of NM, basically, in experiences in vitro. On the other hand, even this small number of works specifies ability of NM to induce DNA-damage, chromosomal aberrations, micronuclei, aneuploidy. Consequences genotoxic actions of NM are recently revealed: ultrathin particles of titan dioxide (<100 nanometers in diameter), caused fibrosis and a cancer of a lung in rats. The basis of a system for estimation of genetic safety of NM can be a standard approach to an estimation of mutagen properties of the chemical compounds. The system should include polyorgan micronucleus test in vivo with analysis of cell proliferation and apoptosis.

New Opportunities for Diagnostics using Nanobiotechnological Approaches

Prof. M.-Pilar Marco

Applied Molecular Receptors Group (AMRg).(IQAC-CSIC http://www.iiqab.csic.es/amrg).
(CIBER-BBN. www.ciber-bbn.es). Jorge Girona, 18-26, 08034-Barcelona, Spain

pilar.marco@cid.csic.es

Nanobiotechnology has a great impact in science, particularly on healthcare, as result of the confluence of physical sciences, molecular engineering, biology, biotechnology and medicine. Research in nanobiotechnology provides tools to understand mechanisms of disease, improving molecular diagnostics and new strategies for drug discovery and delivery. The so-called "nanodiagnostics" and "nano-pharmaceuticals" are two of the most important areas in nanomedicine [1]. Nanodiagnostics or "nanomolecular diagnostics" refers to the use of nanobiotechnology in molecular diagnostics based on the use of molecular technologies (nucleic acids, antibodies, enzymes, etc) to elucidate, diagnose or monitor human diseases. A wide range of inorganic nanodevices or nanostructures, including nanoparticles, are being investigated in combination with bioreceptors to detect (bio)markers of disease of food/environmental contamination. On the other hand, due to the inherent nanoscale of bioreceptors and other functional cell components, the development of nanoscale probes becomes an attractive approach to investigate mechanism of disease and to develop in vivo or in vitro early diagnostic approaches.

In this communication, the potential of the nanobiotechnology to develop improved in vitro diagnostic approaches will be presented through examples of the research conducted at the Applied Molecular Receptors Group (AMRg) of the IQAC-CSIC. The unique properties of the materials at the nanolevel have opened the opportunity to develop novel diagnostic approaches making use of nanoparticles as tag systems. Moreover, the increased miniaturization possibilities in the semiconductor industry has resulted in faster and more powerful computing and instrumentation devices. Research in nanobiotechnology has allowed developing approaches to construct functional multiplexed (bio) hybrid biomaterials through novel approaches such as DNA-directed immobilization(DDI) strategies [2], that can be integrated on well-designed integrated or lab-on a chip devices to develop biosensors with improved features and novel capabilities. Thus, based on the well-know plasmon resonance effect generated at the surface of a metal (usually Ag or Au) by an electric field (light) at an appropriate wavelength and incident angle, SPR biosensors (surface plasmon resonance) with improved features have been developed. Recently, Homola et al. [3] reported a highperformance SPR sensor based on a novel approach that employs a special diffraction grating structure which simultaneously couples light into a surface plasmon and disperses the diffracted light for spectral readout of SPR signal (SPR Coupler and Disperser, SPRCD). Combined with a set of microfluidic channels parallel to the plane of diffraction and appropriate designed broad-selectivity antibodies, we have demonstrated that the sensor can be used to detect contamination of milk samples by antibiotics with an excellent detectability [4].

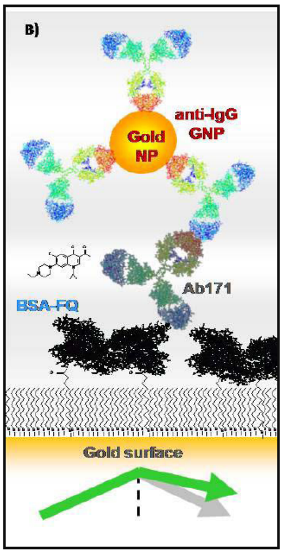
A step forward on the use of the plasmon resonant properties of the materials is the use of particles for biological detection. Thus, colloidal gold or silver particles, typically 10-120 nm in diameter, are plasmon resonant (PR). The particle geometric confinement of the surface plasmon gives rise to a spectral resonance in the visible spectra at frequency band (specific color) that is a function of the size, shape and material properties of the particle. Variations in the refractive index around the nanoparticle surface also affect the resonance peak (frequency band of the scattered light), which allows monitoring biomolecular events taking place close to the surface of these nanoparticles through simpler optical configurations. Recently, we have demonstrated the potential of this approach to detect small concentrations of anabolic androgenic steroids[5].

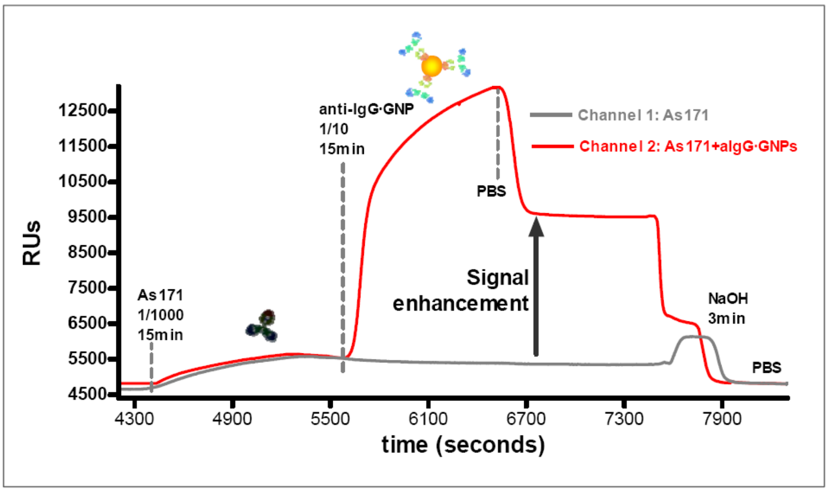
On the other hand, detectability of the known SPR sensors based on the resonance of thin film metals can be significantly enhanced by using gold nanoprobes, antibodies tagged with gold nanoparticles (AuNP) as it will shown in this communication.

References

[1] Jain, K. K. *The handbook of Nanomedicine*; Humana Press: Totowa, USA, 2008.
[2] Tort, N.; Salvador, J. P.; Eritja, R.; Poch, M.; Martinez, E.; Samitier, J.; Marco, M. P. *Trac-Trends in Analytical Chemistry* **28**, (2009), 718.
[3] Piliarik, M.; Vala, M.; Tichy, I.; Homola, J. *Biosens Bioelectron* **24** (2009), 3430.
[4] Fernández, F.; Hegnerova, K.; Piliarik, M.; Sanchez-Baeza, F.; Homola, J.; Marco, M.- P. submitted.

[5] Kreuzer, M.; Quidant, R.; Salvador, J. P.; Marco, M. P.; Badenes, G. *Analytical and Bioanalytical Chemistry* **391**, (2008) 1813.





Functional Molecular Self-Assembled Monolayers

M. Mas-Torrent,[a] N. Crivillers, [a] C. Simao, [a] J. Veciana, [a] C. Rovira, [a] C. Ocal, [a] B. J. Ravoo, [b] S. De Feyter, [c] R. Lazzaroni [d]

[a] Institut de Ciència de Materials de Barcelona (CSIC), Campus de la UAB E-0183, Bellaterra,, Spain
[b] Laboratory of Supramolecular Chemistry and Technology MESA+ Research Institute, University of Twente, P.O. Box 217, NL-7500 AE Enschede, The Netherlands
[c] Katholieke UniVersiteit LeuVen, Celestijnenlaan 200-F, 3001 Heverlee, Belgium
[d] Université de Mons-Hainaut, 20, Place du Parc, B-7000 Mons, Belgium
mmas@icmab.es

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 device implementation the immobilisation of functional molecules on surfaces is also often required. Here, we describe the preparation of self-assembled monolayers (SAMs) of multifunctional polychorotriphenylmethyl (PTM) radicals on different substrates (SiO_2, Au and ITO) (Figure 1) [1-2].

The family of PTM radicals is highly stable due to the fact that their open-shell centres are shielded by six bulky chlorine atoms.[3] These radicals are colored and also exhibit fluorescence in the red region of the spectra. PTM radicals are also electroactive and can be easily and reversibly reduced (or oxidized) to their anionic (or cationic) species. The oxidised and reduced states show different absorption spectra than the radical and are in addition non magnetic and non fluorescent. Thus, the preparation of SAMs functionalised with PTM radicals on substrates results in multifunctional surfaces which are electrochemically, optically and magnetically active. We also demonstrate that these SAMs can be used as chemical and electrochemical redox switches with optical and magnetic response (Figure 2).

Also, PTM SAMs can be employed as molecular wires. Very recently two different SAMs based on the closed and open-shell form of a PTM derivative were prepared and the conductivity through these SAMs was investigated by the 3D mode SFM.[4] These two systems exhibited small differences in their molecular structure but large differences in the electronic structure, which dramatically influenced the transport properties, being the radical SAMs much more conducting than the close-shell form.

The self-assembly by physisorption of novel PTM radicals bearing long alkyl chains at the liquid-graphite interface was also investigated. We show that the PTM hierarchical self-assembles giving rise to 3-dimensional ordered nanostructures forming double rows composed by a magnetic core of radicals surrounded by alkyl chains [5].

In conclusion, the chemical flexibility and versatility of PTM radicals combined with their electrochemical and magnetic properties sheds lights on the huge potential of preparing surface self-assembled multifunctional molecular devices.

References

[1] N. Crivillers, M. Mas-Torrent, S. Perruchas, N. Roques, J. Vidal-Gancedo, J. Veciana, C. Rovira, L. Basabe-Desmonts, B-J. Ravoo, M. Crego-Calama, D. N. Reinhoudt, Angew. Chem. Int. Ed. **46** (2007) 2215.
[2] N. Crivillers, M. Mas-Torrent, J. Vidal-Gancedo, J. Veciana, C. Rovira, J. Am. Chem. Soc. **130** (2008) 5499.
[3] M. Ballester, J. Riera, J. Castañer, C. Badia, J. M. Monsó, J. Am. Chem. Soc. **93**, (1971) 2215.
[4] N. Crivillers, C. Munuera, M. Mas-Torrent, S. T. Bromley, C. Ocal, C. Rovira, J. Veciana, Adv. Mater., 21 (2009) 1177.
[5] *N. Crivillers, S. Furukawa, A. Minoia, A. Ver Heyen, C. Sporer, M. Mas-Torrent, M. Linares, A. Volodin, C. Van Haesendonck, M. Van der Auweraer, R. Lazzaroni, S. De Feyter, J. Veciana, C. Rovira,* J. Am. Chem. Soc. 131, (2009) 6246.

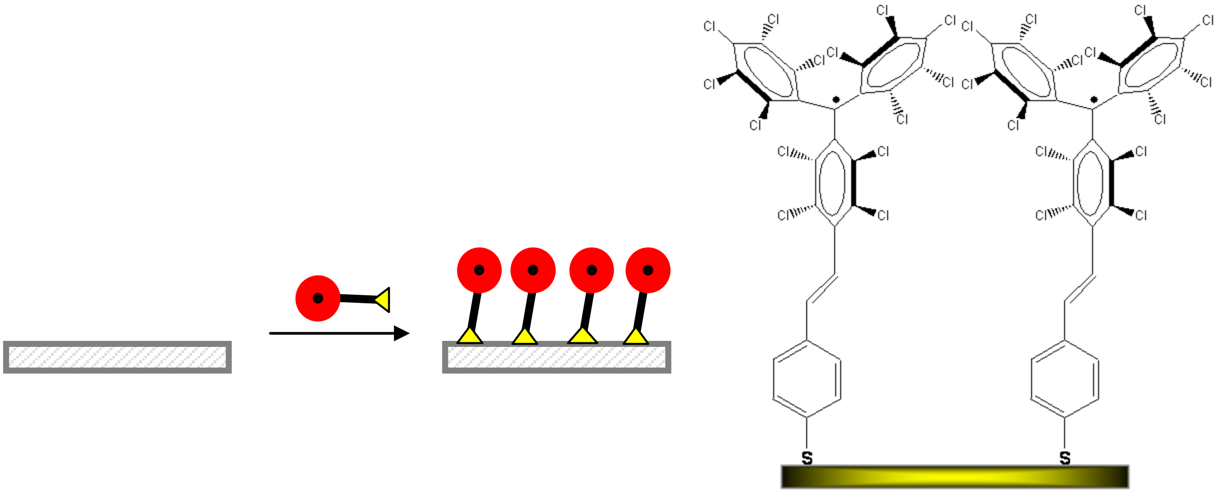


Figure 1. Scheme of a chemically-bonded PTM SAM.

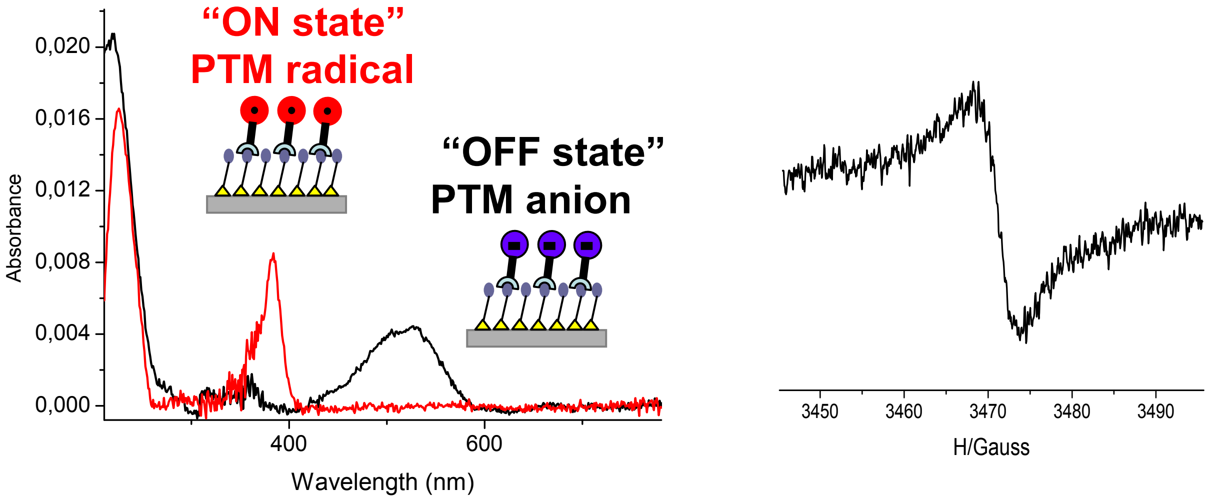


Figure 2. Left. Absorbance spectra of a PTM SAM that works as a molecular redox switch with optical and magnetic response. Right. EPR spectrum of a PTM SAM in the radical form demonstrating that the magnetic character is preserved on surface.

Governance of nanotechnologies: some socio-legal impacts

Garcia Hom, Anna
Moles i Plaza, Ramon-Jordi

GRISC (Governance of Risk Research Centre), Vila Universitària, Edifici Blanc. Campus de la UAB.
Bellaterra (Cerdanyola del Vallès), (Spain)

Anna.garcia@uab.cat
Ramon.moles@uab.cat

Nanotechnologies constitute an emerging area of knowledge with an enormous capacity for impact on the world economy and on science itself. Current research and activities related to nanotechnologies will undoubtedly have a massive social impact (McDonald, 2004). In fact, they constitute one of the areas of scientific research that has experienced the largest growth over the last few decades. The need to address social concerns in the early stages of research and development has been recognised as fundamental, especially in the light of recent controversy on the possible risks associated with certain types of technology (EU, 2004). Examples such as GMOs, nuclear energy and mobile phone masts are phenomena that have led to rejection and conflict simultaneously with their introduction (Walls, et al, 2005). Due to the extremely broad range of potential applications available using nanotechnology and the wide range of characteristics offered by manufactured nanomaterials, research is necessary into public opinion that either facilitates or places obstacles in the path of the development of these technologies in society according to perceptions of the benefits or risks associated with them. In this context, the surge in public debate on the health, technological, regulatory and social implications of nanotechnologies has intensified in recent years. Therefore, in the context of an emerging technology that is partially characterised by uncertainty, two questions and/or hypotheses stand out as being inevitable: the relevance of public opinion in the introduction and development of emerging technologies in general, and nanotechnologies in particular, which are mainly the result of the perceptions and knowledge that people have about them, and on the other hand, the problems that the different regulatory procedures have posed to date in some legislation Regulation of the use and applications of nanosciences and nanoapplications have therefore become a growing focus for attention in the European Area insofar as there are many questions still to be answered in this field concerning potential risks for health and the environment. In a regulatory sense the challenge here is to account for the potential benefits of N+N, minimising the risks through high level protection of health, safety and the environment in fields where nanomaterials are used. To achieve this there is an urgent need to analyse the need for adaptation of Spanish legislation to the proposals of the European Commission. These demand a Spanish regulatory framework for N+N, detailed knowledge of both NNG (materials nanogroups, products and applications based on N+N) which may be the object of regulation in Spain, and the current Spanish regulatory framework in order to identify where the inefficiencies in it lie.

Numerical analysis of the electromagnetic interaction of metallic nanoparticles with substrates

F. Moreno, P. Albella, J.M. Saiz and F. González

Grupo de Óptica. Departamento de Física Aplicada. Facultad de Ciencias. Universidad de Cantabria. 39005 Santander (Spain)

Nanostructures on or above substrates constitute an interesting configuration for nanotechnology applications. From biosensors (SERS) to microscopy with localized plasmons in nanoparticles (surface monitoring), this geometry exhibits very interesting properties worth to be analyzed. We present some recent research on the numerical analysis, by means of the DDA method (Discrete Dipole Approximation), of the electromagnetic interaction of a substrate with a metallic nanoparticle located either on the substrate or close to it. We focus our study in either the spectral behaviour of plasmonic resonances or in the polarimetric aspects. Concerning the latter, we show the interest of a particular measurement: the degree of linear polarization of the scattered light at right angles with respect to the incident beam.

Toxicological and Environmental Issues of Inorganic Nanomaterials

Isaac Ojea-Jiménez, Victor Puntes
Institut Català de Nanotecnologia, Campus UAB, Building Q (ETSE), 3rd floor, Cerdanyola del Vallés, 08193, Spain
Isaac.Ojea.icn@uab.es

Nanoscience envisages a new scientific frontier, in which materials on the length scale of some millions of a millimetre can be engineered. There are significant potential applications of nanotechnology for the benefit of mankind, these ranging from information technology, energy storage and harvesting, and radically new medical technologies: objects in the nanoscale interact with organisms in a fundamentally new way, thus creating common links between nanotechnology and biology. The development of durable, secure and reliable knowledge in this field will be an investment with lasting positive impact. Despite significant R&D investment over the last 10 years, several critical limitations to rapid implementation and commercialisation in a safe and responsible manner were not fully foreseen. The real unknown hazards and risks of nanomaterials, together with concerns about the reliability of current testing approaches have considerably been highlighted from science, media and even to the highest levels of government. In addition, manufacturing of standards and workplace practices of materials are not uniform across market sectors and in different parts of the world. In the absence of an understanding of what constitutes useful standards, the reputation of nanotechnology could be affected by the weakest players. For example, from conventional issues of impurities, wich are unconventionally present in nanomaterials, serious issues involving biocompatibility, stability and others have arisen.

Significant variability of reported biological and toxicity outcomes on nominally identical materials has caused controversy in science and media. Therefore it is crucial the need for standardization in nanotechnology, whether in academic research, regulatory or industrial areas, in order to converge on basic results from identical experiments. At this stage even simple issues must be resolved, such as the presentation of nanoparticulate positive controls, which have profound effect in the way that the community performs its work. Physicochemical and other analytical characterization in the biological and safety contexts are quite different from analysis of nanomaterials for other applications. However, some relevant physicochemical properties of nanomaterials are yet not fully understood. The fact that engineered structures have access to biological environments, combined with their unique (high surface-area) properties, implies that materials quality and reproducibility are important for long term in industry. There is a critical need to separate issues of quality from the tough questions of intrinsic nanoparticle safety.

The underlying theme should be a new quality-based research and application consensus where the emphasis is not just on the novelty of a given experiment, but also its reliability and robustness. And this should affect to all aspects of nanomaterials production, processing, characterization and analysis in a biological and environmental context.

References

[1] http://www.nanowiki.info/#nanotoxicology and references there in.

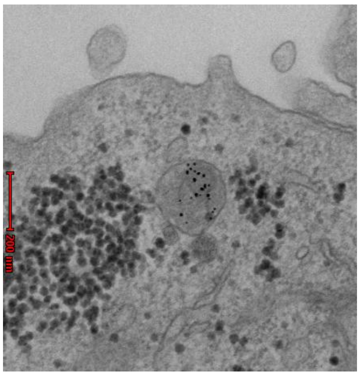


Figure 1. Nanoparticle internalization in HeLa cells

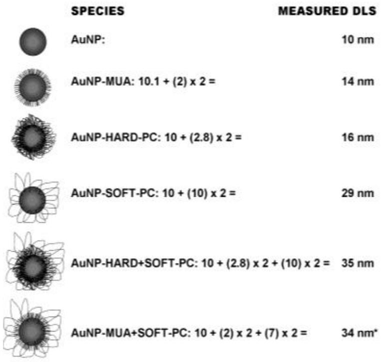


Figure 2. Different species of Protein Corona (PC) depending on size of the nanoparticle, after mixing with a biological media

Controlling light emission: from single molecules to random lasing

Riccardo Sapienza, Niek van Hulst
ICFO - Institut de Ciències Fotòniques Casteldefells, Barcelona
Marco Leonetti, P. David García, Marta Ibisate, J. Galisteo-Lopez, L. Froufe, Álvaro Blanco, Cefe López,
ICMM - Instituto de Ciencia de Materiales de Madrid (CSIC) and Unidad Asociada CSIC-UVigo, Madrid
Claudio Conti,
Research Center SOFT INFM-CNR, c/o Università di Roma Sapienza, I-00185 Rome, Italy
Jacopo Bertolotti, Stefano Gottardo, Diederik S. Wiersma
European Laboratory for Nonlinear Spectroscopy and INFM-BEC, Sesto Fiorentino (Florence), Italy
M. Dolores Martín, Luis Viña
Departamento de Fisica de Materiales, Universidad Autonoma de Madrid, Cantoblanco 28049 Madrid Spain

riccardo.sapienza@icfo.es

To comprehend light matter interaction should we first decipher its components or instead understand the interplay between its building blocks and its underlying complexity? In a journey from the nanoscale dimension of a single fluorescent molecule to the macroscopic scale of self-assembled mm-sized photonic materials I will discuss light transport and lasing. I will show how we can get inspiration from recent advances in the synthesis of 3D nanophotonic materials [1] and of novel light sources [2] to extend the usual picture of a laser to unconventional lasing devices. I will discuss disordered structures, resonant light diffusion [3] and random lasing with a-priori designed lasing peak within the gain curve [4] as well as ordered structures and photonic crystal band-edge laser that are supported by Bloch modes.

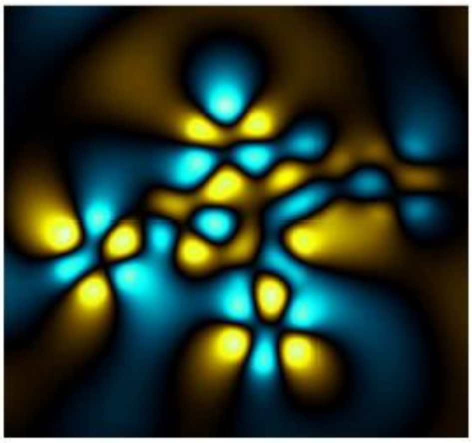


Illustration of Random Lasing in photonic glasses

References

[1] P. D. García, R. Sapienza, Á. Blanco and C. López, “Photonic glass: a novel random material for light” Adv. Mater. 19, 2597-2602 (2007); P D García, R Sapienza, C López “Photonic Glasses: a step beyond white paint” Adv. Mater. 21, 1-8 (2009);

[2] M. Leonetti, R. Sapienza, M. Ibisate, C. Conti, C. Lopez “Optical gain in DNA-DCM for lasing in photonic materials “ Opt. Lett. 34 3764 (2009)

[3] R. Sapienza, P.D. García, J. Bertolotti, M.D. Martín, A. Blanco, L. Viña, C. López, D.S. Wiersma, “Observation of Resonant Behavior in the Energy Velocity of Diffused Light” Phys. Rev. Lett. 99, 233902 (2007)

[4] S. Gottardo, R. Sapienza, P.D. García, A. Blanco, D. S. Wiersma, and C. López, “Resonance driven random lasing” Nature Photonics 2 (7), 429-432 (2008)

Spin currents and spin dynamics in metallic nanostructures

Sergio O. Valenzuela
ICREA and Centre d'Investigació en Nanociència i Nanotecnologia (CSIC-ICN), Bellaterra 08193, Spain

Sergio.Valenzuela.icn@uab.es

Spintronics aims to replace charge with spin as the main computational element in devices. Much effort is being devoted to understand how the electron spin is transferred through interfaces and to identify fundamental processes that modify the spin polarization or that can be used for spin manipulation. Nonlocal lateral structures are a unique tool to study these phenomena because of the ease to fabricate them in multi-terminal configurations. In the first part of the talk, this will be illustrated by some of our experimental results in thin-film devices, where the output voltage is exclusively determined by the spin degree of freedom and provides valuable information on spin-flip scattering mechanisms, spin-polarized tunnelling, spin-orbit interaction and the spin Hall effect. In the second part of the talk, the transport properties of ferromagnet-superconductor-ferromagnet single electron transistors will be described. Spin injection in the superconducting island is demonstrated by extending the Meservey and Tedrow technique to a double junction. It will be shown that, under proper conditions, the Zeeman split density of states can be used as an efficient spin filter.

ORAL CONTRIBUTIONS

PARALLEL SESSIONS

Electrospun cellulose-based membranes for bioelectrochemical devices

A.C. Baptista, E. Fortunato, R. Martins, J.P. Borges and I. Ferreira
CENIMAT/I3N, Departamento de Ciência dos Materiais, Faculdade de Ciências e Tecnologia (FCT),
Universidade Nova de Lisboa, and CEMOP/UNINOVA,
2829-515 Caparica, Portugal.
baptista.anna@gmail.com

Research applications in biomedical science and technology usually require various portable, wearable and implantable devices that can be used in biological and biomedical systems. The development of portable micropower sources has become a demanding and a challenging goal [1]. The decreasing of power requirements for portable electronics and nanodevices has improved the design of flexible energy-storage devices. If integrated structures containing the three essential components (electrodes, separator, and electrolyte) of the electrochemical device can be made mechanically flexible, it would enable these to be embedded into various innovative and functional devices [2]. In order to power electronic medical implant, power-supply systems must be capable of operating independently over a prolonged period of time, without the need of external recharging or refueling [3].

The present work aims the production of thin and flexible bioelectrochemical devices able to generate electrical energy from physiological fluids to supply small biomedical implants and biosensors for health care diagnostics.

Common energy-storage devices such as batteries and capacitors rely on large-surface-area electrodes to function. Due to that a cellulose-based membrane was produced by electrospinning. The electrospun matrix is highly porous, flexible and has a high surface area which are important properties for the present application. The electrospun membrane works both as the separator and as the support of the electrochemical device.

The membrane's electrochemical behavior was analysed by cyclic voltammetry. In pristine membranes the current density obtained is low, in the range of 20 nA.cm^{-2}. However, when impregnated with a salt solution a change of the electronic behavior is observed (Figure 1) as a consequence of the incorporation of ions and solvent molecules into the polymer matrix. Reversible redox reactions were detected and the current density obtained range from 20 nA.cm^{-2} to 0.6 mA.cm^{-2}. The salt solution added (less than 0.1ml of NaCl 0.9% (w/w) in water) intends to simulate a body fluid, such as blood plasma or sweat.

After membrane's electrochemical characterization, thin films were deposited on both sides of membrane to form the electrodes (Figure 2). The power generated by these devices depends not only on the materials used as electrodes but also on the membrane thickness.

To demonstrate the great potential of these bioelectrochemical devices, some of them were tested, and promising results were found. For instance, using silver and aluminium as electrodes in a thin film form, the device with 1cm^2 showed a voltage of 0.62V and a current of 54µA when in contact with sweated skin (Figure 3).

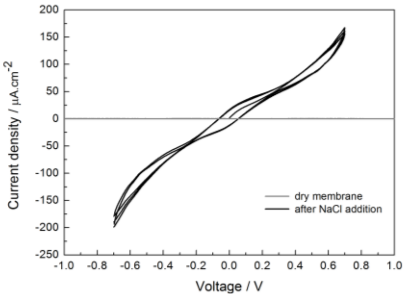


Figure 1: Cyclic voltammogram obtained for a dry pristine membrane (grey line) and after salt solution addition (dark line). This measurement was processed at a voltage scan rate of 40 mV/s. The membrane used has 26.7µm of thickness.

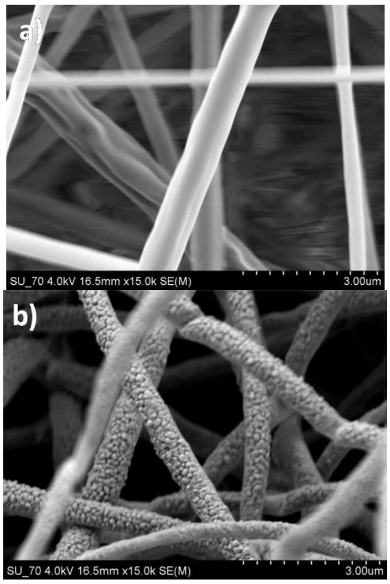


Figure 2: SEM image of membrane's superficial fibres a) uncoated and b) after thin film deposition.

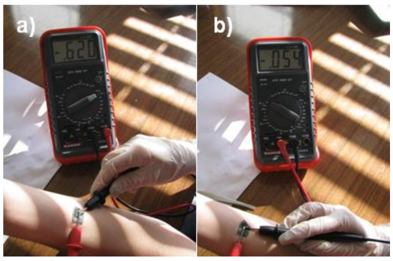


Figure 3: Demonstration of the bioelectrochemical device's performance in sweated skin: a) voltage value (V) and b) current value (mA).

References:

[1] P. Xian Gao, J. Song, J. Liu, and Z. Lin Wang, Adv. Mater., **19** (2007), 67–72.
[2] V. Pushparaj, MM. Shaijumon, A. Kumar, S. Murugesan, L. Ci et al., PNAS, **104** (2007), 13574-13577.
[3] S. Kerzenmacher, J. Ducrée, R. Zengerle and F. von Stetten, Journal of Power Sources, **182** (2008), 1-17.

Nanostructured electrochemical aptasensors for ochratoxin A (OTA) determination

Bonel. L, Duato. P, Vidal. J. C, Castillo. J. R.
Analytical Spectroscopy and Sensors Group (GEAS)
Institute of Environmental Sciences (IUCA) University of Zaragoza
C/ Pedro Cerbuna 12. 50009 ZARAGOZA. (Spain)
E-mail: lbonel@unizar.es

Ochratoxin A is a naturally occuring mycotoxin produced primarily by Aspergillus ochraceus and Penicillium verrucosum usually present in a variety of foods. It is mainly found as a contaminant of cereals, cereal products and coffee beans. Previously, we have developed a device based on Quartz Crystal Microbalance sensor for OTA determination.

In the literature has been reported the combination of electrochemical immunosensor using gold nanoparticles (AuNPs), carbon nanotubes (CNTs) or magnetic beads (MBs). Nanostructured materials have proven as one of the most powerful tool in new technologies and research, due to their absolutely peculiar properties at nanometer size scale.

The interesting approach of this work is related to the using of a selective aptamer to OTA. Aptamers are nucleic acids (DNA or RNA) that selectively bind to low molecular weight organic or inorganic substrates or to macromolecules such as proteins.

Anyway, this work is the first step in the realization of an assay for OTA based on the use of the specific aptamer exploiting the known advantages of these biomimetic receptors. In literature only two papers report the development of an assay for OTA detection using specific aptamer.

A disposable electrochemical assay involving MBs and carbon-based screen-printed electrodes (SPCEs) was developed for the detection of OTA. The Streptavidin Paramagnetic Particles consist of a magnetite core coated with streptavidin. Thus, these particles combine convenient magnetic separation technology with the versatility and high affinity of the biotin-streptavidin interaction. The assay was based on a direct competitive format in which a DNA aptamer biotinylated was used as biorecognition element, and horse-radish-peroxidase (HRP) was used as enzymatic label.

All steps of the assay were carried out onto MBs; only the electrochemical detection was performed transferring the functionalized MBs onto the working electrode of a SPCE. In this assay there is a competition step between OTA and OTA-HRP, finally hycroquinone (HQ) and H_2O_2 were added as co-substrate and substrate.The enzymatic product was determined by DPV.

The performance of the assay in terms of sensitivity, reproducibility and selectivity were studied. The calibration curve carried out shows a LOD and LOQ 0.2 and 6 µg/l respectively and the average coefficient of variation (ACV) resulted 8 %.

Finally, this approach will be applied to the analysis of some OTA samples to determine the concentration of OTA and predict the risk of a possible contamination with OTA.

High frequency resonant tunneling behavior: Testing an analytical small signal equivalent circuit with time dependent many-particle quantum simulations

E.Buccafurri(1), F.L.Traversa(2), X.Oriols(2), A.Alarcòn(2), G.Albareda(2), R.Clerc(3), F.Calmon(1) and A.Poncet(1)

(1) INL-INSA-Lyon, 7 av. Jean Capelle, 69621 Lyon, Villeurbanne Cedex, France
(2) Departament d'Enginyeria Electrònica, Universitat Autónoma de Barcelona 08193 Bellaterra SPAIN
(2) IMEP-LAHC, 3 rue Parvis Louis Néel, BP 257 Grenoble Cedex, France

emanuela.buccafurri@insa-lyon.fr

Since the pioneering work by Tsu and Esaki [1], resonant Tunneling Diodes (RTDs) have attracted a lot of attention. Their peculiar properties like Terahertz maximum operating frequency and Negative Differential Resistance (NDR), offer a wide range of applications, in either analog (frequency divider or multiplier, oscillator [2]) or digital ("multi-value" logic [3]) circuits. Recently, there is renewed interest in such devices because the progress of Silicon On Insulator (SOI) technology made it possible to build RTD devices on ultra-thin crystalline silicon with thickness lower than 10nm [4] (rather than the common III-V materials).

This work is devoted to an accurate analysis of the frequency behavior of RTDs. Such accurate analysis is a really very difficult task because one has to take into account the Coulomb correlation among electrons to assure (i) **current conservation** (the total current is the sum of the conduction plus the displacement currents due to time-dependent variations of the electric field) and (ii) **overall charge neutrality** (screening deep inside the leads assures that the total charge tends to zero). To the best of our knowledge, this is the first time that a detailed analysis of how conditions (i) and (ii) affects the relevant cut-off frequency of RTD.

We apply two different approaches. The first is a time-dependent Quantum Monte Carlo (QMC) based on many-particle Bohm trajectories [5].This powerful simulator can include Coulomb correlations self-consistently and it has been used to extract the RTD intrinsic frequency limitation directly from the current response to a small step voltage signal. Such a rigorous approach it is used to understand the RTD behavior and to test an analytical Small Signal Equivalent Circuit (SSEC) [6] (see fig. 1) derived from a DC physics based model [7] following Liu's approach [8].

To extract information about the different time constants associated to the several processes characterizing the electron dynamics in the RTDs, we accounted for three different conditions employed in NDR regime.

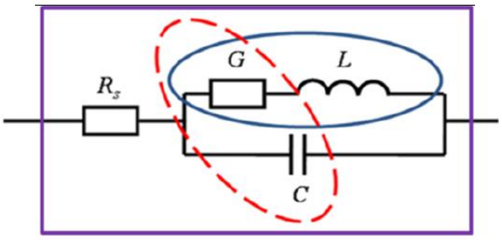
a) **Without conditions (i) and (ii):** we remove self-consistency of the Coulomb interaction in the QMC. The current in the RTD follows the voltage step with an intrinsic delay of about *0,035* ps (see fig. 2). In absence of coulomb interactions, this time is assumed to be equal to the RTD dwell time τ_d. In the analytical model $\tau_d = \hbar/\Gamma$ where Γ is the total width of the resonant level [9]. The value extracted for this structure is *0,03* ps in excellent agreement with QMC. In this case, the SSEC can be simplified by connecting in series a negative conductance *G* and a negative inductance *L* (see fig. 1 solid blue line). The resulting cutoff frequency of this simple filter is $2\pi\ \tau_d = 5$ THz.
b) **With condition (i):** The potential is computed by solving the Poisson equation self-consistently with QMC. In this condition the "simulation box" is very small, thus leads are neglected. The Coulomb interaction can be modeled by a capacitance *C* in parallel to *G* (see fig. 1 dashed red line). The total capacitance *C* account for two contributions, the geometrical capacitance C_0 and the quantum capacitance defined as C_q=-$G\tau$ In this case the cutoff frequency of SSEC results of *3.6* THz and it is consistent with the characteristic time (*0,25* ps see fig. 3) found with QMC.
c) **With conditions (i) and (ii):** In order to ensure charge neutrality in whole device, the leads have been introduced in QMC consistently with the Poisson equation. Conversely in the small signal circuit, contacts have been included by means of a series resistance (see fig. 1 squared solid line). Thus the cut off frequency of SSEC is now *1,4* THz. This value is in very good agreement with cutoff frequency reduction obtained with QMC (see fig. 4).

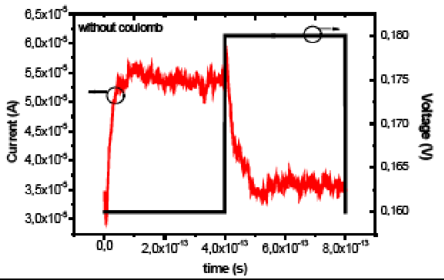
We can conclude that several limitations come into play in the frequency response of an RTD, namely the intrinsic tunneling process, the transit time across the non-tunneling regions and time constant associated to the total capacitance of the structure. On the one hand the full time-dependent simulation provides a rigorous picture of the physics that governs the frequency behavior of RTD. On the other hand, our study shows that the equivalent small signal circuit is able to catch characteristic times, resulting a useful tool to design RTD.

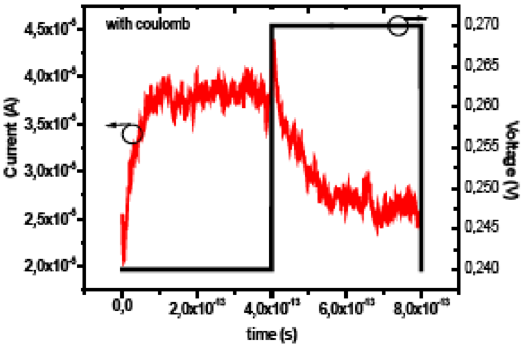
References

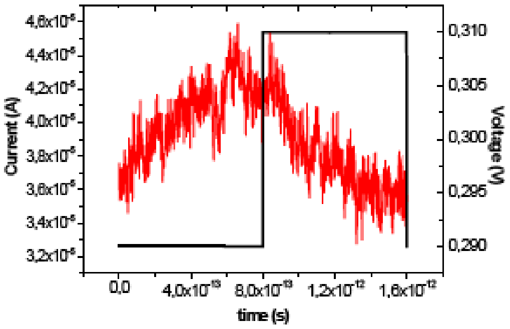
[1] R. Tsu, L. Esaki, Appl. Phys. Lett. **22** (1973) 562-564
[2] H. J. De Los Santos, et al., IEEE Microwave Wireless Compon. Lett. **1** (2001) 193-195
[3] H.C. Lin, Proc. IEEE Int. Symp. Multiple Valued Logic (1994) 188-195
[4] M. Vinet, et al., IEEE Electron Device Lett. **26** 5 (2005) 317-319
[5] X. Oriols, Phys. Rev. Lett. **98** (2007) 066803
[6] E.Buccafurri et al., Phys. Status solidi c, **6** 6 (2009) 1408-1411
[7] E. Buccafurri et al., IEEE ULIS proc. (2009) 91-94
[8] Q. Liu et. al. IEEE Trans. Elec. Dev. **51** (2004) 653 - 657
[9] E.R. Brown, C.D. Parker, L.G. Sollner Appl. Phys. Lett. **54** (1989) 2291-2293

Figures

<table>
<tr>
<td>


</td>
<td>


</td>
</tr>
<tr>
<td>Fig.1- Small signal equivalent circuit (solid circle) model without coulomb interaction, (dashed circle) model including coulomb effect. Total model (square)</td>
<td>Fig.2- Response of the RTD to a voltage step, without coulomb interaction.</td>
</tr>
<tr>
<td>


</td>
<td>


</td>
</tr>
<tr>
<td>Fig.3- Response of the RTD to a voltage step, including current conservation.</td>
<td>Fig.4- Response of the RTD to a voltage step, including charge neutrality</td>
</tr>
</table>

Electron microscopy techniques for nano-particle analysis

Wim Busing

FEI Europe B.V. (Netherlands)

In a Nature article, Vol. 323, dated 23rd of October 1986 it is announced that Ernst Ruska receives that years Nobel Price in Physics. His most important work began when he was a graduated student in late 20ties of last century and he worked on electron microscope ever since.

In those days the goal was to improve the performance of the microscope by developments focusing on resolution improvements on the one hand: on the other hand and surely not less important by improving and "finding" new preparation methods or techniques.

At the end of the last century computer technology, motorized stages, monitor and CCD cameras became essential parts of a modern electron microscope. Was in the old microscopes the alignment of microscope extremely important to achieve top quality results, in modern times the application part "how to prepare and handle the specimen became more and more important, not the microscope but the specimen determines the direction.

Innovation is still very important but nowadays the developments are done "with the voice of the customer". The development of the tools is not longer done in isolation at the manufacturer's site by physicists only. Many users from different discipline, e.g. nano biology, pharmacology are consulted before starting with a new application or a new design of a microscope. This resulted in specific developments to serve these markets, so are new techniques like electron microscopy and 3D-imaging extremely important for Life Science applications; ……..and many more exciting developments will follow.

Nevertheless one should not forget that developments in other area's then electron microcopy contributed in an important way "how a modern microscope functions and looks like"! A well performing microscope is never the result of one or two parameters; it depends on the many variables working together.

The flat screen monitors, the computer control of the microscopes, the motorized stages, the CCD cameras to mention a few, changed in the last 10 years, a microscope session completely. Was the alignment of the microscope in the past an exercise of many hours, nowadays it is a matter of seconds since one restores the alignments of a computer file. In the past the recording of images was on film meaning that the images needed to be processed in the dark room and only were available 2 days after the microscope session. Nowadays one records the on a CCD camera (with very sensitive detectors for Direct Electron Detection) and the image appears instantly on one of the monitors.

All these developments make it possible to automate the microscope for specific applications like automated data collection, volume imaging, etc. Was, till about 10 years ago, an image from a TEM 2-dimensional and very difficult to interpret now one can collect a series of images automatically and represent them as a volume? A typical microscope session starts in the evening and continues during the night without the presents of an operator. The microscope or perhaps better the combination of hardware and dedicated software controls all the necessary functions of the microscope; the computer program checks the movement and tilting of the stage, corrects the focus, corrects for image shifts etc. and collects a number of images during the night.

This approach reduces the time to result and instead of showing static results like one image, one is able to show dynamic images, movies or volumes from all directions making the interpretation of the result a lot easier. Examples will be showed of single article analysis using these modern microscopy techniques.

Simultaneous, Real-time, Mutli-parameter Analysis of Nanoparticles in Liquids

Bob Carr[1], Veronique Pires[2], Patrick Hole[1], Agnieszka Siupa[1], Matthew Smith[1]

[1]NanoSight Ltd., Minton Park, Amesbury, Salisbury, SP4 7RT, UK
[2]Schaefer Techniques Sarl, 1, Rue du Ruisseau, Nozay, France
bob.carr@nanosight.com

A new nanoparticle sizing and characterization technique is described allowing nanoparticles in a suspension to be individually but simultaneously detected and analysed in real time using a laser-based microscope system. The technique uniquely allows the user a simple and direct qualitative view of the sample under analysis and from which an independent quantitative estimation of sample size, size distribution and concentration can be immediately obtained.

Nanoparticles of all types and in any solvent can be detected, sized and counted through video-based tracking of their Brownian motion when illuminated by a specially configured laser beam. Examples of analyses of a wide range of sample types will be shown including nano-emulsions from pharmaceutical and clinical applications and metal oxides and nano-ceramics from the chemical, pigments and coatings industries.

Novel advances in the technique will be described which allow each particle to be simultaneously analysed not just in terms of its size but also light scattering power (mass/refractive index) and fluorescence from which 3D plots of size v. light scatter or fluorescence can be produced.

Introduction

In a wide range of industry sectors it is increasingly important to obtain accurate estimates of size, size distribution and concentration of nanoscale particles. However, existing techniques for obtaining such information (e.g. electron microscopy, light scattering) are time consuming, complex and the results difficult to interpret, particularly in samples which are heterogeneous in composition or which contain a range of particle sizes, e.g. are polydisperse.

A newly developed method for the direct and real-time visualisation and analysis of nanoparticles in liquids has become available and is called Nanoparticle Tracking Analysis (NTA)[1]. Using a laser-illuminated microscopical technique, Brownian motion of nanoparticles is videoed and analysed in real-time by a CCD camera, each particle being simultaneously but separately visualised and tracked by a dedicated particle tracking image analysis programme. Because each and every particle is visualised and analysed separately, the resulting estimate of particle size and particle size distribution does not suffer from the limitation of being an intensity weighted, z-average distribution which is the norm in conventional ensemble methods of particle sizing in this size regime, e.g. the well established method of Dynamic Light Scattering (DLS) or Photon Correlation Spectroscopy (PCS).

Size vs. Intensity

The benefit of being able to simultaneously measure two independent parameters such as particle scattering intensity and particle diameter (from dynamic behaviour) is valuable in resolving mixtures of different particle types (e.g. distinguishing between inorganic and polymer particles of the same diameter). Similarly, small differences in particle size within a population can be resolved with far higher accuracy than would be achieved by other ensemble light scattering techniques.
Fig 1 shows a mixture of 50nm gold particles and 100nm polystyrene. It can be seen that the 50nm gold nanoparticles scatter light more effectively than the 100nm latex despite the fact they are smaller. This is uniquely characterised by a negative slope on the 3-d graph.

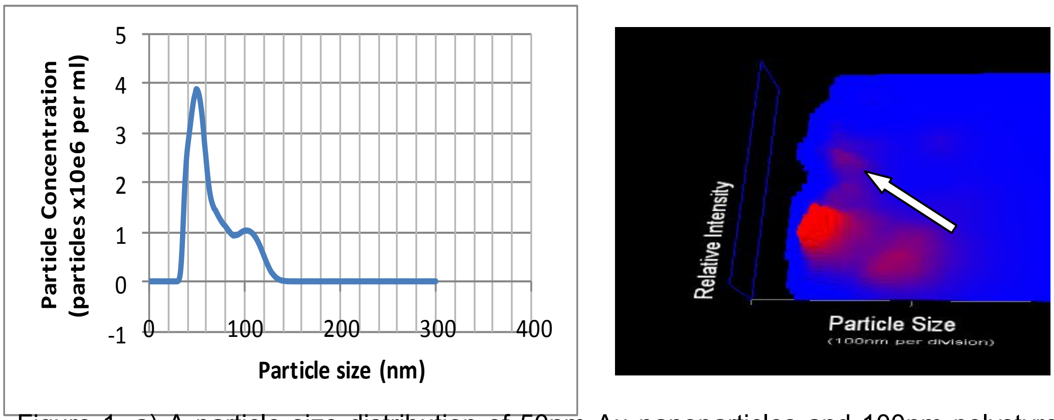


Figure 1. a) A particle size distribution of 50nm Au nanoparticles and 100nm polystyrene. b) a 3D plot of size v. intensity v. concentration of the same sample.

Size vs. Fluorescence

A recent development allows fluorescence measurement of specific particle types to be characterised (sized, counted, etc.) in complex mixtures through, for instance, the use of fluorescently labelled antibodies and other probes.

In Fig 2, a mixture of fluorescently labelled 50nm beads mixed with non-fluorescent 200nm beads can be measured under light scattering mode, in which a) both populations are analysed or b) using fluorescent filters, only the fluorescent population are seen.

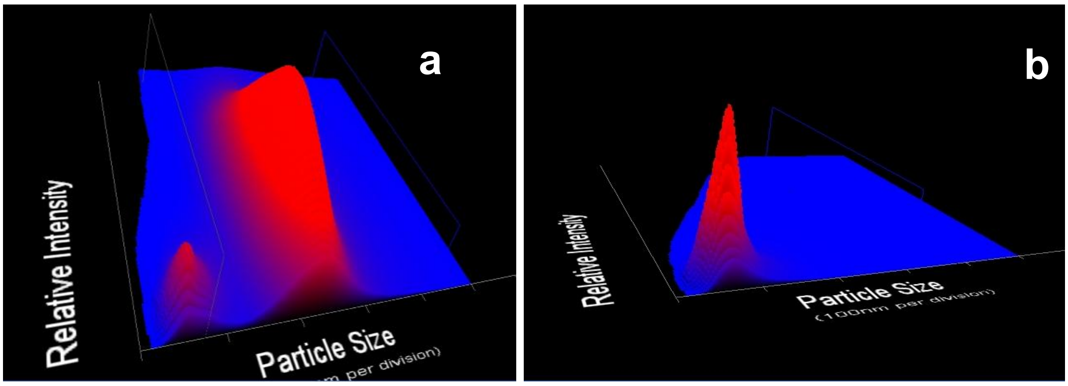


Figure 2. a) Measurement of size and number by light scattering was made using the standard red laser. b) Using a second laser emitting at a shorter wavelength only light emitted from the fluorescent beads was measured.

Conclusion

NTA is a direct and fast technique by which nanoparticles in their natural solvated state in a liquid can be rapidly detected, sized and counted. While limited to particles of 10-20nm and above and to concentration ranges between $10^7 – 10^9$ particles per ml, the ability to simultaneously visualise and analyse nanoparticles on an individual basis allows for much improved resolution of polydisperse and/or heterogeneous sample types. The technique can be used to complement existing techniques for the sizing of nanoparticles (e.g. DLS, PCS) allowing data obtained from these methods to be validated by direct microscopical observation of the sample.

References

[1] Carr, R., Hole, P.,Malloy, A., Nelson, P., Wright, M. and Smith, J. (2009), Applications of nanoparticle tracking analysis in nanoparticle research – a mini-review, European Journal of Parenteral & Pharmaceutical Sciences 2009; 14(2): 45-50
[2] The LM10 and LM20 Nanoparticle Analysis Instruments, www.nanosight.com

Optical Scattering Forces Generated By High Numerical Aperture Microscope Objectives

Ignacio Iglesias[1] and Juan José Sáenz[2]

[1]Depto. de Física, Universidad de Murcia, Campus de Espinardo (CIOyN Bldg.),
30100 Murcia, Spain
[2]Depto. de Física de la Materia Condensada, Universidad Autónoma de Madrid,
28049 Madrid, Spain

iic@um.es

KEY WORDS: optical forces, optical trapping, high numerical aperture microscope objectives.

A detailed description of the dynamics of particles trapped or moved by light is needed for an increasing number of applications. The characteristics and control of light-induced trajectories of particles in fluids[1] or the precise stiffness determination when small trapped particles confined by light are used as probes in force microscopy[2] are just two examples.

It has been shown that the forces involved can be classified as conserving or not mechanical energy. In the past, only the conservative term, arising from the gradient of the optical intensity distribution, was considered[3]. Recently, the relevance of the force generated by the radiation pressure has also been highlighted[4, 5]. Although this term has been traditionally assumed to be the only non-conservative contributor to the total force field, with small Rayleigh particles, another term may be crucial: the force generated by the curl of the spin angular momentum of the light field[6].

While the contribution to the total force of the spin angular momentum has been studied for optical fields in optical lattices[6-8], we demonstrate here how this term also plays a significant role in the total non-conservative force emerging in the focal volume of high numerical aperture objectives.

References

[1] Sun, B., et al., Brownian vortexes. Physical Review E (Statistical, Nonlinear, and Soft Matter Physics), 2009. **80**(1): p. 010401-4.
[2] Ghislain, L.P. and W.W. Webb, Scanning-force microscope based on an optical trap. Opt. Lett., 1993. **18**(19): p. 1678.
[3] Ashkin, A., et al., Observation of a single-beam gradient force optical trap for dielectric particles. Opt. Lett., 1986. **11**(5): p. 288.
[4] Sun, B., Y. Roichman, and D.G. Grier, Theory of holographic optical trapping. Opt. Express, 2008. **16**(20): p. 15765-15776.
[5] Roichman, Y., et al., Influence of Nonconservative Optical Forces on the Dynamics of Optically Trapped Colloidal Spheres: The Fountain of Probability. Phys. Rev. Lett, 2008. **101**: p. 128301.
[6] Albaladejo, S., et al., Scattering forces from the curl of the spin angular momentum of a light field. 2009.
[7] Zapata, S., et al., Deterministic rachet from stationary light fields. arXiv, 2009.
[8] Albaladejo, S., et al., Giant enhanced diffusion of gold nanoparticles in whirllights fields. Nano Lett., 2009.

Supported in part by Fundación Seneca (Region de Murcia, Spain), grant 4524/GERM/06

Nanotechnology approaches for improved based-drug delivery systems of the immunomodulatory neuropeptide vasoactive intestinal peptide

Rebecca Klippstein[1], Paula M. Castillo[1], Rafael Fernandez-Montesinos[1],
Ana P. Zaderenko[2] and David Pozo[1]
[1]CABIMER-Andalusian Center for Molecular Biology and Regenerative Medicine (CSIC-University of Seville, UPO, Junta de Andalucia), Seville, Spain
[2]Department of Physical, Chemical and Natural Systems, UPO-University Pablo de Olavide, Seville, Spain
david.pozo@cabimer.es

In spite of sustained interest in therapeutic applications of vasoactive intestinal peptide (VIP), and the fact that its administration could be largely improved by attachament to functionalized metal nanoparticles, no methods have been described so far to obtain them. The primary aim of the current study was to provide a method for silver nanoparticle conjugation to VIP that would be also useful for tailor-made applications based on nanoparticle multifunctional capabilities (Fernandez-Montesinos et al. 2009). The biological features of VIP are of particular interest to develop multifunctional nanoparticles for innovative therapeutic approaches for human diseases with inflammatory or autoimmune components (Pozo 2008; Delgado et al. 2004). VIP is a 28-aminoacid peptide (His-Ser-Asp-Ala-Leu-Phe-Thr-Asp-Thr-Tyr-Thr-Arg-Leu-Arg-Lys-Gln-Met-Ala-Met-Lys-Lys-Tyr-Leu-Asn-Ser-Val-Leu-Asn) that was initially isolated from the gastrointestinal tract due to its capacity as a vasodilator (Said and Mutt 1970). VIP was subsequently identified in the central and peripheral nervous systems, and recognized as a widely distributed neuropeptide. VIP exerts its biological functions through interaction with VPAC specific receptors belonging to the class II G protein-coupled receptors. Among its physiological roles, VIP and VPAC receptors have shown their relevance as endogenous factors that regulate inflammatory immune responses and immune tolerance, emerging as a very promising therapeutic factor (Pozo 2003; Pozo and Delgado 2004; Pozo et al. 2007). The mechanisms involved include the deviation towards Th2-driven inflammatory pathways, the specific recruitment and development of Th2 cells, and the peripheral expansion of regulatory T cells (Pozo et al. 2009; Chorny et al. 2005; Gonzalez-Rey et al. 2007). Also, VIP and VPAC receptors are overexpressed in 100% of human prostate cancers (Reubi and Maecke 2008; Reubi 2003). In spite the fact that the structure-function relationships of VPAC receptors are well known, the structure-function relations for VIP are however poorly understood. In this sense, VIP has been shown to have diffuse pharmacophoric domains, with important amino acids all along the peptide for binding to VPAC1 and VPAC2 receptors (Ceraudo et al. 2008). Photoaffinity labelling, molecular dynamic simulation and ligand docking studies have determined that the C-terminal part of VIP from Phe^6 to Asn^{28} interacts with the N-terminal ectodomain of human VPAC1 receptor. Recently, it has been shown that the N-terminus of VIP also interacts with the human VPAC1 receptor N-terminal domain. VIP was conjugated to tiopronin-capped silver nanoparticles of a narrow size distribution, by means of proper linkers, to obtain VIP functionalized silver nanoparticles with two different VIP orientations Ag@tiopronin@PEG@succinic@[His]VIP and Ag@tiopronin@PEG@VIP[His]. VIP intermediate nanoparticles were characterised by TEM, FTIR, Raman, ^{1}H-NMR and TOCSY. VIP functionalized silver nanoparticles cytotoxicity was determined by LDH release from mixed glial cultures prepared from cerebral cortices of 1-3 days-old C57/Bl mice. Cells were used for LPS stimulation at day 18-22 of culture. Mixed cultures were checked by immunocytochemistry for high enrichment of GFAP and CD68 positive reactive cells, identifying astrocytes and microglia, respectively. Supernatants from mixed glial cells cultures were harvested 24 hours after treatment, and IL-6, TNF-α, and IL-10 production was determined by ELISA. Two different types of VIP functionalized silver nanoparticles were obtained; both expose the C-terminal part of the neuropeptide, but in the first type VIP is attached to silver nanoparticle trough its free amine terminus Ag@tiopronin@PEG@succinic@[His]VIP while in the second type, VIP N-terminus remains free Ag@tiopronin@PEG@VIP[His]. VIP functionalized silver nanoparticles did not compromise cellular viability and inhibited microglia-induced stimulation under inflammatory conditions. Treatment of primary mixed glial cultures with Ag@tiopronin@PEG@Succinic@[His]VIP or Ag@tiopronin@PEG@VIP[His] nanoparticles with a final concentration of functionalized VIP of 10^{-8} M resulted in an inhibition of LPS-induced production of IL-6 and TNF-α and an increase of IL-10. We have exploited the potential of nanoparticle functionalization as an alternative approach to improve the therapeutic prospect of the endogenous cytokine-like peptide VIP. Our results showed the proof-of-concept for its use, as the chemical synthesis procedure developed to obtain VIP functionalized silver nanoparticles rendered functional products, in terms of biological activity, without any observed cytotoxic effects. The present work provides functional data that demonstrates that VIP can be conjugated to tiopronin-capped silver nanoparticles in two alternative orientations, involving or not the VIP N-terminus, without loss of biological activity. This information is especially valuable for other studies aiming at including VIP in formulations where the possibility of chemical synthesis constraints exists depending on the nanosurface to be functionalized. Our study provides for the first time a proof-of-principle to enhance the therapeutic potential of VIP with the valuable properties of metal nanoparticles for imaging, targeting, and drug delivery. Our study provides for the first time a proof-of-principle to encourage the development of VIP-based nanoparticles that exploit the valuable properties of silver nanoparticles for imaging, targeting, and drug delivery.

References

Ceraudo, E., Y. V. Tan, P. Nicole, A. Couvineau, and M. Laburthe. 2008. The N-Terminal Parts of VIP and Antagonist PG97-269 Physically Interact with Different Regions of the Human VPAC1 Receptor. ***J Mol Neurosci*** 36 (1-3):245-248. .

Chorny, A., E. Gonzalez-Rey, A. Fernandez-Martin, D. Pozo, D. Ganea, and M. Delgado. 2005. Vasoactive intestinal peptide induces regulatory dendritic cells with therapeutic effects on autoimmune disorders. ***Proc Natl Acad Sci U S A*** 102 (38):13562-13567.

Delgado, M., D. Pozo, and D. Ganea. 2004. The significance of vasoactive intestinal peptide in immunomodulation. ***Pharmacol Rev*** 56 (2):249-290.

Fernandez-Montesinos, R., P. M. Castillo, R. Klippstein, E. Gonzalez-Rey, J. A. Mejias, A. P. Zaderenko, and D. Pozo. 2009. Chemical synthesis and characterization of silver-protected vasoactive intestinal peptide nanoparticles. ***Nanomed*** 4 (8):919-930.

Gonzalez-Rey, E., A. Chorny, and M. Delgado. 2007. Regulation of immune tolerance by anti-inflammatory neuropeptides. ***Nat Rev Immunol*** 7 (1):52-63.

Pozo, D. 2003. VIP- and PACAP-mediated immunomodulation as prospective therapeutic tools. ***Trends Mol Med*** 9 (5):211-217.

Pozo, D. 2008. Immune-based disorders: the challenges for translational immunology. ***J Cell Mol Med*** 12 (4):1085-1086.

Pozo, D., P. Anderson, and E. Gonzalez-Rey. 2009. Induction of Alloantigen-Specific Human T Regulatory Cells by Vasoactive Intestinal Peptide. ***J Immunology*** 183:4346-4359.

Pozo, D., and M. Delgado. 2004. The many faces of VIP in neuroimmunology: a cytokine rather a neuropeptide? ***FASEB J****.* 18 (12):1325-1334.

Pozo, D., E. Gonzalez-Rey, A. Chorny, P. Anderson, N. Varela, and M. Delgado. 2007. Tuning immune tolerance with vasoactive intestinal peptide: a new therapeutic approach for immune disorders. ***Peptides*** 28 (9):1833-1846.

Reubi, J. C. 2003. Peptide receptors as molecular targets for cancer diagnosis and therapy. ***Endocr Rev*** 24 (4):389-427.

Reubi, J. C., and H. R. Maecke. 2008. Peptide-based probes for cancer imaging. *J Nucl Med* 49 (11):1735-1738.

Said, S., and V. Mutt. 1970. Polypeptide with broad biological activity: isolation from small intestine. ***Science*** 169:1217-1218.

Decrease of the adhesion force with vapor pressure

Mariana Köber[1], Enrique Sahagún[2], Pedro García-Mochales[2], Fernando Briones[1], Mónica Luna[1], Juan José Sáenz[2]

[1]Instituto de Microelectrónica de Madrid (IMM-CSIC), Isaac Newton 8, 28760 Tres Cantos, Spain
[2]Departamento de Física de la Materia Condensada, Universidad Autónoma de Madrid, 28049 Madrid, Spain
mariana.koeber@imm.cnm.csic.es

Experimental evidence of a monotonous decrease of the capillary forces between hydrophilic surfaces with increasing relative humidity from 0 to 100% is presented. In concordance with the results of a theoretical simulation, we identified the objects' shape as the origin of different adhesion force vs. RH behaviours when treating with nanoscale objects. If the water neck is formed between a flat surface and a nanometric object presenting a truncated cone shape the adhesion force decreases with increasing vapour pressure. The variety of meniscus force behaviours found for different shapes emphasizes the importance of geometry in capillary phenomena at the nanometric scale.

Moisture alters the cohesion among particles in powders and the adhesion of particles to surfaces. The principal reason for this effect is the formation of a liquid neck or meniscus at the contact region between particles or between the particles and the surface. The attractive force caused by such a liquid meniscus is called "capillary force" and it generally predominates (for hydrophilic surfaces) over other surface forces under ambient conditions [1]. A profound understanding of capillary forces is essential in the studies of the behaviour of powders and soils [2], friction, hydrophobic interactions, and has implications in industries as pharmaceutical (colloid stability, suntan creams), food engineering (the cleaning of food) [3], and new materials (coatings, lubricants).

Atomic Force Microscopy (AFM) allows for the investigation of adhesion forces between bodies of micro or nanometer sizes and plays, therefore, a major role in the studies of capillarity. In this study, AFM experiments were performed using sharp as well as dull Si tips and flat mica surfaces. Adhesion force vs. environmental water pressure curves were obtained by measuring force vs. distance curves (from which adhesion forces were extracted) [4] while increasing the relative humidity slowly from 0 to 100%. In order to preserve small tip apex dimensions very low normal loads have been applied. When using sharp Si tips the adhesion force decreases monotonously with increasing water vapour pressure (Fig. 1, left), while it shows a maximum behaviour when using larger (> 15nm) tips (not shown here). While the maximum behaviour has been reported reiterately [1, 5-11], we found no reference to a strict decrease of the adhesion force with increasing humidity in literature.

A simple model explaining the experimental findings has been developed, based on a previously described model [12], using continuum theory and the formation of minimum energy water necks. The model suggests that, when bringing a hydrophilic nanoscale object in proximity to a hydrophilic surface the object's shape is a decisive factor for determining the adhesion behaviour with humidity. While conical shapes present increasing F_{adh} vs. H curves, sharp and nearly flat caps yield decreasing curves (Fig. 1, right). Curved tips, in turn, show the well known force curves displaying a maximum.

Experimental and theoretical results are consistent if we assume that the "small" tips, preserved up to what the SEM can elucidate, exhibit a nanometer sized flat surface free of asperities. The Nanosensors Si tip is likely to exhibit a flat surface after entering into first contact with the stiff mica sample since Nanosensors Si cantilevers are aligned parallel to the <110> direction [13] (thus the <110> direction is perpendicular to the cone axis) along which cracks are easily propagated resulting in a nearly perfectly flat fracture surface [14].

The results imply that the undesirable sticking effect between surfaces occurring at increasing relative humidity could be avoided by controlling the shape of the surface asperities at the nanometric scale. Furthermore, for a correct interpretation of AFM adhesion maps the tip size and shape have to be taken into account – hydrophilic samples do not necessarily yield a capillary force increase with increasing moisture.

References

[1] H.-J. Butt, and M. Kappl, *Adv. Colloid Interface Sci.* **146**, 48 (2009).
[2] L. Bocquet, E. Charlaix, S. Ciliberto & J. Crassous, *Nature* **396**, 735-737 (1998).
[3] W. Liu, P.J. Fryer, Z. Zhang, Q. Zhao and Y. Liu, *Innovative Food Science and Emerging Technologies* **7**, 263–269 (2006).
[4] Weisenhorn, A. L.; Hansma, P. K.; Albrecht, T. R.; Quate, C. F. *Appl. Phys. Lett.* **54**, 2651 (1989).
[5] O H Pakarinen, A S Foster, M Paajanen, T Kalinainen, J Katainen,I Makkonen, J Lahtinen and R M Nieminen, *Modelling Simul. Mater. Sci. Eng.* **13**, 1175–1186 (2005).
[6] D. B. Asay and S. H. Kim, *J. Chem. Phys* **124**, 174712 (2006).
[7] A. Fukunishi and Y. Mori, *Advanced Powder Technol.* **17**, 567–580 (2006).

[8] M. Farshchi-Tabrizi, M. Kappl and H. -J. Butt. *Journal of Adhesion Science and Technology* **22**, 181–203 (2008).
[9] X. D. Xiao, and L. M. Qian, *Langmuir* **16**, 8153 (2000).
[10] O. Stukalov, C. A. Murray, A. Jacina, and J. R. Dutcher, *Rev. Sci. Instrum.* **77**, 033704 (2006).
[11] . M. He, A. S. Blum, D. E. Aston, C. Buenviaje, R. M. Overney and R. Luginbühl, *J. Chem. Phys.* **114**, 1355-60 (2001).
[12] E. Sahagún, P. García-Mochales, Sacha G.M. and J.J. Sáenz, *Phis. Rev. Lett.* **98**, 176106 (2007)
[13] http://www.nanosensors.com/faq.html
[14] A. George, G. Michot, *Mater. Sci. Eng. A* **164**, 118 (1993); R. Pérez and P. Gumbsch, *Phys. Rev. Lett.* **84**, 5347 (2000)

Figures

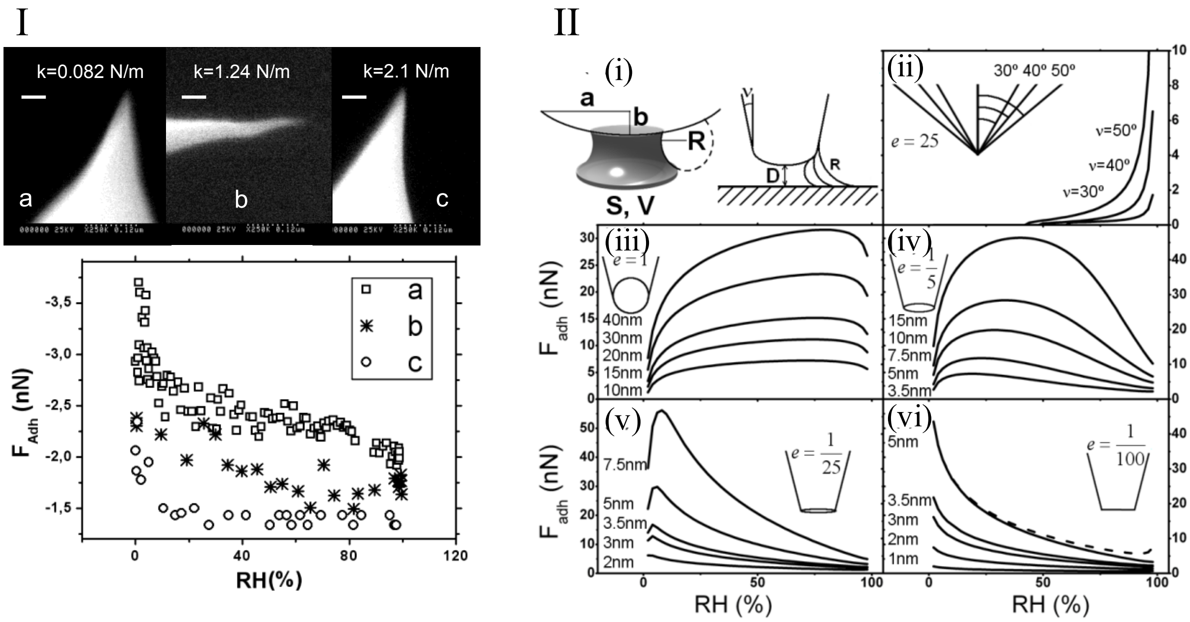


Figure. 1. Experimental (I) and model (II) curves of the adhesion force vs. relative humidity.
Top left (I): SEM images showing three tips after they had been used to measure the adhesion force with flat mica surfaces (the scale bar represents 60 nm). Bottom left (I): adhesion force as a function of the relative humidity for the three sharp Si tips. Nominal tip radii are 7 nm for (a) and (c) and 2 nm for (b). **II**, (i) Scheme of the modelled tip geometry and water meniscus (ii-vi) F_{adh} vs humidity curves calculated with the ellipsoid model (D = 0.2 nm) for different values of the tip apex form factor e = *b*/*a* (= 25, 1, 0.2, 0.04 and 0.01, respectively) and the ellipsoid transverse semi axis *a*. In (b) we show the results for a quasi conical tip (*b*/*a* = 25, *a* = 5 nm) for different aperture angles. In (iii-vi) solid lines are results for tips with ν = 10º and different *a* (curve labels correspond to *a* values used). In (vi) the dashed line corresponds to a quasi-truncated tip with a = 5 nm and ν = 30º.

Enhanced emission in self assembled photonic crystals by hybrid photonic-plasmonic modes

M. López-García, J.F. Galisteo-López, A. Blanco, C. López
Instituto de Ciencias de Materiales de Madrid (CSIC), c/ Sor Juana Inés de la Cruz 3, 28049, Cantoblanco, (Madrid) Spain
mlopez@icmm.csic.es

A. García-Martín
Instituto de Microelectrónica de Madrid (CSIC), C/ Isaac Newton 8, 28760, Tres Cantos, (Madrid) Spain

Coupling between plasmonic and photonic systems has become one of the most efficient ways to obtain small scale waveguiding and emitting devices [1]. In this work, a novel structure for obtaining enhanced emission in a hybrid plasmonic-photonic structure is presented. The samples under study consist of large area close-packed ordered monolayers of dye doped polystyrene spheres grown on a thin (60nm) gold film. This system allows surface resonant plasmonic modes to couple efficiently to photonic ones leading to the formation of localized surface plasmon polariton (SPP) modes, propagating waveguide modes and hybrid ones [2].

The dispersion relation of these modes is retrieved by means of angle and polarization resolved reflectance measurements for different crystallographic orientations. Comparison with calculated reflectance spectra as well as the spatial distribution of the electric field in the system allows us to identify different mode types. Field enhancement inside the spheres is seen to be much larger than that obtained for similar samples grown on dielectric substrates evidencing the role of the metallic layer in preventing leakage losses into the substrate [3] (Figure 1).

Finally we have studied the effect of such field enhancement on the emission of the dye by studying angle and polarization resolved photoluminescence (PL). We have observed that enhanced emission is obtained for those modes where the field is mainly concentrated in the region containing the emitter (i.e. polymeric spheres). A comparison with a reference system non structured thin dye doped polymer films deposited on gold, further points to the efficiency of our samples to obtain enhanced emission. The spectral tunability of the mode dispersion with sphere size makes this system a versatile one for many applications involving efficient emitting devices.

References

[1] R.F. Oulton, V.J. Sorger, T. Zentgraf, R-M. Ma, C. Gladden, L. Dai, G. Bartal and X. Zhang, *Nature*, **461**, 629 (2009).
[2] R.M. Cole, Y. Sugawara, J.J. Baumber, S. Mahajan, M. Abdelsalam and P.N. Barlett, *Phys. Rev. Lett*, **97**, 137401 (2006).
[3] Y. Kurokawa, H. Miyazaki, Y. Jimbo, *Phys. Rev. B*, **69**, 155117 (2004).

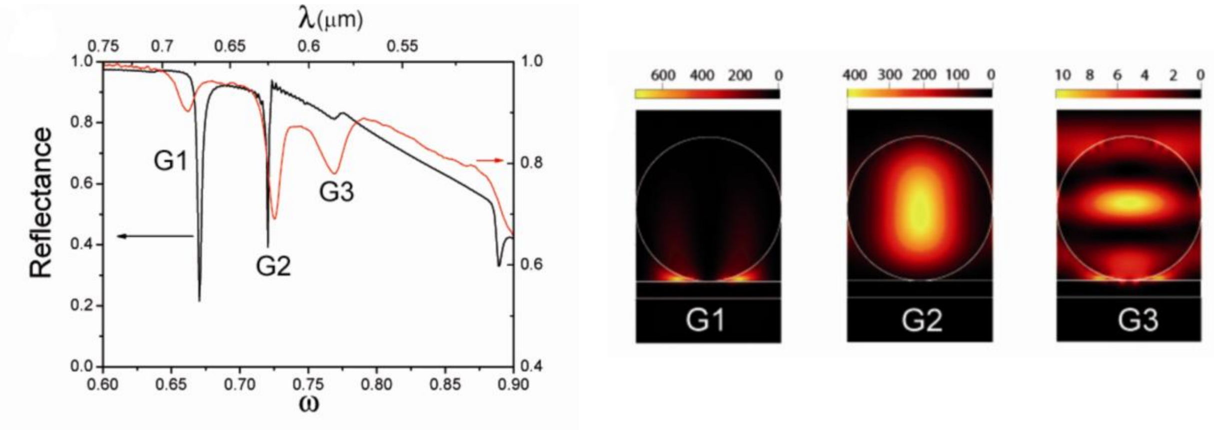


Figure 1. Left : Calculated (black curve) and measured (red curve) normal incidence reflection spectra of a ML of 520nm PS spheres grown on a gold substrate. Right: Total field intensity distribution of selected modes (as indicated in spectra.

Multifunctional nanomechanical systems for multiplexed highly selective and sensitive biological detection

Nicolás F. Martinez[2], Javier Tamayo[1], Priscila M. Kosaka[1], Johann Mertens[1], Oscar Ahumada[2], Hien-Duy Tong[3] and
Montserrat Calleja[1]

[1]Bionanomechanics Lab-Instituto de Microelectrónica de Madrid- CSIC, Isaac Newton 8
(PTM), Tres Cantos 28760, Madrid, (Spain)
[2]Mecwins S.L., Santiago Grisolía , Tres Cantos 28760, Madrid , (Spain)
[3]Nanosens, Berkelkade 11, NL 7201 JE Zutphen, (The Netherlands)

jtamayo@imm.cnm.csic.es

Prediction of risk factors and early diagnosis of disease are the best means to preserve health and to avoid costly and inefficient medical interventions after symptoms and disease have developed. Current platforms for analysis require large amount of sample, have many sample pre-treatment steps prone to human error, are relatively slow, suffer of low sensitivity for the detection of multiple malignancies, and often provide false positives and negatives. In addition, these instruments are bulky equipment that is frequently not available to clinics or point of care diagnosis. The goal of discovering new devices and new transduction concepts for biological detection remains of paramount importance. Nanotechnology based approaches are promising candidates for providing portable and low cost nanosensor devices, capable of analyzing tiny amounts of sample, and specifically disease markers from patients. Also, the advancement of new approaches that provide the needed robustness and reproducibility of the response, as well as a high degree of multiplexing, is needed. MEMS/NEMS devices are good candidates to attain this goal, but this approach needs the further development of advanced instrumentation which demands combined expertise in fabrication, design, engineering and modelling. We have found that a private – public partnership is especially suitable to attain the cited purposes. In this work, two spin-off companies Mecwins S.L. and Nanosens Gmbh have collaborated with our group to develop an instrument with the capability for highly multiplexed detection (up to 128 sensors in parallel already demonstrated) together with an accurate control of the gas environment [1] and a biochip comprising 128 cantilevers in groups of 8 cantilevers for differential measurements.

The developed nanomechanical systems and transduction schemes and techniques have been tested and applied to solve problems in the field of biomedicine but also in other areas such as polymer science. The largest potential is in the detection of the hybridization of nucleid acids for early disease detection, including the early detection of cancer based on downregulation or overexpression of genes. Also, the detection of harmful pathogens by nanomechanical systems is in need of a cost-effective and rapid technique, as the one described here, for detecting pathogens in the early stages to avoid epidemics. The advantage of immunosensors based on nanomechanical sensors over traditional diagnosis systems such as Enzyme-Linked Immunosorbent Assay (ELISA) is that intact bacteria or viruses can be detected without need of secondary markers. More interestingly, nanomechanical sensors proposed provide unprecedented levels of sensitivity and specificity as we demonstrate in this work [1,2].

References:

[1] Mertens, J., Rogero, C., Calleja, M., Ramos, D., Martín-Gago, J.A., Briones, C. & Tamayo, J., Nature Nanotechnology **3** (2008) 301.
[2] D. Ramos, M. Arroyo-Hernandez, E. Gil Santos, H. Duy Tong, C. van Rijn, M. Calleja, J.Tamayo, Analytical Chemistry 81 (2009) 2274

Figures:

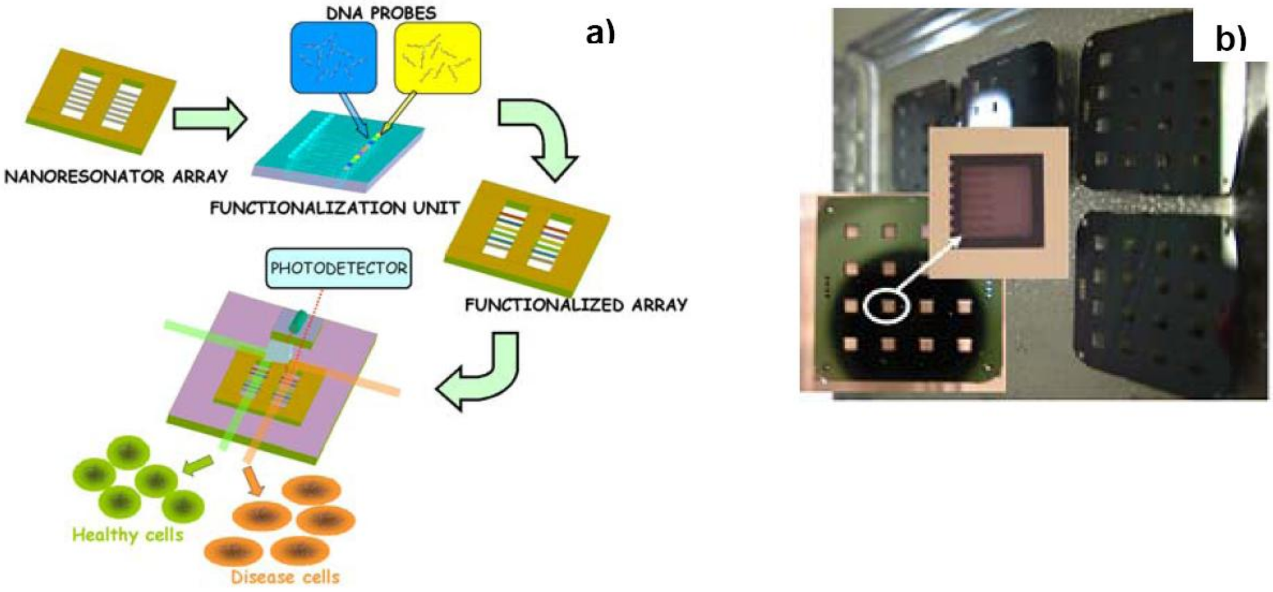


Figure 1: a) Conceptual drawing of the Mecwins chips and platform. The fabricated array consists of several separated rows of cantilevers. Each row of cantilevers is sensitized with the same combination of DNA probes by means of a microfluidics or microinjection techniques. The sensitised array is then inserted in the readout instrument composed of a scanning optical system for measuring the resonant frequency and mechanical deformations of each cantilever. 128 cantilevers have been detected simultaneously. In a possible application, the gene expressed content of disease and healthy cells is flowed over each row of cantilevers for comparison of the gene expression pattern and determination of genes responsible of disease. A picture of the actual chips manufactured by Nanosens is also shown in b).

Colloidal nano- and microparticles towards sensing applications in biology

Wolfgang Parak

Philipps Universität Marburg, Fachbereich Physik, Renthof 7, 35037 Marburg. Germany
wolfgang.parak@physik.uni-marburg.de

Nanomedicine nowadays is a popular key word in the media, though everyone seems to associate it with different visions, hopes, and even fears. From the point of view of a materials scientist it will be pointed out what new materials will be possible, how they will be designed, and which properties they could offer for diagnosis and treatment. It will be critically discussed that though sophisticated materials with advanced novel properties will be available in the future, they do not automatically match the requirements and demands of clinicians. The discussion is centred around one example, multifunctional polyelectrolyte capsules which might act as a "nano-submarine" for in vivo sensing and delivery, which is used to highlight promising interfaces between both disciplines.

References

[1] C. Röcker, M. Pötzl, F. Zhang, W. J. Parak, G. U. Nienhaus, "A quantitative fluorescence study of protein monolayer formation on colloidal nanoparticles", Nature Nanotechnology 4, 577-580 (2009).
[2] P. Rivera Gil, S. de Koker, B. G. de Geest, W. J. Parak, "Intracellular processing of proteins mediated by biodegradable polyelectrolyte capsules", Nanoletters 9, 4398-4402 (2009).
[3] J. Peteiro-Cartelle, M. Rodríguez-Pedreira, F. Zhang, P. Rivera Gil, L. L. del Mercato, W. J. Parak, "How colloidal nano- and microparticles could contribute to medicine - a personal perspective both from the eyes of physicians and materials scientists", Nanomedicine 4, 967-979 (2009).

Cu/SiO$_2$ films for 3D filling in microelectronic applications by an organometallic chemical liquid deposition (OMCLD) route

Kilian Piettre[a,b] , Virginie Latour[a], Olivier Margeat[c], Clément Barrière[a], Marina Proust[b], Benoît Riou[b], Bruno Chaudret[a], Pierre Fau[a]*

[a] Laboratoire de Chimie de Coordination, 205, route de Narbonne, 31077 Toulouse,
[b] STMicroelectronics, 16, rue Pierre et Marie Curie, 37071 Tours
[c] Université de la Méditerranée, Faculté des Sciences, 163 av Luminy, 13288 Marseille
Kilian.Piettre@lcc-toulouse.fr

Organometallic chemistry has recently been emphasized [1] in microelectronics processes and new cost effective copper deposition films have been proposed [2, 3]. In this talk, we present a fully liquid method to specifically produce thin conductive copper films on silicon substrates at specific temperature and under specific H_2 pressure. Metallization of the surface will be achieved by simultaneous decomposition under reducing H_2 gas of a copper precursor ((N-N'-diisopropylactemidinato) copper (I)) in the presence of a silica source (tetraethoxysilane TEOS). This unique organometallic approach allows the formation of adherent copper/SiO$_2$ clusters around 100 nm thick, on silicon surfaces presenting a large aspect ratio. The continuous precursor availability in the liquid phase during deposition will allow good coverage of both walls and bottom structures and evenly deposit (figure 1)+.
The copper precursor decomposition is followed by nuclear magnetic resonance (NMR) monitoring and TEOS hydrolysis and condensation reactions are controlled by the precursor chemistry. The reaction pathways involved in the formation of these composite films are detailed and the process parameters are discussed. The resulting films are characterized by scanning electron microscopy (SEM), focused ion beam (FIB), back-scattered electrons (BSE) and X-rays diffraction (XRD). The resulting Cu/SiO$_2$ films present the double interest of forming an adherent copper layer directly on silica surfaces thanks to SiO$_2$ anchoring, and behave as an effective catalyst layer for a further deposition of thick copper by electroless technique. This approach can easily be extended to other classes of organometallic precursors and brings a new example of the growing role of organometallic chemistry solutions in the field of the actual microelectronic challenges.

References

[1] G. A. Somorjai, F. Tao and J. Y. Park, *Top. Catal.*, **2008**, 47, 1
[2] C. Barrière, P. Fau et al. J. Mater. Chem., **2008**, 18, 3084–3086
[3] O. Margeat, C. Barrière, P. Fau, B. Chaudret, **2009**, FR2929449_WO200912514

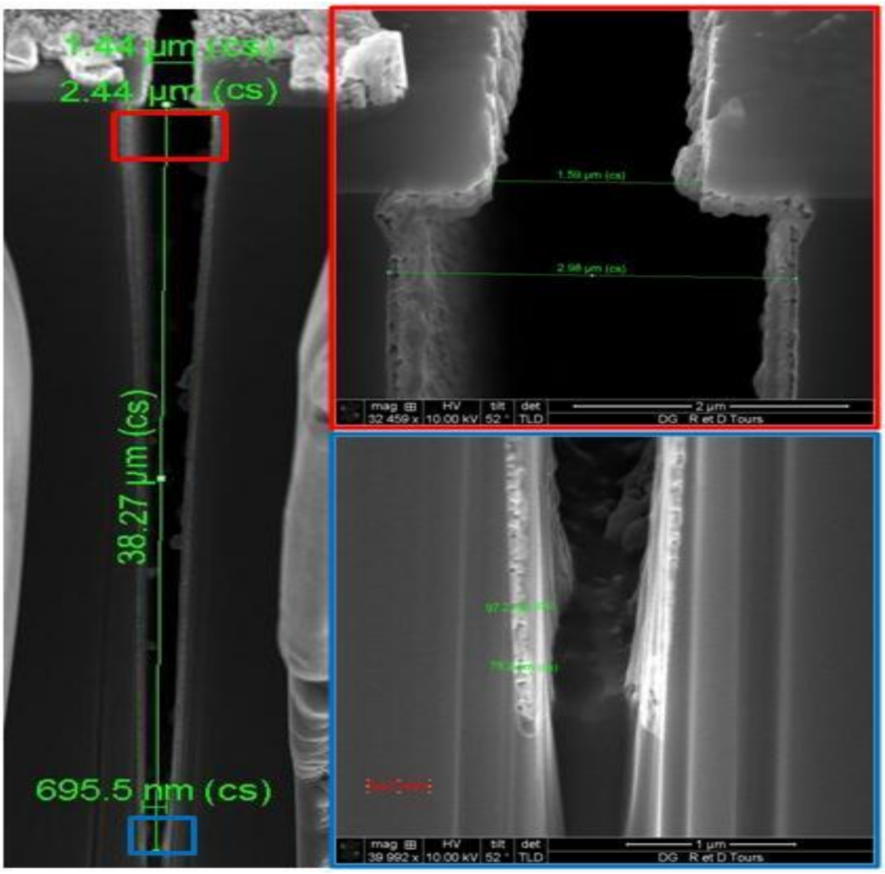


Figure 1. FIB pictures of Cu/SiO_2 deposit: panoramic view and dimension of the trench (left), top of the trench (top right) and bottom of the trench (bottom right)

INDEX - POSTERS

Please, find your final **poster number** by looking up your name in the **Author Index** displayed in the Poster Exhibition Area.

Poster Session (119)				
Presenting Author		**Country**	**Topic**	**Poster Title**
Alphabetical Order				
Agüeros	Maite	Spain	NanoBiotechnology	*Cyclodextrin-bioadhesive nanoparticles for oral delivery of paclitaxel*
Aguilar-Caballos	María Paz	Spain	NanoBiotechnology	*Recent trends in the use of nanotechnology for the control of tumor markers*
Ahmadi	Maryam	Iran	NanoBiotechnology	*Production and development of rapid test for analyse of PSA gene expression with oligonucleotide conjugate gold nanoparticle as probe*
Albareda	Guillem	Spain	Simulation at the nanoscale	*Boundary conditions for nanoscale electron devices with realistic lead-sample Coulomb correlations in small simulating boxes*
Aliev	Farkhad	Spain	Nanomagnetism	*Strongly suppressed 1/f noise and enhanced magnetoresistance due to reduced interface mismatch in epitaxial Fe<V>/MgO /Fe magnetic tunnel junctions*
Álvarez	Lucia	Spain	NanoMaterials	*XPS and STM study of Metalorganic nanostrucures*
Aparicio Rebollo	Francisco Javier	Spain	NanoMaterials	*Luminescent nanocomposites for photonic sensing*
Assali	Mohyeddin	Spain	Nanotubes	*Bioengineering of Carbon Nanotubes: Glyconanoabacus with Biomimetic Display of Carbohydrates*
Awad	Ahmad	Spain	Nanomagnetism	*Precise probing spin wave dynamics in circular magnetic dots: influence of dots aspect ratio, magnetic field and direction of microwave field pumping*
Balint	Paul	France	Nanomagnetism	*Magnetic particles for biotechnology*
Baptista	Ana Catarina	Portugal	NanoBiotechnology	*Electrospun cellulose-based membranes for bioelectrochemical devices*
Barranco Quero	Ángel	Spain	Nanophotonics	*Conformal Growth of Organic Luminescent Planar Defects within Artificial Opals*
Behme	Gerd	Germany	Scanning Probe Microscopies (SPM)	*Analysis of cellular and molecular interactions using Atomic Force Microscopy*
Bonel	Laura	Spain	NanoChemistry	*Nanostructured electrochemical aptasensors for ochratoxin A (OTA) determination*
Borges	João	Portugal	NanoBiotechnology	*Electrospinning of PVP-calcium phosphates sol precursors for the production of hydroxyapatite nanofibres*
Boutinguiza Larosi	Mohamed	Spain	NanoBiotechnology	*Generation of Calcium Phosphate Nanoparticles by Laser Ablation in Ambient Conditions*
Buccafurri	Emanuela	France	NanoElectronics	*High frequency resonant tunneling behavior: Testing an analytical small signal equivalent circuit with time dependent many-particle quantum simulations*
Cabal	Belén	Spain	NanoBiotechnology	*Synthesis and antimicrobial study of silver-kaolinite nanocomposites*
Castellanos	Idoia	Spain	NanoChemistry	*Pd Nanoparticles Functionalized with alkylamines: Structural and Magnetic Characterization*
Castrillón García	Mariana	Spain	NanoMaterials	*Development of superparamagnetic nanocomposite: The effect of nanoparticles dispersion and matrix structure on magnetic properties*
Collado Martín	Daniel	Spain	NanoChemistry	*Functionalization and Characterization of Carbon Nanotubes solubles in physiological media*

Cortez	João	Portugal	NanoBiotechnology	*Tyrosinase conjugates with gold nanoparticles for use as nanoprobes*
Cózar-Bernal	Mª José	Spain	NanoBiotechnology	*Insulin-loaded poly(D,L-lactide-co-glycolide) micro- and nanoparticles obtained by Flow Focusing technology*
Cuesta-López	Santiago	Spain	NanoBiotechnology	*Physical view of biomolecular interactions in nano-technological applications.*
Cussó	Fernando	Spain	Nanophotonics	*YF3:Tm,Yb nanocrystals: enhanced up-conversion blue and UV emitters*
de Assis	Thiago	Madrid	Simulation at the nanoscale	*Effect of nano-irregularities in the work function and field emission properties of metallic surfaces.*
Diéguez	Lorena	Spain	NanoBiotechnology	*Fabrication of optical gratings coated with Si3N4 for efficient immunosensing monitored by Optical Waveguide Spectroscopy*
Dieleman	Dennis	Spain	Nanomagnetism	*Micromagnetic simulations of metastable states in circular magnetic dots*
Dominik	Pawel	Poland	NanoMaterials	*Application of gold nanocolloidal system to obtain gallium nitride nanowires by Sublimation Sandwich Method*
Dussan Cuenca	Anderson	Colombia	NanoMaterials	*Influence of boron on the nanocrystalline silicon films grown by plasma enhanced CVD*
Eguílaz	Marcos	Spain	NanoBiotechnology	*Magnetic immunosensors for the determination of cortisol*
Enríquez-Navas	Pedro Miguel	Spain	NanoBiotechnology	*Gold nanoparticles capped with mannose glycans block HIV-1 gp120 binding to antibody 2G12 as studied by means of NMR and SPR techniques.*
Félix-González	Nazario	Spain	NanoBiotechnology	*Challenges on the Characterization of Superparamagnetic Particles as Contrast Agents in MRI*
Fernández	Mercedes	Spain	NanoMaterials	*Striking effect of temperature on conductivity of polyurethane/CNT nanocomposites*
Fernández García	María Paz	Spain	Nanomagnetism	*striking nano-onion nanoparticles with core (gamma-Fe)/ double shell (alfa-Fe/ Fe-oxide): synthesis, microstructure and magnetism*
Fernández Torrado	Jorge	Spain	Nanophotonics	*Transverse magneto-optical effects in Fe antidot arrays*
Ferro	Vicente	Spain	NanoBiotechnology	*Using Alternating Gradient Field Magnetometers for the characterization of the mechanical and magnetic behavior of magnetic nanoparticles in biological samples*
Franco	Ricardo	Portugal	NanoBiotechnology	*Gold Nanoparticle-Based Immunoassay for detection of Plasmodium falciparum Hsp70*
Galán Cascales	Teresa	Spain	NanoBiotechnology	*Fabrication by Dip-Pen Nanolithography of Polypyrrole Nanowires for DNA biosensors*
Galisteo	Juan	Spain	Nanophotonics	*Enhanced emission in self assembled photonic crystals by hybrid photonic-plasmonic modes*
Gálvez Rodríguez	Natividad	Spain	NanoBiotechnology	*Maghemite Nanoparticles-Templated Assembly of Apoferritin Protein Functionalized with Carbohydrates for Targetting Cells*
García Mendoza	Rubén Antonio	Spain	NanoBiotechnology	*Magnetic fields interactions phenomena in guidance and focusing of magnetic micro and nanoparticles*
García Sánchez	Pablo	Spain	NanoMaterials	*Nanoparticle Electrofluidization*

García-Sánchez	Pablo	Spain	NanoBiotechnology	*Manipulation of nanoparticles by arrays of electrodes: a theoretical analysis*
Goiti	Eunate	Spain	NanoMaterials	*Zero valent iron nanoparticles for in-situ remediation*
Gomes	Ana Paula	Portugal	NanoBiotechnology	*Layer-by-Layer deposition of antimicrobial nanolayers on natural fibres*
Gomes	Inês	Portugal	NanoBiotechnology	*Tyrosinase-Gold Nanoparticles Conjugates on Nanostructured Gold Surfaces: Towards a Biosensor of Phenolic Compounds*
González Vivas	Laura	Spain	Nanomagnetism	*Magnetization process and magnetoresistance in tailored arrays of CoNi nanowires*
Guillén Ruiz	Elena	Spain	NanoChemistry	*Synthesis of Substituted Tripod-Shaped Tri(p-phenylene)s*
Gutiérrez	Fco Javier	Spain	NanoChemistry	*Development of Nanoencapsulates for Nutritional Use*
Haffouz	Soufien	Canada	Nanophotonics	*1.1-um broadband superluminescent diodes with height-engineered InAs*
Heredia-Guerrero	José Alejandro	Spain	Scanning Probe Microscopies (SPM)	*Shaking molecules: detection of defects in SAMs of aliphatic amines with jumping mode AFM*
Herranz Aragoncillo	David	Spain	Nanomagnetism	*Oscillatory dependence of magnetoresistance with bias voltage in Fe/MgO/Fe/MgO/Fe epitaxial double magnetic tunnel junctions with dielectric breakdown*
Hierrezuelo León	Jesús-Mario	Spain	NanoChemistry	*Modification of a Regenerated Cellulose Membrane with Lipid Nanoparticles and Layers. Nanoparticle Preparation, Morphological and Physicochemical Characterization of Nanoparticles and Modified Membran*
Holgado	Mª Ángeles	Spain	NanoBiotechnology	*Engineering of gemcitabine-loaded poly(D,L-lactide-co-glycolide) nanoparticles by flow focusing for cancer treatment*
Idigoras	Olatz	Spain	Nanomagnetism	*Magnetization reversal and the intermediate state stability in Co-films*
Iglesias	Ignacio	Spain	Nanophotonics	*Optical Scattering Forces Generated By High Numerical Aperture Microscope Objectives*
Jiménez de Aberasturi	Dorleta	Spain	NanoChemistry	*Adsorption of palladium ions by magnetite nanoparticles*
Jos	Ángeles	Spain	Nanotubes	*Basal citotoxicity of single wall carbon nanotubes on a human endothelial cell line (HUVEC)*
Juanola-Feliu	Esteve	Spain	NanoBiotechnology	*Nanobiotechnologies and nanomedicine: Organizational and market challenges in a technology convergence scenario*
Khiar	Noureddine	Spain	Nanotubes	*A Butterfly-like model for non-covalent functionalization of MWCNTs as a biocompatible nanoglycoarrays*
Kirilov	Plamen	France	NanoMaterials	*Cationic Surfactants Based on Renewable Raw Materials: New Emulsifiers for Elaboration of Nanoparticles of Dispersed Oil*
Klippstein	Rebecca	Spain	NanoBiotechnology	*Nanotechnology approaches for improved based-drug delivery systems of the immunomodulatory neuropeptide vasoactive intestinal peptide*
Köber	Mariana	Spain	NanoChemistry	*Decrease of the adhesion force with vapor pressure*
Koerdel	Christian	Germany	NanoChemistry	*Photoresponsive Amphiphiles Based on Azobenzene Glycerol Conjugates for Drug Delivery*

Kovylina	Miroslavna	Spain	Nanomagnetism	*Tuning exchange bias in Ni/FeF2 heterostructures using antidot arrays*
López Fernández	Xavier	Spain	Simulation at the nanoscale	*Techntetium derivatives of Dawson Heteropolyanions: Redox properties and α1/α2 Relative Stability*
López-Arce	Paula	Spain	NanoMaterials	*Consolidating stone materials by means of nanoparticles*
Lottici	Pier Paolo	Italy	NanoBiotechnology	*Effect of the synthesis factors in the structure of Dopamine-silica sol-gel functionalized neurological nanoreservoirs*
Márquez	Manuel	United States	NanoBiotechnology	*A New Paradigm for Cell Architecture: Celloidosomes®*
Martin Banderas	Lucia	Spain	NanoBiotechnology	*Nanotechnology-based new systems in drug delivery*
Martín Jiménez	Francisco de Paula	Spain	NanoMaterials	*Metal oxides nanofibers obtained by electrospinning*
Martínez	Nicolás F.	Spain	NEMS / MEMS	*Multifunctional nanomechanical systems for multiplexed highly selective and sensitive biological detection*
Mina Rosales	Alejandra	Spain	NanoBiotechnology	*First studies with a new wide frequency range device for the induction of hyperthermia in magnetic fluids, for magnetic fluids experimentation in biomedical applications*
Montero Alejo	Ana Lilian	Spain	NanoChemistry	*Electron excitations of carbon nanostructures by the CNDOL Hamiltonian*
Monti	Matteo	Spain	Other	*Design and Construction of an Ultra High Vacuum Integral Low Energy Electron Mössbauer Spectrometer for Surface Analysis*
Moradi Garakani	Fereshteh	Iran	Nanotubes	*Investigation of Ionic Water Flow Over a Carbon Nanotube: Stick-Slip Mechanism*
Moya	Sergio	Spain	NanoBiotechnology	*Health Impact of Engineered Metal and Metal Oxide Nanoparticles: Response, Bioimaging and Distribution at Cellular and Body Level*
Muñoz-Rubio	Inmaculada	Spain	NanoBiotechnology	*Design and production of cannabinoids-loaded PLGA nanoparticles for treatment of neuropathic pain*
Núñez	Nuria	Spain	NanoMaterials	*Uniform YF3:Yb,Er up-conversion nanophosphors of various morphologies synthesised in polyol media through an ionic liquid.*
Orfanidou	Charis	Spain	NEMS / MEMS	*Optomechanical multiplexed detection with large arrays of cantilevers*
Osório	Inés V.	Portugal	NanoMaterials	*Functionalisation of textile fibres with metal nanoparticles*
Ozaita	Milagros	Spain	Scanning Probe Microscopies (SPM)	*Design and development of the CEM metrological long range scanning probe microscope*
Padilla	Diana	Spain	NanoChemistry	*Simultaneous ir (1064 nm) pulsed laser deposition and annealing of zno films with an splitted 1064 nm beam*
Parak	Wolfgang	Germany	NanoBiotechnology	*Colloidal nano- and microparticles towards sensing applications in biology*
Pérez Rodríguez	Nicolás	Spain	Nanomagnetism	*Surface anisotropy, orbital moment and biomedical applications in magnetic nanoparticles*
Pérez-Carrillo	Lourdes Adriana	Spain	NanoMaterials	*Synthesis and Characterization of Porous Materials Prepared by Templating in Oil-in-Alcohol Highly Concentrated Emulsions*

Pérez-Puigdemont	Jordi	Spain	NanoMaterials	*Simulation and impedance analysis of carbon nanotube thin films*
Piettre	Kilian	France	NanoChemistry	*Cu/SiO2 films for 3D filling in microelectronic applications by an organometallic chemical liquid deposition (OMCLD) route*
Piksova	Katerina	Czech Republic	Other	*The bactericidal effect of silver nanoparticles*
Popeney	Chris	Germany	Nanotubes	*Polyglycerol-Based Amphiphiles for the Water Solubilization and Aggregate Disruption of Single-Walled Carbon Nanotubes: Structure-Property Relationships*
Queiroz	Maria-João R.P.	Portugal	NanoBiotechnology	*Studies of encapsulation of new antitumoral fluorescent compounds in nanoliposomes for drug delivery purposes*
Ramalho	Rubén	Portugal	NanoMaterials	*Using biomolecules with micro and nanosystems: electrically aligned microtubules as a foundation for further integration*
Ramos-Barrado	José	Spain	NanoChemistry	*Preparation and characterization of single-crystalline silicon nanowire arrays*
Rizvi	Sarwat Butool	United Kingdom	NanoBiotechnology	*Polyhedral oligomeric silsesquioxanes and poly (carbonate-urea) urethane coated semiconductor nanocrystals for biomedical application*
Rodriguez	Cristina	Spain	NanoBiotechnology	*Synthesis and evaluation of magnetic poly(styrene/divinylbenzene/acrylic acid) microspheres for applications in bio-molecular recognition.*
Roura	Pere	Spain	NanoMaterials	*Thermal decomposition of cerium propionate in oxidant atmosphere to obtain ceria nanocrystalline films at low temperature*
Ruiz Sánchez	Antonio Jesús	Spain	NanoBiotechnology	*Dendrimeric-Nanocarriers for easy in vitro detection of allergic reactions induced by b-lactams*
Ruiz Zamarreño	Carlos	Spain	Nanophotonics	*Label-Free Optical Fiber Sensing Platform based on Lossy Mode Resonances Supported by Transparent Conducting Oxides*
Salamanca	Laura	Spain	NanoBiotechnology	*Information processing needs and challenges in the context of Nanomedicine*
Saliba	Sarmenio	France	NanoMaterials	*Liquid Crystalline-ZnO Nanoparticle Hybrids*
Sánchez Paradinas	Sara	Spain	NanoBiotechnology	*Quantum dots in aqueous medium. Size, quantum efficiency and stability*
Sánchez Sánchez	M. Purificación	Spain	NanoBiotechnology	*Non innocent oxoanions encapsulated in Ferritin for SPECT imaging*
Sánchez-Valencia	Juan Ramón	Spain	NanoMaterials	*Tunable in plane optical anisotropy of Ag nanostructures growth on columnar SiO2 template thin film*
Sánchez-Valencia2	Juan Ramón	Spain	Nanophotonics	*Control of the aggregation state of Rhodamine 6G dye molecules adsorbed in porous columnar GAPVD thin films*
Santos	Silvia	France	Nanotubes	*Saturation, spectroscopy and time correlated studies of single-walled carbon nanotubes*
Santos	Benito	Spain	Nanomagnetism	*Controlling the magnetization direction with hydrogen*
Sencadas	Vitor	Portugal	NanoBiotechnology	*Electroactive poly(vinylidene fluoride-trifluoroethylene) membranes obtained by isothermal crystallization from solution*
Silkin	Vyacheslav	Spain	NanoMaterials	*Time-evolution of the screening charge around a suddenly created point charge at a metal surface*
Sledzinska	Marianna	Spain	NEMS / MEMS	*Carbon Nanotube Electron Windmills*

Tellechea Malda	Edurne	Spain	NanoBiotechnology	*Gold nanoparticle-sod enzyme conjugates for therapeutic applications*
Téllez	Helena	Spain	NanoMaterials	*Depth Profiling Analysis of Metallic Nanolayers on Polymer Films for Microelectronics Applications by Secondary Ion Mass Spectrometry*
Traversa	Fabio Lorenzo	Spain	NanoElectronics	*Quantifying many-particle Coulomb correlation through the super-poissonian noise of electron current in resonant structures*
Umek	Polona	Slovenia	NanoMaterials	*Tayloring of morphology, dimensions and magnetic properties of α-MnO2 nanoparticles by the change of reaction parameters*
Vadillo	José Miguel	Spain	NanoMaterials	*In-depth Characterization of Nanolayered Structures in III-V Semiconductors by Secondary Ion Mass Spectrometry (SIMS)*
Vera Saz	Francisco	Spain	NanoChemistry	*Supramolecular Architectures Formed by Hierarchical Self-Assembled PTM radicals*
Vida	Yolanda	Spain	NanoChemistry	*Solid supports for Dendrimers. Preparation and Bio-Applications*
Vilhena Albuquerque d'Orey	José Guilherme	France	NanoMaterials	*Excitonic effects in the optical properties of CdSe nanowires*
Vizuete	María	Spain	Nanotubes	*Supramolecular Assembles of Carbon Nanohorns and Porphyrin for Photovoltaic Devices*

Poster Session (119)			
Presenting Author		**Country**	**Poster Title**
TOPIC: NanoBiotechnology / Nanomedicine			
Agüeros	Maite	Spain	*Cyclodextrin-bioadhesive nanoparticles for oral delivery of paclitaxel*
Aguilar-Caballos	Maria Paz	Spain	*Recent trends in the use of nanotechnology for the control of tumor markers*
Ahmadi	Maryam	Iran	*Production and development of rapid test for analyse of PSA gene expression with oligonucleotide conjugate gold nanoparticle as probe*
Baptista	Ana Catarina	Portugal	*Electrospun cellulose-based membranes for bioelectrochemical devices*
Borges	João	Portugal	*Electrospinning of PVP-calcium phosphates sol precursors for the production of hydroxyapatite nanofibres*
Boutinguiza Larosi	Mohamed	Spain	*Generation of Calcium Phosphate Nanoparticles by Laser Ablation in Ambient Conditions*
Cabal	Belén	Spain	*Synthesis and antimicrobial study of silver-kaolinite nanocomposites*
Cortez	João	Portugal	*Tyrosinase conjugates with gold nanoparticles for use as nanoprobes*
Cózar-Bernal	Mª José	Spain	*Insulin-loaded poly(D,L-lactide-co-glycolide) micro- and nanoparticles obtained by Flow Focusing technology*
Cuesta-López	Santiago	Spain	*Physical view of biomolecular interactions in nano-technological applications.*
Diéguez	Lorena	Spain	*Fabrication of optical gratings coated with Si3N4 for efficient immunosensing monitored by Optical Waveguide Spectroscopy*
Eguílaz	Marcos	Spain	*Magnetic immunosensors for the determination of cortisol*
Enríquez-Navas	Pedro Miguel	Spain	*Gold nanoparticles capped with mannose glycans block HIV-1 gp120 binding to antibody 2G12 as studied by means of NMR and SPR techniques.*
Félix-González	Nazario	Spain	*Challenges on the Characterization of Superparamagnetic Particles as Contrast Agents in MRI*
Ferro	Vicente	Spain	*Using Alternating Gradient Field Magnetometers for the characterization of the mechanical and magnetic behavior of magnetic nanoparticles in biological samples*
Franco	Ricardo	Portugal	*Gold Nanoparticle-Based Immunoassay for detection of Plasmodium falciparum Hsp70*
Galán Cascales	Teresa	Spain	*Fabrication by Dip-Pen Nanolithography of Polypyrrole Nanowires for DNA biosensors*
Gálvez Rodríguez	Natividad	Spain	*Maghemite Nanoparticles-Templated Assembly of Apoferritin Protein Functionalized with Carbohydrates for Targetting Cells*
García Mendoza	Rubén Antonio	Spain	*Magnetic fields interactions phenomena in guidance and focusing of magnetic micro and nanoparticles*
García-Sánchez	Pablo	Spain	*Manipulation of nanoparticles by arrays of electrodes: a theoretical analysis*
Gomes	Ana Paula	Portugal	*Layer-by-Layer deposition of antimicrobial nanolayers on natural fibres*
Gomes	Inês	Portugal	*Tyrosinase-Gold Nanoparticles Conjugates on Nanostructured Gold Surfaces: Towards a Biosensor of Phenolic Compounds*
Holgado	Mª Ángeles	Spain	*Engineering of gemcitabine-loaded poly(D,L-lactide-co-glycolide) nanoparticles by flow focusing for cancer treatment*

Juanola-Feliu	Esteve	Spain	*Nanobiotechnologies and nanomedicine: Organizational and market challenges in a technology convergence scenario*
Klippstein	Rebecca	Spain	*Nanotechnology approaches for improved based-drug delivery systems of the immunomodulatory neuropeptide vasoactive intestinal peptide*
Lotticí	Pier Paolo	Italy	*Effect of the synthesis factors in the structure of Dopamine-silica sol-gel functionalized neurological nanoreservoirs*
Márquez	Manuel	United States	*A New Paradigm for Cell Architecture: Celloidosomes®*
Martin Banderas	Lucia	Spain	*Nanotechnology-based new systems in drug delivery*
Mina Rosales	Alejandra	Spain	*First studies with a new wide frequency range device for the induction of hyperthermia in magnetic fluids, for magnetic fluids experimentation in biomedical applications*
Moya	Sergio	Spain	*Health Impact of Engineered Metal and Metal Oxide Nanoparticles: Response, Bioimaging and Distribution at Cellular and Body Level*
Muñoz-Rubio	Inmaculada	Spain	*Design and production of cannabinoids-loaded PLGA nanoparticles for treatment of neuropathic pain*
Parak	Wolfgang	Germany	*Colloidal nano- and microparticles towards sensing applications in biology*
Queiroz	Maria-João R.P.	Portugal	*Studies of encapsulation of new antitumoral fluorescent compounds in nanoliposomes for drug delivery purposes*
Rizvi	Sarwat Butool	United Kingdom	*Polyhedral oligomeric silsesquioxanes and poly (carbonate-urea) urethane coated semiconductor nanocrystals for biomedical application*
Rodríguez	Cristina	Spain	*Synthesis and evaluation of magnetic poly(styrene/divinylbenzene/acrylic acid) microspheres for applications in bio-molecular recognition.*
Ruiz Sánchez	Antonio Jesús	Spain	*Dendrimeric-Nanocarriers for easy in vitro detection of allergic reactions induced by b-lactams*
Salamanca	Laura	Spain	*Information processing needs and challenges in the context of Nanomedicine*
Sánchez Paradinas	Sara	Spain	*Quantum dots in aqueous medium. Size, quantum efficiency and stability*
Sánchez Sánchez	M. Purificación	Spain	*Non innocent oxoanions encapsulated in Ferritin for SPECT imaging*
Sencadas	Vitor	Portugal	*Electroactive poly(vinylidene fluoride-trifluoroethylene) membranes obtained by isothermal crystallization from solution*
Tellechea Malda	Edurne	Spain	*Gold nanoparticle-sod enzyme conjugates for therapeutic applications*

TOPIC: NanoChemistry

Bonel	Laura	Spain	*Nanostructured electrochemical aptasensors for ochratoxin A (OTA) determination*
Castellanos	Idoia	Spain	*Pd Nanoparticles Functionalized with alkylamines: Structural and Magnetic Characterization*
Collado Martín	Daniel	Spain	*Functionalization and Characterization of Carbon Nanotubes solubles in physiological media*
Guillén Ruiz	Elena	Spain	*Synthesis of Substituted Tripod-Shaped Tri(p-phenylene)s*
Gutiérrez	Fco Javier	Spain	*Development of Nanoencapsulates for Nutritional Use*
Hierrezuelo León	Jesús-Mario	Spain	*Modification of a Regenerated Cellulose Membrane with Lipid Nanoparticles and Layers. Nanoparticle Preparation, Morphological and Physicochemical Characterization of Nanoparticles and Modified Membran*

Jiménez de Aberasturi	Dorleta	Spain	*Adsorption of palladium ions by magnetite nanoparticles*
Köber	Mariana	Spain	*Decrease of the adhesion force with vapor pressure*
Koerdel	Christian	Germany	*Photoresponsive Amphiphiles Based on Azobenzene Glycerol Conjugates for Drug Delivery*
Montero Alejo	Ana Lilian	Spain	*Electron excitations of carbon nanostructures by the CNDOL Hamiltonian*
Padilla	Diana	Spain	*Simultaneous ir (1064 nm) pulsed laser deposition and annealing of zno films with an splitted 1064 nm beam*
Piettre	Kilian	France	*Cu/SiO2 films for 3D filling in microelectronic applications by an organometallic chemical liquid deposition (OMCLD) route*
Ramos-Barrado	José	Spain	*Preparation and characterization of single-crystalline silicon nanowire arrays*
Vera Saz	Francisco	Spain	*Supramolecular Architectures Formed by Hierarchical Self-Assembled PTM radicals*
Vida	Yolanda	Spain	*Solid supports for Dendrimers. Preparation and Bio-Applications*

TOPIC: NanoElectronics / Molecular Electronics

Buccafurri	Emanuela	France	*High frequency resonant tunneling behavior: Testing an analytical small signal equivalent circuit with time dependent many-particle quantum simulations*
Traversa	Fabio Lorenzo	Spain	*Quantifying many-particle Coulomb correlation through the super-poissonian noise of electron current in resonant structures*

TOPIC: Nanomagnetism

Aliev	Farkhad	Spain	*Strongly suppressed 1/f noise and enhanced magnetoresistance due to reduced interface mismatch in epitaxial Fe<V>/MgO /Fe magnetic tunnel junctions*
Awad	Ahmad	Spain	*Precise probing spin wave dynamics in circular magnetic dots: influence of dots aspect ratio, magnetic field and direction of microwave field pumping*
Balint	Paul	France	*Magnetic particles for biotechnology*
Dieleman	Dennis	Spain	*Micromagnetic simulations of metastable states in circular magnetic dots*
Fernández García	María Paz	Spain	*striking nano-onion nanoparticles with core (gamma-Fe)/ double shell (alfa-Fe/ Fe-oxide): synthesis, microstructure and magnetism*
González Vivas	Laura	Spain	*Magnetization process and magnetoresistance in tailored arrays of CoNi nanowires*
Herranz Aragoncillo	David	Spain	*Oscillatory dependence of magnetoresistance with bias voltage in Fe/MgO/Fe/MgO/Fe epitaxial double magnetic tunnel junctions with dielectric breakdown*
Idigoras	Olatz	Spain	*Magnetization reversal and the intermediate state stability in Co-films*
Kovylina	Miroslavna	Spain	*Tuning exchange bias in Ni/FeF2 heterostructures using antidot arrays*
Pérez Rodríguez	Nicolás	Spain	*Surface anisotropy, orbital moment and biomedical applications in magnetic nanoparticles*
Santos	Benito	Spain	*Controlling the magnetization direction with hydrogen*

TOPIC: NanoMaterials

Álvarez	Lucia	Spain	*XPS and STM study of Metalorganic nanostrucures*
Aparicio Rebollo	Francisco Javier	Spain	*Luminescent nanocomposites for photonic sensing*
Castrillón García	Mariana	Spain	*Development of superparamagnetic nanocomposite: The effect of nanoparticles dispersion and matrix structure on magnetic properties*
Dominik	Pawel	Poland	*Application of gold nanocolloidal system to obtain gallium nitride nanowires by Sublimation Sandwich Method*
Dussan Cuenca	Anderson	Colombia	*Influence of boron on the nanocrystalline silicon films grown by plasma enhanced CVD*
Fernández	Mercedes	Spain	*Striking effect of temperature on conductivity of polyurethane/CNT nanocomposites*
García Sánchez	Pablo	Spain	*Nanoparticle Electrofluidization*
Goiti	Eunate	Spain	*Zero valent iron nanoparticles for in-situ remediation*
Kirilov	Plamen	France	*Cationic Surfactants Based on Renewable Raw Materials: New Emulsifiers for Elaboration of Nanoparticles of Dispersed Oil*
López-Arce	Paula	Spain	*Consolidating stone materials by means of nanoparticles*
Martín Jiménez	Francisco de Paula	Spain	*Metal oxides nanofibers obtained by electrospinning*
Núñez	Nuria	Spain	*Uniform YF3:Yb,Er up-conversion nanophosphors of various morphologies synthesised in polyol media through an ionic liquid.*
Osório	Ines V.	Portugal	*Functionalisation of textile fibres with metal nanoparticles*
Pérez-Carrillo	Lourdes Adriana	Spain	*Synthesis and Characterization of Porous Materials Prepared by Templating in Oil-in-Alcohol Highly Concentrated Emulsions*
Pérez-Puigdemont	Jordi	Spain	*Simulation and impedance analysis of carbon nanotube thin films*
Ramalho	Rubén	Portugal	*Using biomolecules with micro and nanosystems: electrically aligned microtubules as a foundation for further integration*
Roura	Pere	Spain	*Thermal decomposition of cerium propionate in oxidant atmosphere to obtain ceria nanocrystalline films at low temperature*
Saliba	Sarmenio	France	*Liquid Crystalline-ZnO Nanoparticle Hybrids*
Sánchez-Valencia	Juan Ramón	Spain	*Tunable in plane optical anisotropy of Ag nanostructures growth on columnar SiO2 template thin film*
Silkin	Vyacheslav	Spain	*Time-evolution of the screening charge around a suddenly created point charge at a metal surface*
Téllez	Helena	Spain	*Depth Profiling Analysis of Metallic Nanolayers on Polymer Films for Microelectronics Applications by Secondary Ion Mass Spectrometry*
Umek	Polona	Slovenia	*Tayloring of morphology, dimensions and magnetic properties of α-MnO2 nanoparticles by the change of reaction parameters*
Vadillo	José Miguel	Spain	*In-depth Characterization of Nanolayered Structures in III-V Semiconductors by Secondary Ion Mass Spectrometry (SIMS)*
Vilhena Albuquerque d'Orey	José Guilherme	France	*Excitonic effects in the optical properties of CdSe nanowires*

TOPIC: Nanophotonics			
Barranco Quero	Ángel	Spain	*Conformal Growth of Organic Luminescent Planar Defects within Artificial Opals*
Cussó	Fernando	Spain	*YF3:Tm,Yb nanocrystals: enhanced up-conversion blue and UV emitters*
Fernández Torrado	Jorge	Spain	*Transverse magneto-optical effects in Fe antidot arrays*
Galisteo	Juan	Spain	*Enhanced emission in self assembled photonic crystals by hybrid photonic-plasmonic modes*
Haffouz	Soufien	Canada	*1.1-um broadband superluminescent diodes with height-engineered InAs*
Iglesias	Ignacio	Spain	*Optical Scattering Forces Generated By High Numerical Aperture Microscope Objectives*
Ruiz Zamarreño	Carlos	Spain	*Label-Free Optical Fiber Sensing Platform based on Lossy Mode Resonances Supported by Transparent Conducting Oxides*
Sánchez-Valencia	Juan Ramón	Spain	*Control of the aggregation state of Rhodamine 6G dye molecules adsorbed in porous columnar GAPVD thin films*

TOPIC: Nanotubes			
Assali	Mohyeddin	Spain	*Bioengineering of Carbon Nanotubes: Glyconanoabacus with Biomimetic Display of Carbohydrates*
Jos	Ángeles	Spain	*Basal citotoxicity of single wall carbon nanotubes on a human endothelial cell line (HUVEC)*
Khiar	Noureddine	Spain	*A Butterfly-like model for non-covalent functionalization of MWCNTs as a biocompatible nanoglycoarrays*
Moradi Garakani	Fereshteh	Iran	*Investigation of Ionic Water Flow Over a Carbon Nanotube: Stick-Slip Mechanism*
Popeney	Chris	Germany	*Polyglycerol-Based Amphiphiles for the Water Solubilization and Aggregate Disruption of Single-Walled Carbon Nanotubes: Structure-Property Relationships*
Santos	Silvia	France	*Saturation, spectroscopy and time correlated studies of single-walled carbon nanotubes*
Vizuete	María	Spain	*Supramolecular Assembles of Carbon Nanohorns and Porphyrin for Photovoltaic Devices*

TOPIC: NEMS / MEMS			
Martínez	Nicolás F.	Spain	*Multifunctional nanomechanical systems for multiplexed highly selective and sensitive biological detection*
Orfanidou	Charis	Spain	*Optomechanical multiplexed detection with large arrays of cantilevers*
Sledzinska	Marianna	Spain	*Carbon Nanotube Electron Windmills*

TOPIC: Scanning Probe Microscopies (SPM)			
Behme	Gerd	Germany	*Analysis of cellular and molecular interactions using Atomic Force Microscopy*
Heredia-Guerrero	José Alejandro	Spain	*Shaking molecules: detection of defects in SAMs of aliphatic amines with jumping mode AFM*
Ozaita	Milagros	Spain	*Design and development of the CEM metrological long range scanning probe microscope*

TOPIC: Simulation at the Nanoscale

Albareda	Guillem	Spain	*Boundary conditions for nanoscale electron devices with realistic lead-sample Coulomb correlations in small simulating boxes*
de Assis	Thiago	Madrid	*Effect of nano-irregularities in the work function and field emission properties of metallic surfaces.*
lopez Fernandez	Xavier	Spain	*Techntetium derivatives of Dawson Heteropolyanions: Redox properties and $\alpha1/\alpha2$ Relative Stability*

TOPIC: Other

Monti	Matteo	Spain	*Design and Construction of an Ultra High Vacuum Integral Low Energy Electron Mössbauer Spectrometer for Surface Analysis*
Piksova	Katerina	Czech Republic	*The bactericidal effect of silver nanoparticles*

science • industry • society

IMAGINENANO

Bringing together Nanoscience and Nanotechnology

April 11-14, 2011 - Bilbao Exhibition Centre (Spain)

www.imaginenano.com

ImagineNano will comprise 5 parallel international conferences, a huge industrial exhibition and a social event where everyone can meet and greet Nanotechnology side by side

science

- **Graphene 2011**
- **nanoBio&Med 2011**
- **NanoIberian 2011**
- **TNA Energy**
  Trends in NanoApplications
- **PPM 2011**
  Photonics/Plasmonics/Magneto-Optics

society

industry