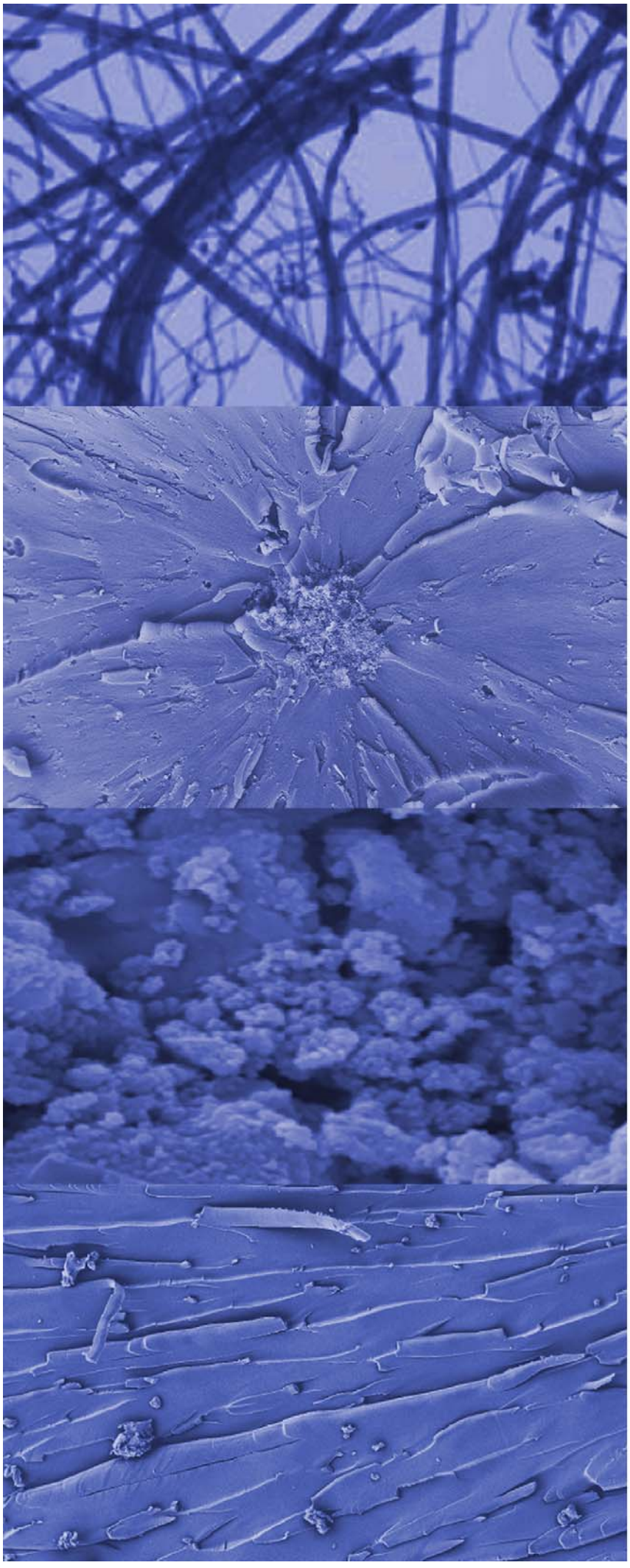

TNT2008

Trends in NanoTechnology

Oviedo (Spain)

September 01-05, 2008

PHANTOMS foundation

400 cuarto centenario

Universidad de Oviedo 1608-2008

Georgia Tech

Purdue University

DONOSTIA INTERNATIONAL PHYSICS CENTER

CIC nanoGUNE nanoscience cooperative research center

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On behalf of the Honorary, International, Local and Technical Committees, we take great pleasure in welcoming you to Oviedo (Spain) for the 9th "Trends in NanoTechnology" (TNT2008) International Conference.

TNT2008 is being held in large part due to the overwhelming success of earlier TNT Nanotechnology Conferences and will be organised in a similar way to the eight prior TNT conferences.

This high-level scientific meeting series aims to present a broad range of current research in Nanoscience and Nanotechnology worldwide, as well as initiatives such as iNANO, EU/ICT/FET, GDR-E, MANA, CIC nanoGUNE Consolider, etc. TNT events have demonstrated that they are particularly effective in transmitting information and promoting interaction and new contacts among workers in this field. Furthermore, this event offers visitors and sponsors an ideal opportunity to interact with each other.

One of the main objectives of the Trends in Nanotechnology conference is to provide a platform where young researchers can present their latest work and also interact with high-level scientists. For this purpose, the Organising Committee provides every year around 80 travel grants for students. In addition, this year, 19 awards (4500 Euros in total) will be given to young PhD students for their contributions presented at TNT. More than 60 senior scientists are involved in the selection process. Grants and awards are funded by the TNT Organisation in collaboration with several governmental and research institutions.

TNT is now one of the premier European conferences devoted to nanoscale science and technology with around 350-400 participants worldwide.

We are indebted to the following Scientific Institutions, Companies, Individuals and Government Agencies for their help and financial support: Phantoms Foundation, Universidad de Oviedo, Donostia International Physics Center (DIPC), CIC nanoGUNE Consolider, Consejo Superior de Investigaciones Científicas, Universidad Autónoma de Madrid, Universidad Complutense de Madrid, University of Purdue, Georgia Institute of Technology, CEA/LETI, MINATEC, Instituto Español de Comercio Exterior (ICEX) & "españa-technology for life" program, NIMS (Nanomaterials Laboratory) and MANA (International Center for Materials and Nanoarchitectonics), University of Fribourg and frimat, Air Force Office of Scientific Research, The Office of Naval Research International Field Office (ONRIFO), iNANO, NSERC/CRSNG (Nano Innovation Platform), GDR-E/NanoE, Raith GmbH, Parque Científico de Barcelona (PCB), IE Universidad, cajAstur, Gobierno del Principado de Asturias, Ayuntamiento de Oviedo, Auditorio Palacio de Congresos Príncipe Felipe, Fundación Itma, Instituto de Desarrollo Económico del Principado de Asturias (IDEPA), Bioker Research, Ministerio de Ciencia e Innovación, Parque Científico de Madrid (PCM), Forschungszentrum Jülich, nanoICT Coordination Action & EU/ICT/FET, P. Van Hove (private donation) and Wiley-VCH & PSS.

We would also like to thank the following companies and Institutions for their participation: Nanotec Electronica, Raith, Scientec, Biometa, Telstar Instrumat, Omicron Nanotechnology, Crestec Corporation, Phantoms Foundation, ICEX, Wiley-VCH and nanoICT EU project.

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

THE ORGANISING COMMITTEE

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* Contact person: antonio@phantomsnet.net

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TNT2008 POSTER AWARDS Funded by		Award
	Parc Cientific de Barcelona (PCB)	350 Euros
	NIMS / MANA	300 Euros
	Physica Status Solidi	300 Euros
	NSERC-CRSNG (NanoIP)	300 Euros
	NSERC-CRSNG (NanoIP)	300 Euros
	NSERC-CRSNG (NanoIP)	300 Euros
	CIC nanoGUNE Consolider	250 Euros
Private Donation	**Patrick Van-Hove**	250 Euros
	Parque Científico de Madrid (PCM)	200 Euros
	Parque Científico de Madrid (PCM)	200 Euros
	GDR-E on Science and Applications of Nanotubes	200 Euros
	Phantoms Foundation	Ipod Nano
	Phantoms Foundation	Ipod Nano
	Phantoms Foundation	Ipod Nano
Private Donation	**David Prize**	300 Dollars
Private Donation	**Keren Prize**	300 Dollars
	Forschungszentrum Jülich	One Textbook "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices"
	Forschungszentrum Jülich	One Textbook "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices"
	TNT2008 Organisation	Free registration to the TNT2009 Conference

TNT 2008 PLATINUM SPONSORS

SPANISH INSTITUTE FOR FOREIGN TRADE ICEX

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IDEPA Instituto de Desarrollo Económico del Principado de Asturias

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Gobierno del Principado de Asturias

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Fundación itma

cinn Centro de Investigación en Nanomateriales y Nanotecnología

TNT2008 EXHIBITORS

Raith GmbH

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E-mail: postmaster@raith.de / **WEB:** http://www.raith.com

eLINE
The First electron-beam lithography Workstation with nano engineering capabilities

For more than two decades **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 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.

Nanotec Electronica

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E-mail: nanotec@nanotec.es / **WEB:** http://www.nanotec.es

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.

Crestec Corporation

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Crestec Corporation is a leading manufacture of Electron Beam Lithography System.CABL-9000C High Resolution EB Lithography System with CE certifications has easier operation and higher performance compared to the standard model CABL series. We will show you the fine lithography pattern data. If you have any requirement of test sample, please contact us.Today, our products like, for example, the new NanoESCA or the UHV Gemini Column are right at the forefront of research. We are used to redefining the limits of the technically feasible again and again. More than 500 articles demonstrate this to the full. Many of them were published in leading journals such as Nature, Science, Physical Review Letters or Chemical Review Letters.

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ScienTec objectively studies your individual needs, advises you and proposes the right product for your application, from our product range. We can provide a specific service, with dedicated engineers for after-sales follow-up and support. **ScienTec** has the in-house expertise to analyse your problem and resolve it, by designing solutions using products and accessories from our range of electronics, optics, mechanics and data processing.

Molecular Imaging is dedicated to providing innovative scanning probe microscopy (SPM) solutions for all academic research and industrial applications. The new PicoPlus microscope is the "all-in-one" solution for applications such as biology, polymers, nanomaterials, electrochemistry...etc, and integrates a number of imaging techniques, such as Scanning Tunneling Microscopy (STM), Low Current STM, Contact Atomic Force Microscopy (AFM), MacMode AFM, including phase imaging, acoustic AC AFM, Lateral Force Microscopy, Current-Sensing AFM, Pulsed Force Mode (PFM), Magnetic Force Microscopy (MFM)...etc. Phase Shift is a manufacturer of 3D non-contact surface metrology instruments. The MicroXAM optical interferometer allows to measure step heights, roughness, waviness, flatness and microstructures etc..., and it is dedicated to many applications such as biomedical optics, hard disks and magnetic media, general optics, semi conductors, polymers, MEMS...etc.

Biometa

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Parcela 38, 33428 Llanera
Asturias (Spain)
Phone: +34 902 24 43 43 / Fax: +34 985 26 91 69
E-mail: info@biometa.es / **WEB:** http://www.biometa.es

BIOMETA was set up in 1998. Its activities are centred on the supply of products and services for research laboratories, industrial quality control and clinical diagnostic. The offices at Parque Tecnológico de Asturias centralize the main services: commercial department, warehouse and technical service. There is an spacious application laboratory where training courses take place quite often, as well as seminars and demos. In order to give the customer the best service there are commercial branches spreaded over the Spanish territory: Vigo, Bilbao, Barcelona, Valencia, Sevilla and Madrid, where the technical service is located as well. The current staff is formed by 21 people, most of them with a high degree and wide experience. Materials Science is one of the most relevant fields in which Biometa participates.
The following are some of the most important companies settled in the nano-field and represented by Biometa in Spain:
- PSIA: Atomic Force Microscopes able to measure in True Non Contact mode.
- Hysitron: Nanoindenters designed to specifically indent in the nano-range and able to perform in-situ SPM images.
Other important companies represented by Biometa are:
BUEHLER: Metallography / GALDABINI: Universal Testing Machine / LENTON: Camera and Tube furnaces up to 1800°C RETSCH: Grinding of samples. Particle size analysis / FLUXANA: Sample preparation and accessories for XRF / PARR: Combustion calorimeters. Laboratory reactors

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TELSTAR INSTRUMAT, S.L. is the TELSTAR group's company dedicated to scientific instrumentation, which was born from the union, at the end of 1998, between TELSTAR's Instrumentation and New Technologies Department and INSTRUMAT TÉCNICAS DE MEDICIÓN, S.A., incorporated into the group due to the synergy in their product range. In these last few years, TELSTAR INSTRUMAT has strengthened its activities representing leading companies in Spain, as well as some companies in Portugal, in the following applications:

- Surface and material characterisation
- Vacuum and cryogenics instrumentation and technology
- Radiometry and photometry
- Particle counting

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

WILEY-VCH

WEB: http://www.wiley-vch.de/

Wiley-VCH bundles its publishing activities in the various business areas of natural and engineering sciences as well as economics. The company provides publications with the best possible distribution on an international scale, coupled with a high standard of quality. From providing students with the basic literature needed, via primary research right up to the latest laboratory methods and research results into active substances: company focus on specific areas of expertise covers the entire spectrum of human knowledge.

ICEX & Phantoms Foundation

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: http://www.icex.es
España, Technology for life: http://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: http://www.phantomsnet.net

Omicron Nanotechnology

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E-mail: info@omicron.de **/ WEB:** http://www.omicron.de

Nanotechnology has been our everyday business since long before the term ever existed. Founded in 1984 by Norbert Nold, Omicron started business by introducing the SPECTALEED and the legendary Ultra High Vacuum STM 1 as their first and highly successful products. The STM 1, which still delivers state-of-the-art performance even by today's standards in nearly 200 laboratories worldwide, firmly established Omicron's present position as the world market leader in UHV scanning probe microscopy.
Today, our products like, for example, the new NanoESCA or the UHV Gemini Column are right at the forefront of research. We are used to redefining the limits of the technically feasible again and again. More than 500 articles demonstrate this to the full. Many of them were published in leading journals such as Nature, Science, Physical Review Letters or Chemical Review Letters.

nanoICT Coordination Action

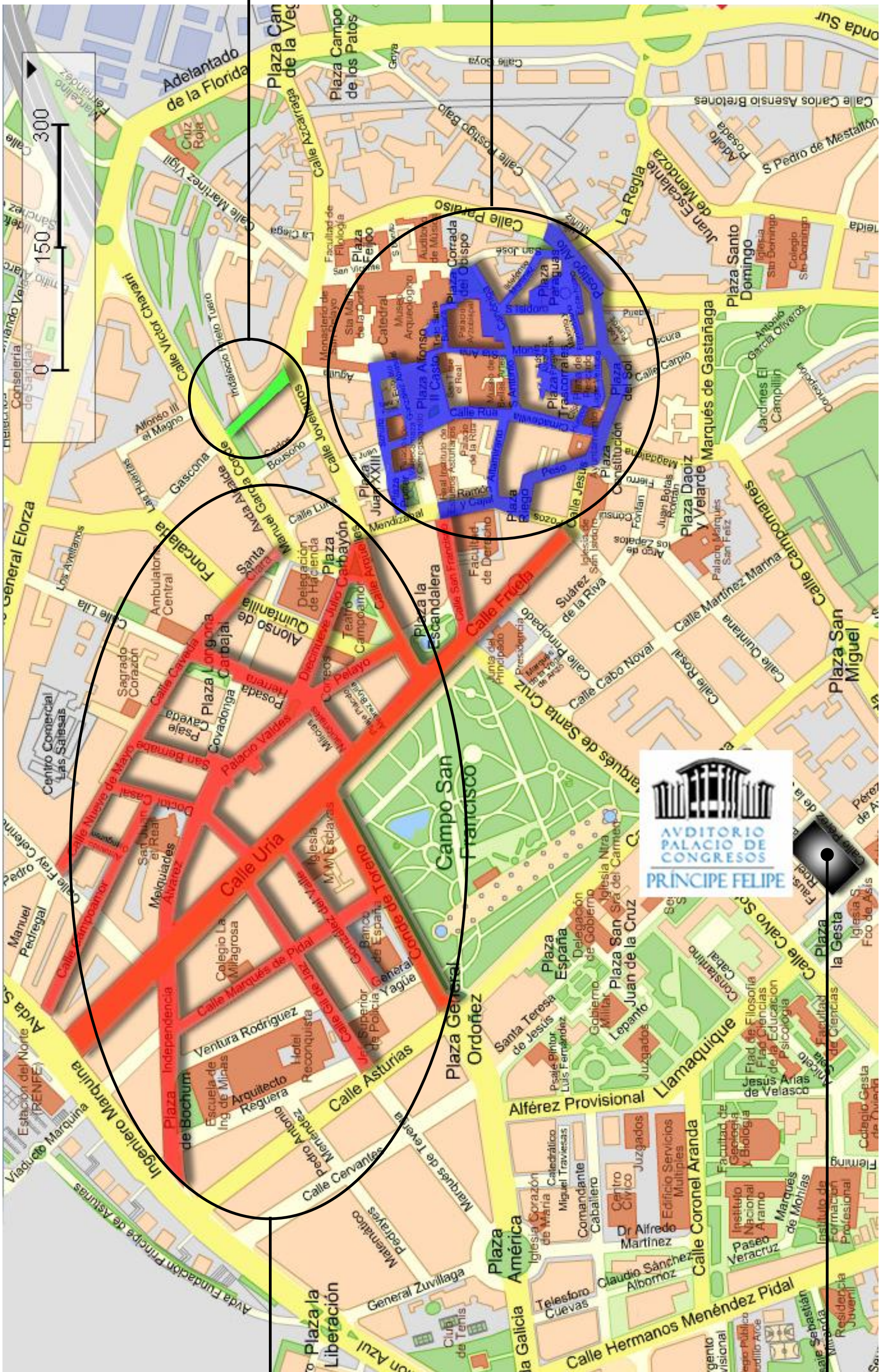
Short facts

NanoICT	Nanoscale ICT Devices and Systems
Instrument	Coordination Action
EC Contribution	950.000 Euros
Contract number	216165
Nº of partners	12
Coordinator	Phantoms Foundation / Dr. Antonio Correia
Start date	January 01, 2008
Duration	36 months
WEB site	www.nanoict.org

The nanoICT plan to strengthen scientific and technological excellence will go beyond the organisation of conferences, workshops, exchange of personnel, WEB site, etc. developing the following activities:
1. Consolidation and visibility of the research community in ICT Nanoscale devices
2. Mapping and benchmarking of research at European level, and its comparison with other continents
3. Identification of drivers and measures to assess research in ICT nanoscale devices, and to assess the potential of results to be taken up in industrial research
4. Coordination of research agendas and development of research roadmaps
5. The coordination of national or regional research programmes or activities, with the aim to involve funding authorities in building the ERA around this topic

"Sidrerias" Area

Night Life Area



Commercial Area

Conference location:
Auditorio Palacio de Congresos Príncipe Felipe
Plaza de la Gesta s/n – 33007 Oviedo (Spain)

TNT2008

Trends in NanoTechnology

Oviedo (Spain)

September 01-05, 2008

SCIENTIFIC PROGRAM

(Only those abstracts received before August 25, 2008 are included in the abstracts' booklet)

TNT2008 - POSTER PRESENTATION DETAILS

Poster size: A0 format (width: 841 mm x Height: 1189 mm)

Session A (PA) - students: From Monday morning to Tuesday evening.
Session B (PB) - seniors: From Wednesday morning to Friday lunch time.

Posters from Session A (PA) should be installed on Monday morning and removed on Tuesday between 18h00 and 19h30.

Posters from Session B (PB) should be installed on Wednesday before 13h00 and removed on Friday before 13h00.

K: Keynote Lecture (30 min. including discussion time)
O: Oral Presentation (15 min. including discussion time)
PS: Poster Session

SCIENTIFIC PROGRAM - TNT2008
Monday – September 01, 2008

08h00-09h00	**REGISTRATION**	
09h00-09h15	**TNT2008 Opening Ceremony - Welcome and Introduction**	
	Chairman: Jose-Maria Alameda (University of Oviedo, Spain)	
09h15-09h45	**Uzi Landman** (Georgia Tech. Institute, USA)	**K**
p. 31	*"Control of Dimensionality, Structure, and Reactivity of Gold Nanocatalysts: 2-D or not 2-D?"*	
09h45-10h15	**Emilio Mendez** (Brookhaven National Laboratory, USA)	**K**
p. 35	*"Electronic Noise in Nanostructures"*	
10h15-10h45	**Masakazu Aono** (MANA / NIMS, Japan)	**K**
p. 7	*"Dynamic control of electrical conductivity of single polymer chains for molecular nanowiring"*	
10h45-11h15	**Andre Geim** (University of Manchester, UK)	**K**
p. 19	*"Introduction to Graphene"*	
11h15-12h00	**Coffee Break - Poster Session A - Instrument Exhibition**	
	Chairman: Flemming Besenbacher (iNANO, Denmark)	
12h00-12h30	**Danny Porath** (The Hebrew University of Jerusalem, Israel)	**K**
p. 53	*"SP1 Protein-Nanoparticle Hybrids as Building Blocks for Nanostructures: Memory Arrays and Nanowires"*	
12h30-12h45	**Darby Kozak** (Australian Inst. of Bioengineering and Nanotechnology, Australia)	**O**
p. 91	*"Optically Encoded Particles and Flow Cytometry as a High-Throughput Platform for the Analysis of Protein Resistant Surfaces, Protease Efficacy and Biomarker Detection"*	
12h45-13h00	**Socorro Vazquez-Campos** (ICN, Spain)	**O**
p. 119	*"Gold nanoparticles as carriers of cisplatin: A new approach for cancer treatment"*	
13h00-15h00	**Lunch**	
	"Nanofabrication" Session – Sponsored by Raith GmbH 	
	Chairman: Frank Nouvertne (Raith GmbH, Germany)	
15h00-15h15	**Frank Nouvertne** (Raith GmbH, Germany)	**O**
p. 107	*"Extending electron and ion beam lithography schemes to innovative nanofabrication processes"*	
15h15-15h45	**Urs Staufer** (Delft University of Technology, Netherlands)	**K**
p. 63	*"Autonomous Nanotools – Scanning Submicron Particles on Mars"*	
15h45-16h15	**Emmerich Beragnolli** (Vienna Univ. of Technology, Austria)	**K**
p. 9	*"Functional Nanostructure Formation by Focused Particle Beams"*	
16h15-16h45	**Lars Montelius** (Lund University, Sweden)	**K**
p. 47	*"Nanoimprint lithography: From technological explorative research to an industrial technology"*	
16h45-17h15	**Kornelius Nielsch** (University of Hamburg, Germany)	**K**
p. 49	*"Synthesis of Complex Nanostructures by Atomic Layer Deposition"*	
17h15-20h00	**Coffee Break - Poster Session A - Instrument Exhibition**	
20h00	**WELCOME RECEPTION (AUDITORIO PRINCIPE FELIPE)**	

SCIENTIFIC PROGRAM - TNT2008		
Tuesday – September 02, 2008		
Chairman: Juan José Saenz (Universidad Autónoma de Madrid, Spain)		
08h30-09h00	**Kazuo Kadowaki** (University of Tsukuba, Japan)	**K**
p. 29	*"Intense Continuous THz Emission from High Temperature Superconductor Bi2Sr2CaCu2O8+d Single Crystal Mesa Structures"*	
09h00-09h30	**Efrat Lifshitz** (Technion, Israel)	**K**
p. 33	*"Single- and multi-excitons in semiconductor nanocrystal quantum dots"*	
09h30-10h00	**Brahim Lounis** (Université Bordeaux 1 and CNRS, France)	**K**
p. 39	*"Optical detection and spectroscopy of individual nano-objects"*	
10h00-10h30	**Cefe Lopez** (ICMM-CSIC, Spain)	**K**
p. 37	*"Photonic glasses as matrices for random lasers"*	
10h30-11h00	**Luis M. liz-Marzan** (Universidad de Vigo, Spain)	**K**
p. 35	*"Colloid Chemistry – Based Nanophotonics"*	
11h00-12h00	**Coffee Break - Poster Session A - Instrument Exhibition**	
Chairman: Masakazu Aono (MANA/NIMS, Japan)		
12h00-12h30	**Dmitri Golberg** (NIMS & MANA, Japan)	**K**
p. 21	*"Nanomaterial electrical and mechanical properties measured in a transmission electron microscope"*	
12h30-12h45	**Petra Granitzer** (Karl Franzens University Graz, Austria)	**O**
p. 87	*"The interior interfaces of a semiconductor/metal nanocomposite and their influence on its physical properties"*	
12h45-13h00	**Fernando Briones** (IMM-CNM-CSIC, Spain)	**O**
p. 75	*"Digital stress compensation for stacked InAs/GaAs quantum dots solar cells"*	
13h00-15h00	**Lunch**	

Afternoon ☛

SCIENTIFIC PROGRAM - TNT2008

Tuesday – September 02, 2008

"Nanomagnetism" Session – Sponsored by CIC nanoGUNE

Chairman: Andreas Berger (CIC nanoGUNE Consolider, Spain)

15h00-15h30	**Ivan Schuller** (University of California, USA)	**K**
p. 59	*"Magnetism and Superconductivity with Nanostructured Materials"*	
15h30-16h00	**Paolo Vavassori** (CIC nanoGUNE Consolider, Spain)	**K**
p. 69	*"Magnetoresistance and domain wall displacement in submicrometer Permalloy ring structures"*	
16h00-16h15	**Jaime Ferrer** (Universidad de Oviedo, Spain)	**O**
p. 81	*"Enhancing the magnetic anisotropy and anisotropic magnetorresistance of atomic clusters, chains and molecular magnets"*	
16h15-16h30	**Carlos Martínez Boubeta** (ICMAB-CSIC, Spain)	**O**
p. 103	*"High magnetization particles coated with inorganic magnesia for biomedicine, catalysis and spintronics applications"*	
16h30-17h00	**Josep Nogues** (Institut Catala de Nanotecnologia, Spain)	**K**
p. 51	*"Direct nanoscale magnetic lithography in on FeAl alloys by means of ion irradiation"*	
17h00-17h30	**Dieter Suess** (Vienna University of Technology, Austria)	**K**
p. 65	*"Concepts of magnetic 3D and multilayer storage"*	
17h30-18h00	**Coffee Break - Poster Session A - Instrument Exhibition**	

Chairman: Danny Porath (The Hebrew University of Jerusalem, Israel)

18h00-18h30	**Flemming Besenbacher** (iNANO, Denmark)	**K**
p. 13	*"Self–assembly of DNA molecules on surfaces studied by STM: dynamics, self-organization, WC base pairing, and DNA dolphins"*	
18h30-18h45	**Humberto Sánchez** (Erasmus University Medical Center, Netherlands)	**O**
p. 111	*"Nanometer localization and identification of DNA repair proteins by combined AFM-fluorescence analysis"*	
18h45-19h00	**Jorge Lobo-Checa** (University of Basel, Switzerland)	**O**
p. 93	*"Thermally induced surface polymerization of a perylene derivative on Cu(111)"*	
19h00-19h30	**Alexander Bittner** (CIC nanoGUNE Consolider, Spain)	**K**
p. 15	*"Biomolecular Tubes and Fibers"*	

REMINDER: Please note that those posters corresponding to Session A must be removed today between 18:00 and 19:30

SCIENTIFIC PROGRAM - TNT2008

Wednesday – September 03, 2008

Chairman: Alexander Bittner (CIC nanoGUNE, Spain)

08h30-09h00	**Toshitsugu Sakamoto** (NEC Corporation, Japan)	**K**
p. 55	*"A Ta2O5 Solid-electrolyte Switch with Improved Reliability"*	
09h00-09h15	**Andreia Luisa da Rosa** (University Bremen, Germany)	**O**
p. 77	*"Functionalization of ZnO nanowires for sensing applications"*	
09h15-09h30	**Javier Tamayo** (IMM/CSIC-Bionanomechanics Lab, Spain)	**O**
p. 117	*"Label-free biosensing through nanomechanical transduction of hydration induced tension in nucleic acid films"*	
09h30-10h00	**Abderrazzak Douhal** (Univ. de Castilla-La Mancha, Spain)	**K**
p. 17	*"Interrogating one and several molecules within nanotubes, nanocapsules and nanopools"*	
10h00-11h00	**Coffee Break - Poster Session B - Instrument Exhibition** REMINDER: Please note that those posters corresponding to Session B must be installed today before 13:00	

"nanoICT" Session

Chairman: David Guedj (EU/ICT-FET-nanoICT, Belgium)

11h00-11h15	**David Guedj** (EU-ICT/FET/nanoICT, Belgium)	**O**
p. 89	*"EU nanoscale devices and systems proactive initiative"*	
11h15-11h45	**Leonhard Grill** (Freie Universität Berlin, Germany)	**K**
p. 23	*"Manipulation of single molecules with the STM: Towards molecular nanotechnology"*	
11h45-12h15	**Michelle Simmons** (University of New South Wales, Australia)	**K**
p. 61	*"Engineered Materials for Atomic-scale Architectures for Computation"*	
12h15-12h45	**Abdelmadjid Anane** (THALES & CNRS, France)	**K**
p. 5	*"Current-driven domain wall dynamics in magnetic multilayer nanostripes"*	
12h45-13h00	**Martin Persson** (CEA, France)	**O**
p. 109	*"Modeling of electronic and transport properties of semiconductor nanowires"*	
13h00-15h00	**Lunch**	
15h00-17h30	☛ **Parallel Session: "PhD"** ☛ **Parallel Session: "Nano-Asturias"**	
17h30-18h00	**Coffee Break - Poster Session B - Instrument Exhibition**	
19h00	Bus departure to Gijón (Conference Dinner)	
20h30	**CONFERENCE DINNER (Gijón)**	
00h00	**POSTER AWARDS CEREMONY (Casino of Gijón)**	

Parallel Sessions ☛

SCIENTIFIC PROGRAM - TNT2008 / Wednesday – September 03, 2008

"NanoScience in Asturias" Parallel Session / Chairman: José I. Martín (University of Oviedo, Spain)		
15h00-15h15	**Rafael Morales** (Universidad de Oviedo, Spain)	
p. 157	*"Onset of positive exchange bias in nanostructured thin films"*	**O**
15h15-15h30	**Carlos Quirós** (Universidad de Oviedo, Spain)	
p. 163	*"Antiferromagnetic coupling in amorphous CoSi/Si multilayers: characterization and modification by ion beam nanopatterning"*	**O**
15h30-15h45	**María Vélez** (Universidad de Oviedo, Spain)	
p. 165	*"Closure structures around non magnetic inclusions in uniaxial magnetic thin film: MFM characterization and theoretical analysis"*	**O**
15h45-16h00	**Pedro Gorría** (Universidad de Oviedo, Spain)	
p. 155	*"Nickel nanoparticles deposited into an activated porous carbon: synthesis, microstructure and magnetic properties"*	**O**
16h00-16h15	**Victor Prida** (Universidad de Oviedo, Spain)	
p. 161	*"Nanostructured materials: synthesis, structural and magnetic properties"*	**O**
16h15-16h30	**Marta Elena Díaz** (Universidad de Oviedo, Spain)	
p. 153	*"Interaction of functionalized gold nanoparticles with metal ions and amine compounds: development of selective analytical methods."*	**O**
16h30-16h45	**Agustín Costa** (Universidad de Oviedo, Spain)	
p. 151	*"Dual sensor based on gold nanostructured screen-printed carbon electrodes for the detection of Prostate Specific Antigen (PSA)"*	**O**
16h45-17h00	**Nerea Bordel** (Universidad de Oviedo, Spain)	
p. 149	*"Chemical analysis and characterization of nanolayers on conducting and insulating substrates by pulsed radiofrequency glow discharge time of flight mass spectrometry"*	**O**
17h00-17h15	**Serafín Moya** (ICMM-CSIC, Spain)	
p. 159	*"Hardening effect of metal nanoparticles in ceramic-matrix composites"*	**O**
17h15-17h30	**Jesús Ángel Blanco** (Universidad de Oviedo, Spain)	
p. 147	*"An old material in the nanoworld: organic-inorganic hybrid nanotubes based on γ- titanium phosphate layered structure"*	**O**

SCIENTIFIC PROGRAM - TNT2008 / Wednesday – September 03, 2008

"PhD" Parallel Session / Chairman: Jaime Ferrer (Universidad de Oviedo. Spain)		
15h00-15h15	**Alan Reguer** (CINAM, France)	
p. 133	*"Growth study of silicon nanowires using gold and gallium as catalyst by In Situ scanning electron microscopy"*	**O**
15h15-15h30	**Ken Reynolds** (Tyndall National Institute, Ireland)	
p. 135	*"Manipulation, Assembly and Characterization of Optically Functional 1-D Organic Nanostructures"*	**O**
15h30-15h45	**Alfonso Alarcón Pardo** (UAB, Spain)	
p. 125	*"Time-dependent Electron Driven Tunneling Phenomena for multipurpose Terahertz applications: self-consistent computation of conduction and displacement current in mesoscopic systems"*	**O**
15h45-16h00	**Hugo Silva** (University of Oporto, Portugal)	
p. 141	*"Temperature and Voltage TMR Dependencies for High Performance Magnetic Junctions"*	**O**
16h00-16h15	**Florian Massuyeau** (Inst. des Matériaux de Nantes, France)	
p. 129	*"Conjugated polymer nanofibers: effects of nanostructuration on photoemission properties"*	**O**
16h15-16h30	**Pierre Lovera** (Tyndall National Institute, Ireland)	
p. 127	*"Determination of Molecular Orientations in Single Polyfluorene Nanowires Using Polarisation Dependent Nonlinear Microscopy"*	**O**
16h30-16h45	**Gaël Robert** (CEA Saclay / SPEC, France)	
p. 137	*"Carbon Nanotubes as Electrodes for Molecular Electronics: from SAMs to Single-Molecule Connection"*	**O**
16h45-17h00	**Tomas Samuely** (University of Basel, Switzerland)	
p. 139	*"Phthtalocyanine derivatives on (111) noble metal surfaces – multiphase behavior and capability of hosting other molecules"*	**O**
17h00-17h15	**Elisabetta Primiceri** (Nat. Nanotech. Lab of CNR-INFM, Italy)	
p. 131	*"On-Line Monitoring of Cytotoxic Effects Using EIS based Cell-Chips"*	**O**
17h15-17h30	**José Teixeira** (University of Oporto, Portugal)	
p. 143	*"Temperature dependent transport properties of MgO-based ultra-thin magnetic tunnel junctions: experiment and modeling."*	**O**

SCIENTIFIC PROGRAM - TNT2008

Thursday – September 04, 2008

	Chairman: Uzi Landman (Georgia Tech, USA)	
13h30-13h45	**David Sanchez** (Universitat de les Illes Balears, Spain)	**O**
p. 113	*"Microreversibility breaking in mesoscopic systems coupled to nonequilibrium environments"*	
13h45-14h00	**Kaushik Mallick** (MINTEK, South Africa)	**O**
p. 97	*"Charge Transport Property of One Dimensional Gold-Polyaniline Composite Networks"*	
14h00-14h15	**Victor Manuel García Suárez** (Lancaster University, UK)	**O**
p. 85	*"Tailoring the Fermi level of the leads in molecular-electronic devices"*	
14h15-14h30	**Enrique Louis** (Universidad de Alicante, Spain)	**O**
p. 95	*"Transport through organic molecules containing magnetic atoms: effects of symmetry and Coulomb interaction"*	
14h30-15h00	**Frank Scheffold** (University of Fribourg/frimat, Switzerland)	**K**
p. 57	*"Glassy dynamics and elasticity in temperature sensitive nanoparticle pastes"*	
15h00-15h30	**Jacob Israelachvili** (University of California, USA)	**K**
p. 27	*"How are nanoparticle interactions and assemblies different from molecular and colloidal assemblies"*	
15h30-16h15	**Coffee Break - Poster Session B - Instrument Exhibition**	
	Chairman: Antonio García Martín (IMM-CSIC, Spain)	
16h15-16h45	**Nongjian Tao** (Arizona State University, USA)	**K**
p. 67	*"Controlling Electron Transport in Single Molecules"*	
16h45-17h00	**Jorge M. García** (IMM-CNM-CSIC, Spain)	**O**
p. 83	*"Self-assembled Quantum Rings"*	
17h00-17h30	**Ulrich Wiesner** (Cornell University, USA)	**K**
p. 71	*"Nanostructured and Nanoparticle based Hybrids"*	
17h30-20h00	**Coffee Break - Poster Session B - Instrument Exhibition**	**PS**
20h30	**CLASSICAL MUSIC CONCERT (AUDITORIO PRINCIPE FELIPE)**	

SCIENTIFIC PROGRAM - TNT2008

Friday – September 05, 2008

Chairman: José-Luís Costa Kramer (IMM-CSIC, Spain)

08h30-09h00	**José I. Martín** (University of Oviedo, Spain)	**K**
p. 41	*"Competing ratchets and memory effects for domain wall motion in magnetic films with asymmetric arrays of antidots"*	
09h00-09h30	**Christian Bernhard** (Univ. of Fribourg / FriMat, Switzerland)	**K**
p. 11	*"Study of spin transport and novel quantum states in multilayers from organic and oxide materials"*	
09h30-10h00	**Neil Mathur** (University of Cambridge, UK)	**K**
p. 43	*"Transformation of spin information into large electrical signals"*	
10h00-10h15	**Juan José de Miguel** (UAM, Spain)	**O**
p. 79	*"Self-organised hexagonal patterns of independent magnetic nanodots"*	
10h15-10h30	**Marisol Martin Gonzalez** (IMM-CNM-CSIC, Spain)	**O**
p. 101	*"Magnetic properties of oxide interfaces"*	
10h30-10h45	**Giuseppe Maruccio** (Nat. Nanotech. Lab of CNR-INFM, Italy)	**O**
p. 105	*"Nanoscale Spin-Filters based on magnetic CoPt3-Au heterodimers"*	
10h45-11h30	**Coffee Break - Poster Session B – Instrument Exhibition**	

"Nanotubes" Session – Sponsored by GDR-I/Nano-I

Chairman: Robert Baptist (CEA/LETI, France)

11h30-11h45	**Hiroyuki Shima** (Hokkaido University, Japan)	**O**
p. 115	*"Pressure-Induced Structural Transitions in Multiwall Carbon Nanotubes"*	
11h45-12h00	**José A. Martín Gago** (ICMM-CSIC, Spain)	**O**
p. 99	*"Fullerenes formation from aromatic precursors by a surface catalysed cyclodehydrogenation process"*	
12h00-12h15	**Mariusz Zdrojek** (ICN, Spain)	**O**
p. 121	*"Single Electron Counting Spectroscopy based on Carbon Nanotube Transistors"*	
12h15-12h45	**Stephan Hofmann** (University of Cambridge, UK)	**K**
p. 25	*"Catalyst Dynamics during Si Nanowire and Carbon Nanotube CVD"*	
12h45-13h00	**CLOSING REMARKS & TNT2009 ANNOUNCEMENT**	

TNT2008

Trends in NanoTechnology

Oviedo (Spain)

September 01-05, 2008

in collaboration with

PHANTOMS foundation

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"PASSPORT TO PRIZES" PROGRAM

At this new edition of the Trends in Nanotechnology conference we are pleased to organise the TNT2008 "Passport to Prizes" program.

How does the "Passport to Prizes" program work?

Each TNT2008 conference attendee will find a passport card inside his TNT2008 conference bag. You will take your card around the exhibit hall on Monday, Tuesday and Wednesday. Take this opportunity to visit the stands that the exhibitors have prepared, and to learn about the companies and their new products. Each exhibiting company has received a stamp with a number. Attendees will be responsible for collecting stamps from the participating exhibitors that are listed on their passport.

Once you have completed your passport card with a minimum of 8 stamps, **fill in your personal data** and take the card to the ticket tumbler located in the Registration Area. Please, do not forget to complete the passport card with your name and institution before you put it into the box.

All completed entries will be eligible for a prize drawing that will be conducted on the evening of Wednesday (3/9/2008) during the Poster Award Ceremony.

Do not miss this opportunity to win one of our **two "Pentax Optio M40"** (kindly donated by Phantoms Foundation).

And remember that winners need to be present to win. So… see you at the conference dinner and the poster award ceremony!

KEYNOTE CONTRIBUTIONS

ORAL CONTRIBUTIONS – SENIORS (PLENARY SESSION)

ORAL CONTRIBUTIONS – PHD (PARALLEL SESSION)

ORAL CONTRIBUTIONS – "NANOSCIENCE IN ASTURIAS" (PARALLEL SESSION)

ALPHABETICAL ORDER

Rafael Morales (Universidad de Oviedo, Spain)	**ORAL - Parallel Session**	**p.157**
"Onset of positive exchange bias in nanostructured thin films"		
Jose Serafin Moya (ICMM-CSIC, Spain) - **Ramón Torrecillas** (CINN-CSIC, Spain)	**ORAL - Parallel Session**	**p. 159**
"Hardening effect of metal nanoparticles in ceramic-matrix composites"		
Kornelius Nielsch (University of Hamburg, Germany)	**KEYNOTE**	**p.49**
"Synthesis of Complex Nanostructures by Atomic Layer Deposition"		
Josep Nogues (Institut Catala de Nanotecnologia, Spain)	**KEYNOTE**	**p.51**
"Direct nanoscale magnetic lithography in on FeAl alloys by means of ion irradiation"		
Frank Nouvertne (Raith GmbH, Germany)	**ORAL**	**p.107**
"Extending electron and ion beam lithography schemes to innovative nanofabrication processes"		
Martin Persson (CEA, France)	**ORAL**	**p.109**
"Modeling of electronic and transport properties of semiconductor nanowires"		
Danny Porath (The Hebrew University of Jerusalem, Israel)	**KEYNOTE**	**p.53**
"SP1 Protein-Nanoparticle Hybrids as Building Blocks for Nanostructures: Memory Arrays and Nanowires"		
Elisabetta Primiceri (Nat. Nanotech. Lab of CNR-INFM, Italy)	**ORAL - Parallel Session**	**p.131**
"On-Line Monitoring of Cytotoxic Effects Using EIS based Cell-Chips"		
Victor Prida (Universidad de Oviedo, Spain)	**ORAL - Parallel Session**	**p.161**
"Nanostructured materials: synthesis, structural and magnetic properties"		
Carlos Quirós (Universidad de Oviedo, Spain)	**ORAL - Parallel Session**	**p.163**
"Antiferromagnetic coupling in amorphous CoSi/Si multilayers: characterization and modification by ion beam nanopatterning"		
Alan Reguer (CINAM, France)	**ORAL - Parallel Session**	**p.133**
"Growth study of silicon nanowires using gold and gallium as catalyst by In Situ scanning electron microscopy"		
Ken Reynolds (Tyndall National Institute, Ireland)	**ORAL - Parallel Session**	**p.135**
"Manipulation, Assembly and Characterization of Optically Functional 1-D Organic Nanostructures"		
Gaël Robert (CEA Saclay / SPEC, France)	**ORAL - Parallel Session**	**p.137**
"Carbon Nanotubes as Electrodes for Molecular Electronics: from SAMs to Single-Molecule Connection"		
Toshitsugu Sakamoto (NEC Corporation, Japan)	**KEYNOTE**	**p.55**
"A Ta_2O_5 Solid-electrolyte Switch with Improved Reliability"		
Tomas Samuely (University of Basel, Switzerland)	**ORAL - Parallel Session**	**p. 139**
"Phthtalocyanine derivatives on (111) noble metal surfaces – multiphase behavior and capability of hosting other molecules"		
Humberto Sanchez (Erasmus Univ. Medical Center, Netherlands)	**ORAL**	**p. 111**
"Nanometer localization and identification of DNA repair proteins by combined AFM-fluorescence analysis"		


TNT2008
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ABSTRACTS

KEYNOTE CONTRIBUTIONS

(Only those abstracts received before August 25, 2008 will be included in the abstracts' booklet)

CURRENT-DRIVEN DOMAIN WALL DYNAMICS IN MAGNETIC MULTILAYER NANOSTRIPES

Abdelmadjid Anane
THALES
France

ABSTRACT NOT AVAILABLE

DYNAMIC CONTROL OF ELECTRICAL CONDUCTIVITY OF SINGLE POLYMER CHAINS FOR MOLECULAR NANOWIRING

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Several years ago, we reported that we succeeded to create single polymer (polydiacetylene (PDA)) chains at any designated positions in a self-assembled monolayer (SAM) of diacetylene compound molecules by inducing a chain polymerization reaction with the tip of the scanning tunneling microscope (STM). Recently, we have found that if we place the tip of STM just above a single PDA chain created by the above-mentioned method at a distance of about a few nanometers and apply an appropriate bias voltage larger than a certain critical value, the PDA chain becomes metallic. By decreasing the applied voltage, the PDA chain returns to the original nonmetallic state. We have furthermore succeeded to make two- and three-terminal nanowiring using such PDA chains to a single molecule or a cluster of molecules (copper phthalocyanine in both cases). The practical use of the dynamic control of the electrical conductivity of the PDA chains used for molecular nanowiring is discussed in relation to novel molecular devices.

FUNCTIONAL NANOSTRUCTURE FORMATION BY FOCUSED PARTICLE BEAMS

Emmerich Beragnolli

Vienna University of Technology, Institute for Solid State Electronics, Vienna, Austria

Focused Particle Beam systems rely on a scanning microprobe technique similar to a Scanning Electron Microscope (SEM). In contrast to a SEM, however, both types of particles, ions or electrons, can be rastered over a surface for surface modificaton. Since the beam extension can be focused to a few nanometer, surface modifications well beyond the state of the art of lithography can be made. Moreover, the beam correlated secondary electrons can be used to image simultaneously the target area under irradiation, thus surface offering direct control of the modifications on a nanometric scale. The focused particle beam functionalities issue ion or electron beam interactions with a target surface in a vacuum or a predefined gas atmosphere. Due to its strict confinement, nanoscale level research and development is the dominant application.

Application of Focused Beams cover a wide range of activities, from basic ion-surface interaction research, over local processing for removal or deposition of layers, up to device fabrication and 3-D-nanofabrication. Since the knowledge of the correct beam profile at the target surface is crucial to any proper solid-beam interaction investigation, our group developed an approach to extract the specific beam profile by a material insensitive approach [1]. Any application of a beam approach in a complex processing scheme like microelectronics, however, is endangered by radiation damage. Therefore, we applied an in situ approach to quantify the impact of a focused Ga beam to specific electronic device parameters during beam exposure. We found that progressive degradation of the device starts only when long-range damage cascades begin to extend into the inversion channel regions of a MOSFET. Premature device breakdown could be attributed to electric discharge, thus can be avoided by faraday shielding. The device degradation due to exposure could be attributed to inversion charge mobility deterioration in the channel region, and – more important - could be quantified in a semi-empirical mobility model [2]. Thus, focused ion beam damage is not prohibitive to device level engineering.

Recently, quantum dots and nanowires have gained much interest, since they promise solutions for the foreseeable onset of the quantum regime at downscaled devices. In this nanoscale fields, focused particle beam processing is a favorable choice, due to its combination of maskless patterning with nanoscale critical dimensions. Accordingly, we developed focused ion beam based techniques for the synthesis of nanowires with diameters of 20 nm and less. In contrast to a broad class of actual techniques neither heating of the sample nor any extra material source is required for a nanowire evolution on substrates like Ge, Sb, GaSb [4], thus this approach is promising for on-chip processing in micro- and nanoelectronics, and in integrated sensorics. The field of catalysed nanowire growth is an additional, future-oriented field of nanotechnology, requiring nanoscaled pure metal aggregations at predefined sites, preferably in an arbitrary array. However, ion beam constituents inherently tend to poison the catalysts. So, to cope with this problem, focused electron beam assisted deposition of metal catalysts for a subsequent nanowire or nanodot growth is a primary choice and enables directly written templates for nanowire arrays.

References:

[1] A. Lugstein et. al., J. Appl. Phys. 92, 4037 (2002).
[2] W. Brezna et al., Sem. Sci. Technol. 18, 195 (2003).
[3] C. Schoendorfer et al., Microelectronic Engineering, 83, 1491 (2006).
[4] C. Schoendorfer et al., J. Appl. Phys. 102 (2007).

STUDY OF SPIN TRANSPORT AND NOVEL QUANTUM STATES IN MULTILAYERS FROM ORGANIC AND OXIDE MATERIALS

Christian Bernhard
Department of Physics and Fribourg Center for Nanomaterials (FriMat), University of Fribourg, Chemin du Musée 3, CH-1700 Fribourg, Switzerland

Our group specialises in experimental techniques to grow thin film multilayers and heterostructures that consist of oxides with strongly correlated electrons and of organic materials. Furthermore, we apply dedicated spectroscopic techniques, like infrared ellipsometry, low-energy muon-spin-rotation and neutron reflectometry, to explore their electronic and magnetic properties on the relevant nanometer scale. Of particular interest are novel quantum phenomena that may arise from competing interactions and the spin-transport phenomena in real devices. As examples I will present our results on oxide multilayers that combine cuprate high T_c superconductors (HTSC) and oxide-based ferromagnets like $La_{2/3}Ca_{1/3}MnO_3$ or $SrRuO_3$. I will also show direct measurements of the current-induced spin transport in the buried layers of an operational spin valve device.

Collaborators: A. Drew[1], J. Hoppler[1,2], V.K. Malik[1], L. Schulz[1], M. Rössle[1], B. Doggett[1], A. Dubroka[1], K.W. Kim[1], J. Stahn[2], E. Morenzoni[3], Ch. Niedermayer[2], Th. Porkscha[3], A. Sutter[3],
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SELF–ASSEMBLY OF DNA MOLECULES ON SURFACES STUDIED BY STM: DYNAMICS, SELF-ORGANIZATION, WC BASE PAIRING, AND DNA DOLPHINS

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Adsorption and organization of organic molecules on solid surfaces is central to self-assembly and bottom-up fabrication within nanoscience and technology. The Scanning Tunneling Microscope allows exploration of atomic-scale phenomena occurring on surfaces: Dynamic processes can be followed by fast-scanning STM, and from data acquired at a range of temperatures; detailed information on kinetic parameters can be extracted such as diffusion, chiral recognition and chiral switching [1-4].
The self-assembly of Nucleic Acid (NA) base molecules on solid surfaces has been investigated thoroughly. I will discuss the fact that Guanine molecules form the so-called G-quartet structure on Au(111) that is stabilized by cooperative hydrogen bonds [5] whereas cytosine molecules only form disordered structures by quenching the sample to low temperatures, which can be described as the formation of a 2D organic glass on Au(111) [6].
Molecular recognition between complementary nucleic acid (NA) bases is vital for the replication and transcription of genetic information, both in the modern cell as well as under prebiotic conditions, when a dedicated molecular machinery of evolved living organisms had not yet been developed. By means of STM we show that on a flat metal surface, the formation of complementary NA bases pairs is favoured. The C+G mixture resilience to heating is due to the formation of G-C Watson-Crick (WC) base pairs. The observation that not the oligonucleotide backbone, but a flat metal surface may be instrumental for specific WC base pairing has interesting implications for the proposed scenarios of the emergence of life [7].
Finally, I will show how the DNA origami method allows us to fold long, single-stranded DNA sequences into arbitrary two-dimensional structures by a set of designed oligonucleotides. The method has revealed an unexpected strength and efficiency for programmed self-assembly of molecular nanostructures, and makes it possible to produce fully addressable nanostructures with wide-reaching application potential within the emerging area of nanoscience [8]. Here I will show how we used DNA Origami Design to form Dolphin-Shaped Structures with Flexible Tails.

[1] Roberto Otero et al., Nature Materials 4 779 (2004)
[2] A. Kühnle et al., Nature 415, 891 (2002).
[3] S. Weigelt et al., Nature Materials, 5 11 (2006)
[4] S. Weigelt et al., Angew. Chem. 119, 9387, 2007
[5] R. Otero et al., Angew. Chem. Int. Ed. 44, 2270-2275 (2005)
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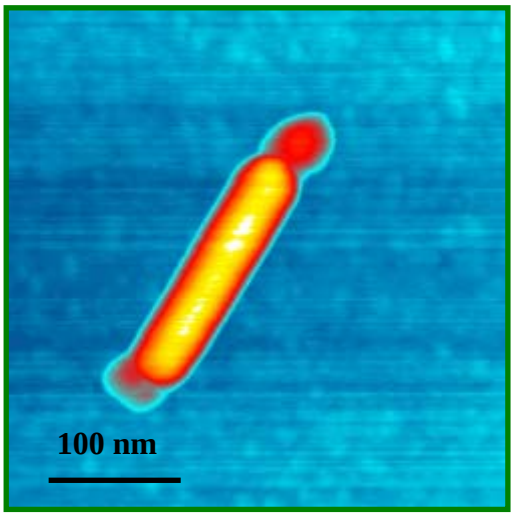
BIOMOLECULAR TUBES AND FIBERS

Alexander Bittner
CIC nanoGUNE

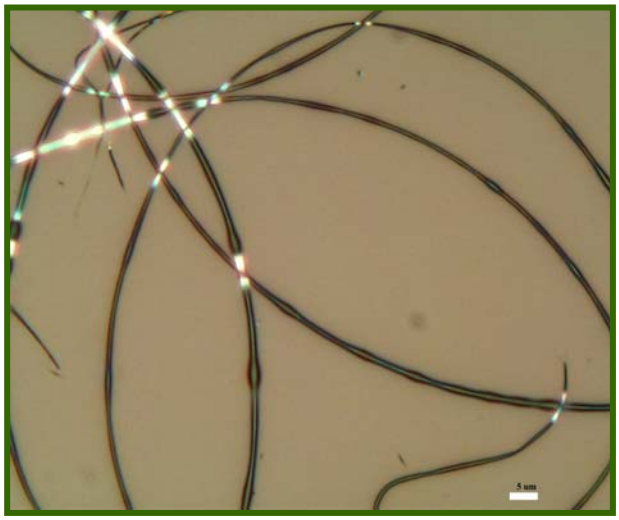
Two methods to assemble peptides and proteins into tubes and fibers will be introduced:

(1) A high voltage is applied a droplet of the material dissolved in a liquid. A jet emerges and hits a counter electrode some cm away. While this method, electrospinning, is well established for polymers, it was only recently adapted to self-assembling monomers such as phospholipids and proteins. We extended this to short peptides, which opens up an apparently quite general method to produce fibers and tubes composed of peptides. The assembly is governed by electrostatic interactions (peptides are zwitterions) and pi stacking of phenyl groups. We also show an alignment method and a possible application for mimicking a part of the Nuclear Pore Complex, an important and very complex gateway to the cell nucleus.

(2) The simplest viruses contain only a single strand composed of nucleic acid and coat proteins. The best known example is the Tobacco mosaic virus, which is pathogenic only for a number of plants. The helically arranged coat proteins and the nucleic acid (RNA) form a 300 nm long tube with an inner channel of only 4 nm diameter. The structure can be metallized and mineralized in aqueous suspension, resulting in unique rod- and tube-shaped deposits with diameters down to 3 nm and lengths up to micrometers. Inspired from the natural self-assembly in infected plants, various strategies can be followed to add even more functionality, e.g. assembly of coat proteins with shortened RNA, mutations, but also chemical reactions at the complete virus.



Gold-virus-gold dumbbell structure



Electrospun di-phenylalanine fibers (scale bar = 5 µm)

INTERROGATING ONE AND SEVERAL MOLECULES WITHIN NANOTUBES, NANOCAPSULES AND NANOPOOLS

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Studies by our group on the excited state dynamics of guest molecules encapsulated in various nanohosts have contributed to the characterization of the confinement effect. It is of great importance to gather knowledge regarding the behavior of chromophores encapsulated in tubes, capsules and pools, at both single molecule and ensemble levels. In this Lecture, we report on three classes of observations.

Single molecule within nanotubes (Figure 1): We discuss results of the first observation of a single molecule photodynamics within a mesoporous structured silicate (MCM-41) and bonded to silicate. A representative image, the photobleach fluorescence trace and the derived monoexponential decay of such complex is presented in Figure 1. We gated its picosecond time-resolved emission using single molecule microscopy. We were able to isolate single lifetime distribution arising from single molecule-nanotube complexes prepared by the ship-in-a-bottle technique whereas the system prepared by free diffusion and interaction with the zeolite framework has three individual lifetime distributions. These we assign to three separate single molecule-zeolite complexes. This assignment is confirmed by additional studies on the single molecule behavior of the proton transfer chromophore covalently bound to silica. We further report on the effect of chemical modification to the framework on the excited state behavior of a single encapsulated chromophore. We also compare the result with that of the ensemble.

Femtosecond dynamics with nanotubes (Figure 2): In this part of the lecture, I will focus on femtosecond dynamics of conformational change of Sudan I within MX (M = Na+, Li+, Mg2+), NaY zeolites and MCM-41 mesoporous silica in presence of solvents. The results show that the rate constant of the initial excited state intramolecular proton transfer (ESIPT) reaction in the trans-azoenol (trans-AZO) structure to give trans-ketohydrazone (trans-HYZ) form of Sudan I remains ultrafast (τ < 50 fs) as in pure solution. However, within these nanocavities/nanopores the time necessary for a trans-cis isomerization in the formed trans-HYZ tautomer to yield the cis-HYZ structure increases. The largest effect was obtained when the pores contain polar and H-bonding solvents (water, methanol). The result is explained in terms of a stronger salvation of the metal cation enhancing its shielding and therefore lowering its interaction with the included dye. The use of different metal cations of MX zeolite shows that nanosolvation of cations increases the measured times for isomerization and relaxation of the involved structures. Furthermore, the observation of similar times for NaX, NaY and MCM-41 (hosts different in polarity and diameter of the pore/cavity) suggests that that the trans-cis isomerization occurs by an inversion mechanism.

Motion of confined water within a nanopool (Figure 3): The last part of the talk will focus on the picosecond and femtosecond dynamics of water confined in a nanocapsule. Using ultrafast spectroscopy and a H-bonded probe to interrogate the dynamics of water network, we were able to get microscopic information on the translational and rotational motion of confined water molecules. We observed and for the first time a new and early domain in the nanostructure of confined water, characterized by a strong transition of water compactness at low water density. The fs-dynamics gives ultrashort time scale for H-bond breaking and making in confined water.

The results show that the behavior of a confined single molecule is far from that of the ensemble where the heterogeneity plays a key role in the observed signal. Within the nanoporos, the dynamics is slow, due to a slow nanosolvation gided by the nature of the framework of the tube. For confined water, it is clear that the nanospace provokes a compactness not allowing a free motion of water molecules. The results obtained here is important for a better understanding of several confined phenomena happening chemistry, physics and biology.

Acknowledgements: This work was supported by the MEC and JCCM through the projects: CTQ-2005-00114/BQU, UNCM05-23-034 and PCI08-0037-5868.

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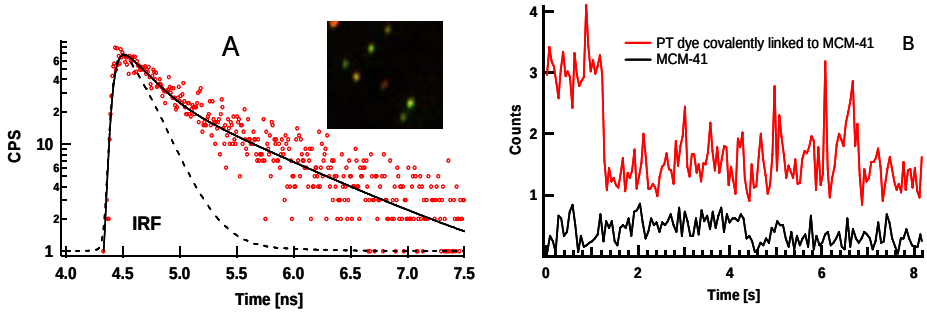

Figure 1. A) representative monoexponential decay of a single molecule within a nanotube (inset) and B) its signature as a single step fluorescence photobleach transient.

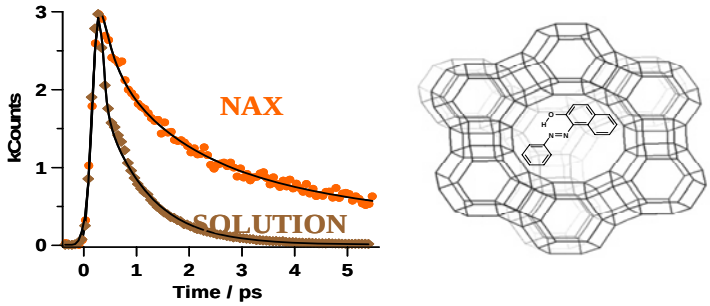

Figure 2: Femtosecond emission transient of Sudan I in solution and within a nanocage.

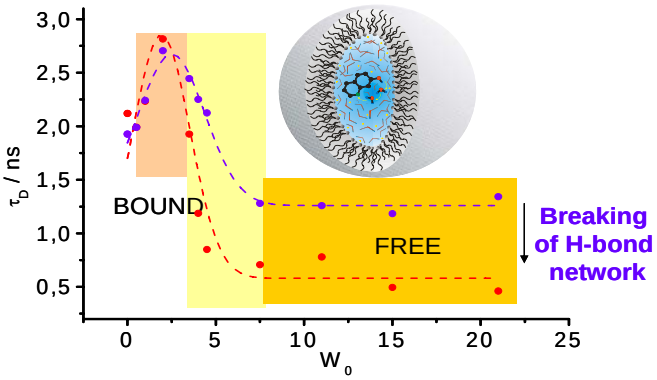

Figure 3: Variation of diffusional relaxation time of the probe within the nanopool of water upon changing the number of water molecules.

INTRODUCTION TO GRAPHENE

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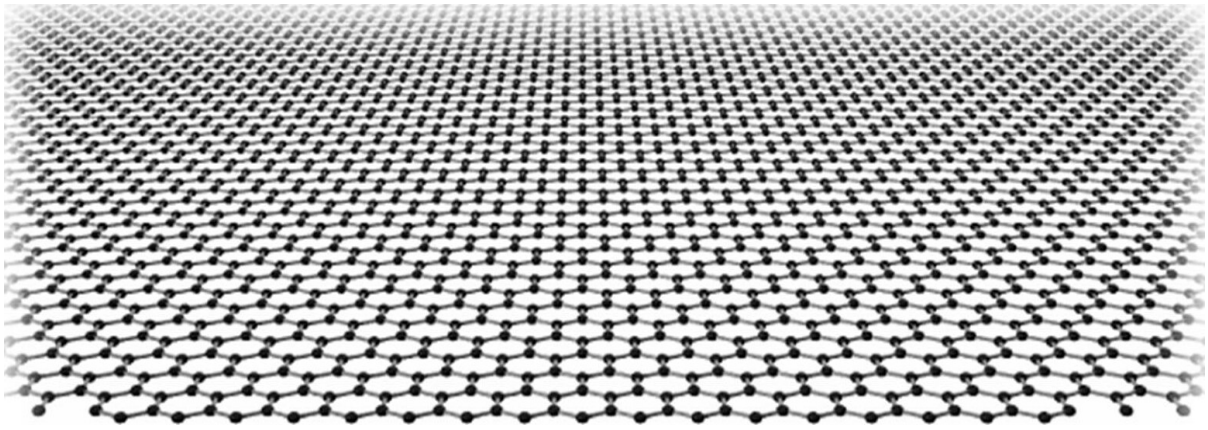
Graphene is a free-standing atomic-scale chicken wire made from carbon atoms. It is one atom thick and the first truly two dimensional crystal. Found only 4 years ago, it has rapidly become one of the brightest stars on the horizon of materials science and condensed matter physics, signifying a new paradigm of two dimensional materials that are now available for fundamental studies and development of novel technologies [1]. Graphene has already revealed a cornucopia of new physics and promises many potential applications that start looking increasingly realistic even at this early stage.



I will overview our experimental work on graphene concentrating on its fascinating electronic and optical properties and speculate about future applications.

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Acknowledgements – I wish to thank all my colleagues and students who contributed to this research over the years and, in particular, Kostya Novoselov, Sergey Morozov, Misha Katsnelson, Fred Schedin, Rahul Nair, Irina Grigorieva, Peter Blake and Tariq Mohiuddin.

NANOMATERIAL ELECTRICAL AND MECHANICAL PROPERTIES MEASURED IN A TRANSMISSION ELECTRON MICROSCOPE

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I will demonstrate the significant progress in electromechanical property measurements of diverse low-dimensional individual nanostructures, e.g. nanotubes, nanowires, nanobelts and nanocones, carried out inside a transmission electron microscope (TEM). The measurements were performed by means of two high-resolution field-emission instruments operating at 300 kV, namely JEOL-3000F and JEM-3100FEF, and on free-standing individual objects using specialized piezo-driven scanning tunnelling microscope (STM)-TEM and atomic force microscope (AFM)-TEM holders (with conductive or non-conductive cantilevers).

A sharp etched Au tip, acting as the STM tip, or a Si cantilever, as the AFM probe, was assembled within the holders. Individual low-dimensional nanostructures were mounted on thin metallic (Au, Al) wires (Ø 250 μm), Fig. 1 and Fig. 2, which then were driven in three dimensions (with a precision better than 1 nm) inside the pole-piece of the microscopes using a piezo-motor until a tight physical contact between a structure and the probe was achieved.

The successful experimental runs to be discussed include multi-walled BN (Figs. 1 and 2) [1-4] and N-doped C nanotubes (NTs) [5,6], ZnO nanorods and nanowires [7], double-walled CNTs, multi-walled CNTs filled with Cu [8], Au, CuI or ZnS, inorganic nanothermometers, e.g. liquid Ga-filled MgO NTs and In-filled SiO_2 NTs, CdS nanobelts, and BN nano- and microcones.

The current-voltage (STM-TEM, Fig. 1) and/or force-displacement (AFM-TEM, Fig. 2) curves were recorded under a full control of the nanomaterial morphological, crystallographic and chemical changes/modifications during all stages of probing/manipulation. This allowed us to clearly interpret many new intriguing physical, chemical and electromechanical phenomena peculiar to novel advanced nanostructures. These include, but are not limited to deformation-driven electrical transport and piezoelectricity in individual Boron Nitride NTs, time-resolved electrical transport in N-doped CNTs, rheostat-like behaviour, femtogram (Cu) and attogram (CuI) mass transports, nanopipetting in Cu- and Cu-halide-filled CNTs, and strength and elasticity modifications of nanoscale composite materials made of filled C nanotubes.

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9. The author is indebted to Drs. P.M.F.J. Costa, X.D. Bai, M. Mitome, Y. Bando, and O. Lourie for their experimental and technical contributions.

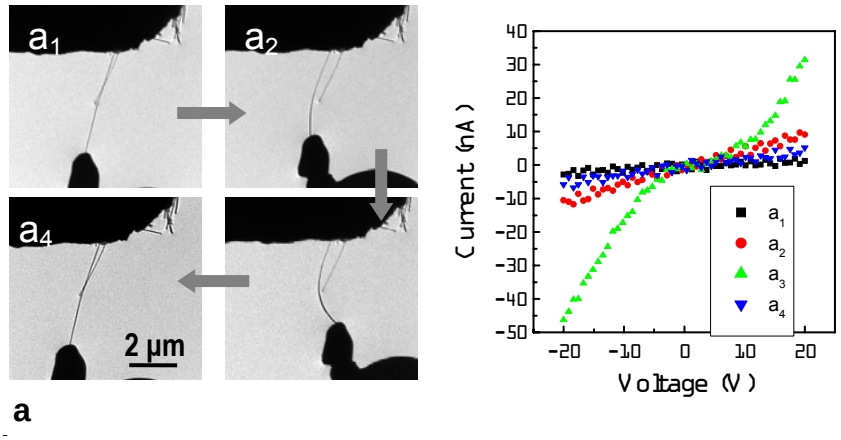

Figure 1. (a) Consecutive TEM images of an individual multi-walled BN nanotube bent inside HRTEM; and (b) the corresponding *I-V* curves recorded at different stages of the experiment (a_1-a_4). A notable current may pass through the nanotube in a bent state, while it disappears if the nanotube is straight; from Ref. [4].

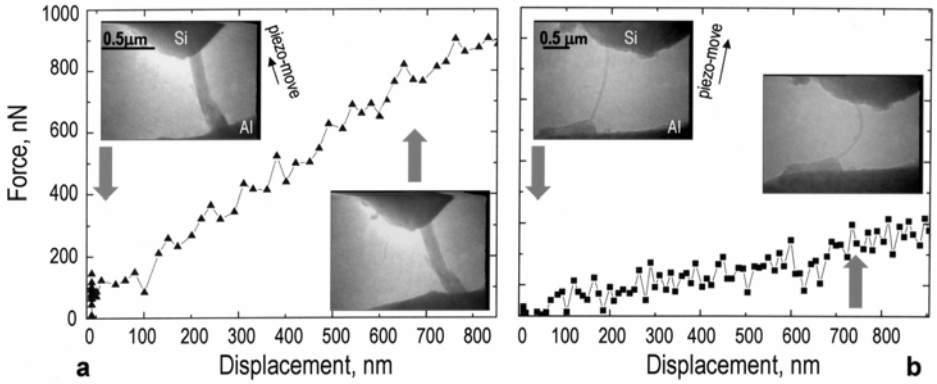

Figure 2. Force-displacement curves directly recorded on a relatively thick (a) and a thin (b) individual multi-walled BN nanotube using an AFM-TEM setup. The insets display the nanotube appearance at different stages of the experiments: from Ref. [2].

MANIPULATION OF SINGLE MOLECULES WITH THE STM: TOWARDS MOLECULAR NANOTECHNOLOGY

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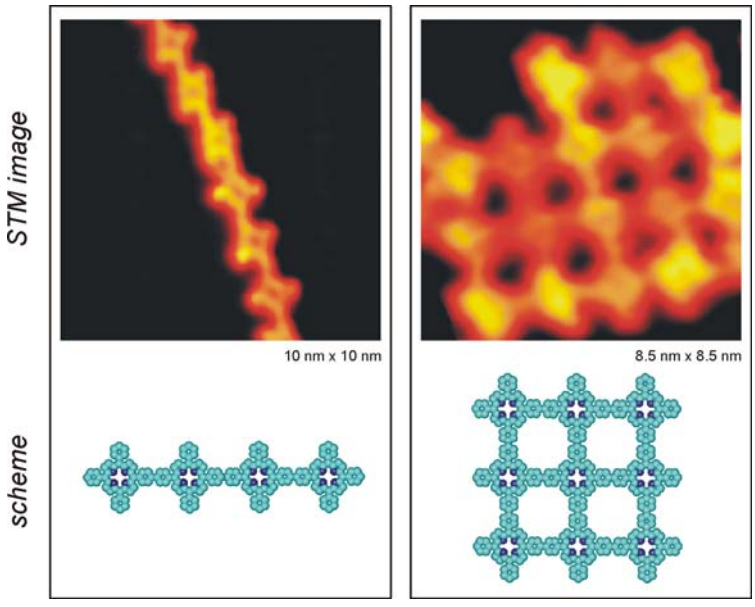
The idea of "molecular nanotechnology" is based on the capabilities of synthetic chemistry to functionalize molecules and to use them as electronic devices ("molecular electronics"), sensors or complex "nano-machines". Some expected advantages in future applications are the high operating speed, the small energy consumption and the chemical recognition and assembly. The scanning tunneling microscope (STM) is one of the most important instruments for the investigation of functionalized molecules, because it can image single molecules with submolecular resolution and is also capable to manipulate them by chemical/electrostatic forces or inelastic tunneling processes.
For technical applications of "molecular nanotechnology" several requirements, as for instance a stable connection between molecules or electric contacts of molecular wires to metallic electrodes, must be fulfilled. A successful approach to form such covalently bound molecular nanostructures, the "on-surface-synthesis", will be discussed [1]. It consists of two steps, the creation of reactive sites in the molecules and their connection on the surface. By choosing suitable chemical structures of the initial molecular building blocks, the nano-architectures of the formed structures can be precisely controlled. In this way, various topologies, as for instance linear molecular chains or two-dimensional networks (see figure), of porphyrin (TPP) molecules are grown and characterized.



Furthermore, a detailed understanding of the molecular motion is needed for efficient operation of nano-machines. Manipulation experiments with the STM tip will be presented, where the lateral displacement of wheel molecules on surfaces - by "hopping" or "rolling" motion - is studied [2]. A detailed investigation of the manipulation process allows the characterization of different (chemical and electrostatic) interactions between STM tip and molecule [3]. In view of "molecular electronics", molecular switches have been investigated. The results show that the azobenzene-based molecules, adsorbed on a metal surface, can be reversibly switched between *trans* and *cis* isomers by different processes [4,5]. It turns out that the chemical side groups of the molecules play a fundamental role for their switching capabilities.

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CATALYST DYNAMICS DURING Si NANOWIRE AND CARBON NANOTUBE CVD

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The self-formation and assembly of semiconducting nanowires and carbon nanotubes offer the prospect of device engineering at atomistic scale in compatibility with Si integrated circuit technology. The most controlled pathway for nanowire/tube formation at present is the exposure of transition metal catalyst particles to gaseous precursors at elevated temperatures, commonly referred to as catalytic chemical vapour deposition (CVD). The understanding of the role of the catalyst and the contributing atomic processes is, however, very incomplete and controversial, even for the most widely cited vapour-liquid-solid growth mechanism. This currently limits progress on more complex nanowire/tube device structures on route to their widespread application.

We present atomic-scale environmental transmission electron microscopy (ETEM) and in-situ X-ray photoelectron spectroscopy (XPS) of catalyst assisted growth of silicon nanowires (SiNWs) [1], single-walled carbon nanotubes (SWNTs) [2,3], and carbon nanofibres (CNFs) [2], combined with a large-throughput ex-situ catalyst screening by plasma assisted and thermal CVD [4,5,6]. We sample Ni, Fe, Au and Pd model catalyst films on SiO2 and Al2O3 supports upon disilane or acetylene exposure. We focus on catalyst island formation and support interactions upon temperature elevation and subsequent interactions with silicon or carbon precursors.

Video-rate ETEM shows that a Si crystal nucleus forms by phase separation for both liquid and solid catalyst systems [1]. We present a detailed comparison of nucleation dynamics and growth limiting processes for VLS and VSS mechanisms. For Pd silicide catalyst crystals (see Fig.) we directly resolve how the dominant, coherent Si nanowire growth interface advances by the lateral propagation of ledges. We propose that interfacial ledge propagation plays a central role in nanowire self-assembly. Our results establish an atomistic framework for nanowire assembly from solid catalysts, relevant also to their contact formation.

We observe catalyst nano-particles to be highly deformable during SWNT/CNF growth, despite their core exhibiting a crystalline structure throughout the process [2]. For Fe and Ni, the active state of the catalyst is a crystalline metallic nano-particle, not the oxide. Graphitic networks do not form on oxidized Fe. Pd forms a silicide on SiO2 under reducing conditions. Pd (silicides) and Au are catalytically less efficient in terms of precursor dissociation, while the low adhesion of C on Au surfaces impedes nanotube nucleation. We observe Fe 2+ and 3+ interface states for metallic Fe on Al2O3 in the absence of measurable Al reduction [3]. This support interaction is much stronger than on SiO2 and it restricts Fe surface mobility. The resulting much narrower Fe catalyst particle size distribution on Al2O3 leads to a higher carbon nanotube nucleation density and a vertical nanotube alignment due to proximity effects, often referred to as “supergrowth”.

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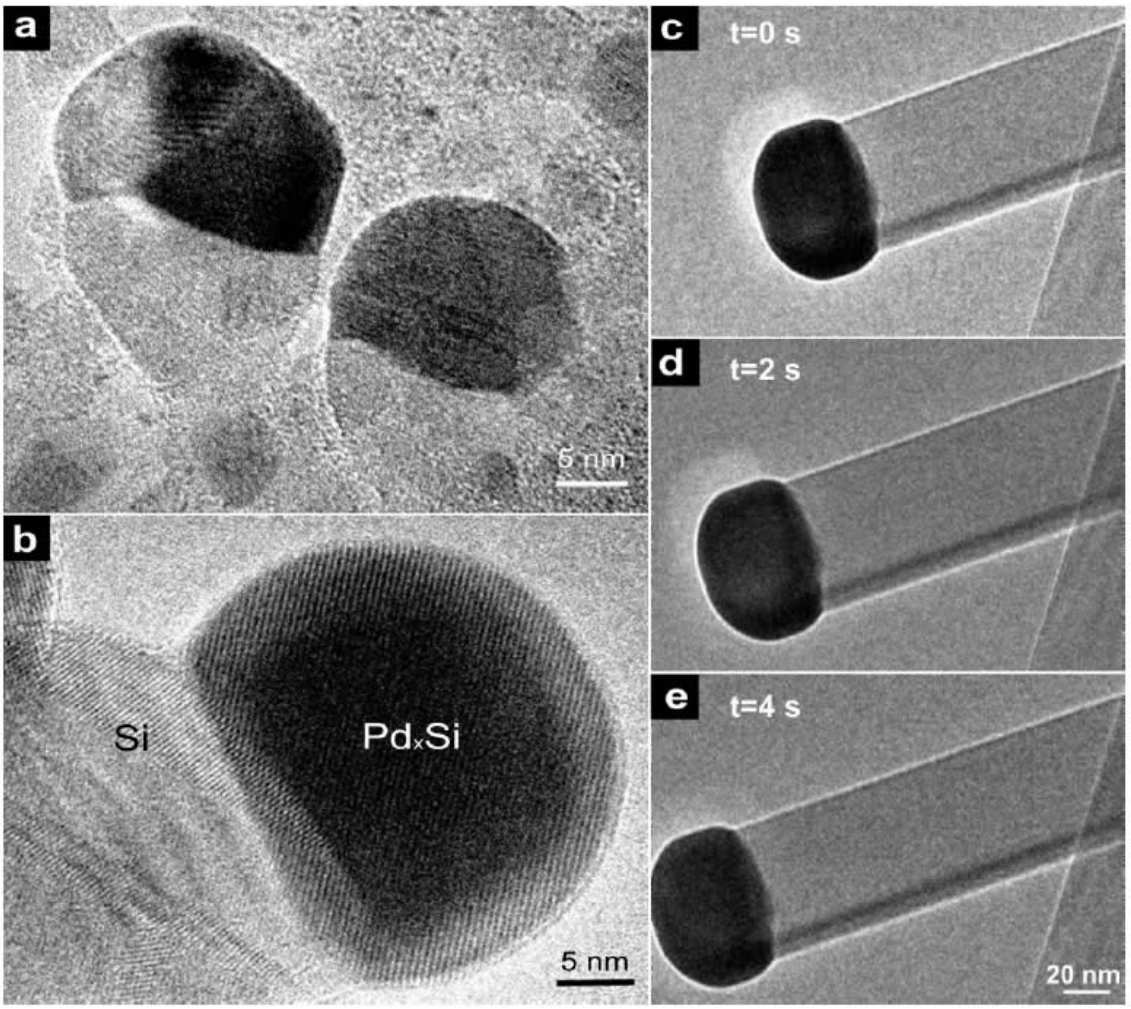

Figure ETEM images of 0.5-1 nm Pd film on SiOx membrane after exposure to ~1.2-1.6×10-2 mbar Si2H6. Image a shows the SiNW nucleation phase with Pd silicide particles at ~760°C. Image b and the sequence c-e show the tip region of growing SiNWs at ~710°C and ~625°C, respectively. t indicates elapsed time with respect to image c.

HOW ARE NANOPARTICLE INTERACTIONS AND ASSEMBLIES DIFFERENT FROM MOLECULAR AND COLLOIDAL ASSEMBLIES

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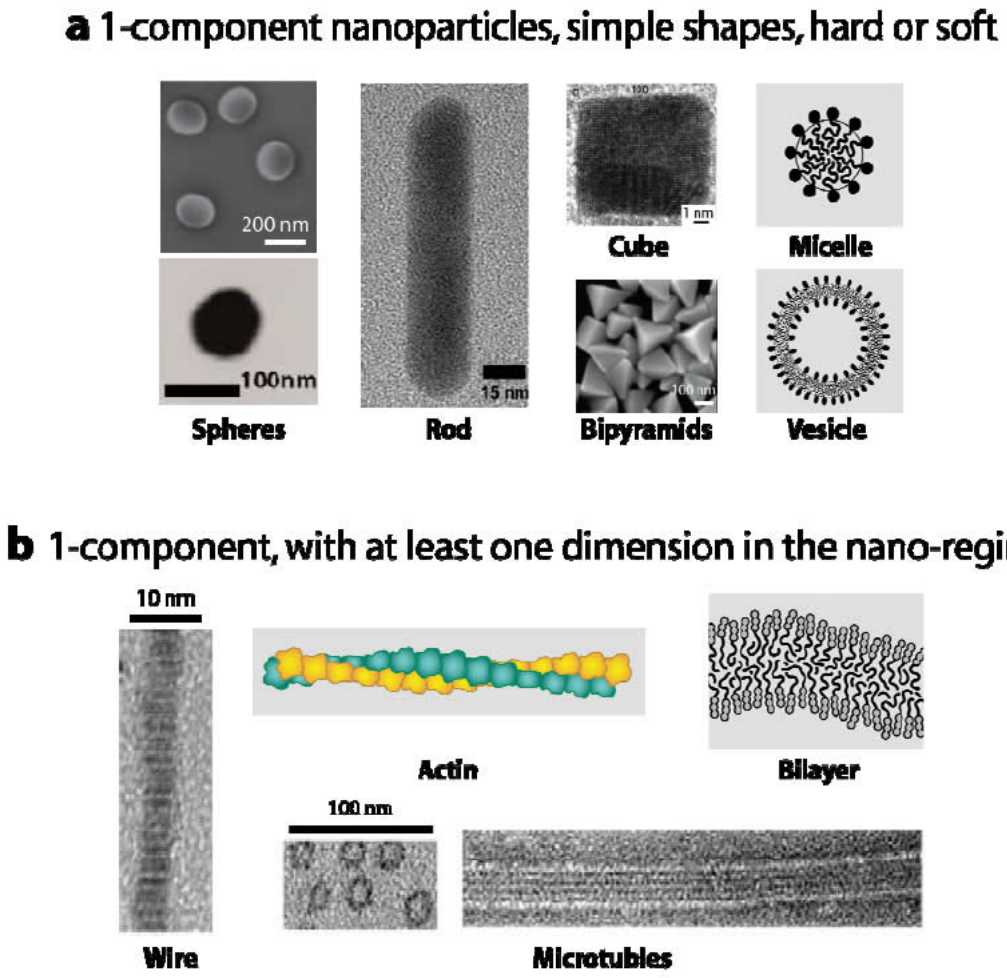
Are nanoparticles and their assembleis fundamentally different from smaller (atomic, molecular) or larger (colloidal) particles and assemblies? For reasons that will be discussed, mos nanoparticles do not spontaneously "self-assemble" into their thermodynamically lowest energy configuration. To do this, or to organize them into a non-equilibrium but stable structure, requires input of energy – a process that is better described as "directed" or "engineered" assembly. A combination of self- and directed-assembly process steps can be employed to obtain desired hierarchical structures, but this requires an understanding of how nanoparticle size, shape, hardness and composition (Fig 1) determine their interaction forces and processing possibilities.



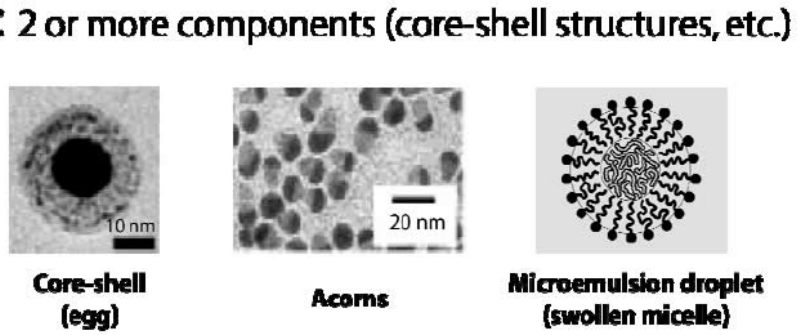


Figure 1. Some typical nanoparticles, here defined as having at least one dimension in the 1-100 nm regime, classified according to their size, shape, hardness and composition. (a) SEM image of main-chain polyether nanoparticle (top of first column) and TEM image of 60 nm gold nanosphere (bottom of first column). TEM image of Au nanorod (second column). HRTEM image of cubic Pt nanocrystal oriented along [001] (top of third column) and SEM image of Ag bipyramids approximately 150 nm in edge length (bottom of third column). Schematic micelle and vesicle are shown in the fourth column. (b) HRTEM image of PbSe nanowire formed in the presence of oleic acid and n-tetradecylphosphonic acid (first column). Schematics of actin and surfactant or lipid bilayer (top of second column). TEM images of microtubules (bottom of second column). (c) TEM image of Au co loid stabilized by sodium citrate and 19 layers of polyelectrolyte (left). HRTEM image of CoPd 'acorns' (middle). Microemulsion droplet (right).

For a variety of thermodynamic and kinetic reasons that will be discussed, most nanoparticle systems are bound to be non-equilibrium ones. Such systems depend on the method of their preparation and can show aging e fects such as slow deformational creep or chemical changes. The complex intermolecular and interparticle forces operating between different types of nanoparticles will be reviewed [1], as will their role in self-assembly and directed-assembly, the latter including the application of external magnetic and electric field forces, pressure confinement, flow, shear and rolling forces, to order nanoparticles. Most of these promising methods have yet to be fully explored.

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INTENSE CONTINUOUS THZ EMISSION FROM HIGH TEMPERATURE SUPERCONDUCTOR $Bi_2Sr_2CaCu_2O_{8+\delta}$ SINGLE CRYSTAL MESA STRUCTURES

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It is well-known that there is a missing frequency region in the electromagnetic spectrum near the THz frequency, where no compact source exists with sufficiently strong emission (≥mW) in spite of a great interest in a variety of applications including not only physical and chemical spectroscopies, but also medical diagnosing, pharmaceutical applications, a variety of imaging applications, environmental studies, security issues, ultrafast communications, quantum computations, *etc*. The mising frequency domain is called the "THz gap", which has been desired for filling in for a long time.

Here, we show an experimental evidence for such a possibility by a generation of intense THz radiation being sufficient for filling the "THz gap". This is realized by utilizing a mesa made of a piece of high temperature superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ single crystal. This material is known to be superconducting at T_c □ 90 K and is comprised of multi-stacked intrinsic Josephson junctions: the superconducting CuO_2 layers being inherently separated by Bi_2O_2 insulating layers only by □1.5 nm, where the unsurpassed packing density of the Josephson junctions are naturally realized in a crystal. In Fig. 1 the crystal structure of $Bi_2Sr_2CaCu_2O_{8+\delta}$ is shown schematically.

When the crystal is a perfect single crystal, no defects would be expected. However, in actual single crystals defect layers and intergrowth of structurally similar phases such as $Bi_2Sr_2CuO_{6+\delta}$ and $Bi_2Sr_2Ca_2Cu_3O_{10+\delta}$ are often found to intervene easily, for instance, in high resolution transmission electron microscopy (TEM) study. This evidence is not so clear by X-ray diffraction technique as usually used for inspecting the phase purity of material, but can very easily be detected in the resistivity measurement in the CuO_2 plane, *i.e.*, the *ab*-plane resistivity. Similarly, a careful measurement of the Meissner diamagnetism can also reveal the contamination of $Bi_2Sr_2Ca_2Cu_3O_{10+\delta}$ phase at around 108 K quite easily. From our experience it is known that our good quality single crystals contain impurities of only about 0.01% including structural defects such as low angle grain boundaries, *etc*. This high quality ensures in our crystals that there would be no defect layers even in a few micrometer thick sample and therefore can sustain surprisingly high static voltages of □50-300 kV/cm across the junctions. The typical *I-V* characteristic curve is shown in Fig. 2.

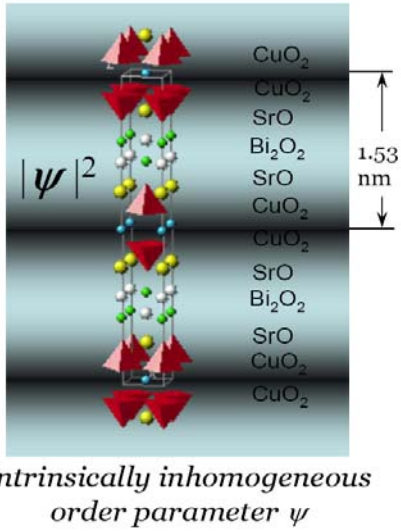

Fig. 1. The schematic crystal structure of $Bi_2Sr_2CaCu_2O_{8+\delta}$. The superconducting CuO_2 layer are sandwitched by the insulating Bi_2O_2 layers.

We fabricated rectangular mesas with dimensions of 300-400 μm in length, 40-100 μm in width, 1-2 μm in thickness from our single crystals by a standard photolithography technique. The example of the optical and the AFM images are shown in Fig. 3. Note that the mesa has not a regular rectangular shape but has a rather trapezoidal shape due to the ion milling effect. This could give a bad effect on the emission of THz radiation.

We show a direct spectroscopic evidence of THz emission of these mesas in Fig. 4, where the

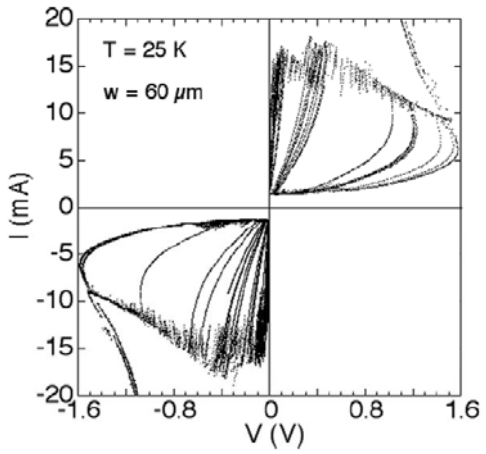

Fig.2 The *I-V* characteristic curves of a 1 μm thick mesa sample at *T*=25 K with 60 μm width.

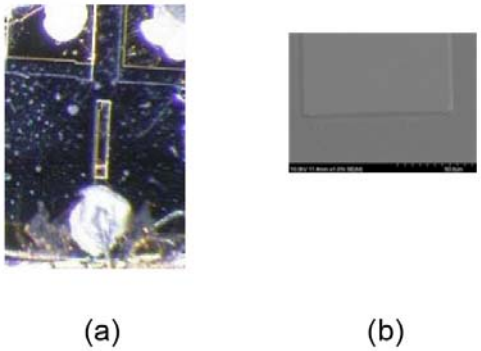

Fig. 3. Photographs of the mesa structure with dimensions of 60 μm in width, 400 μm in length and 1 μm in thickness. (a) A rectangular mesa is seen at the center with three electrodes. (b) AFM image of the mesa structure.

return branch of the *I-V* curve is shown simultaneously with the detecter signal as a function of voltage. As soon as the detector sensed intense EM waves while the voltage is scanned down slowly, the scan stopped at the peak voltage (the top pannel), then the FTIR spectroscopy was done (the bottom pannel) as indicated by red line. A sharp peak at about 12 cm^{-1} was clearly detected. The line width is very sharp and is within the resolution limit of the spectrometer of 0.25 cm^{-1}. It is noted that the emission continues at least more than 1.5 hours without noticeable fluctuations as long as the voltage is kept constant. The frequency of EM radiation obeys a relation

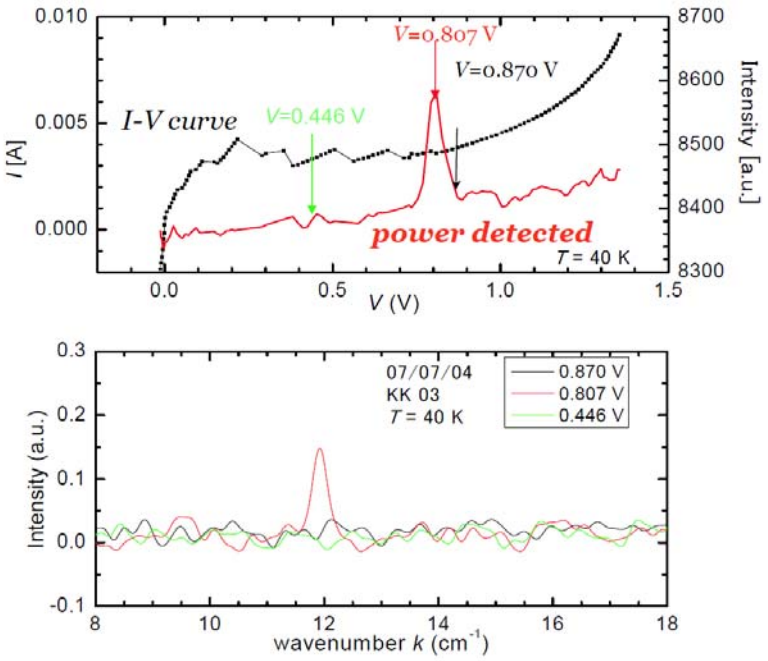

Fig. 4. The *I-V* return branch (black line) was shown simultaneously with the detector signal (red line) as a function of voltage (upper pannel). The detector signal was analyzed by the FTIR spectrometer (bottom pannel).

$$\nu = \frac{c}{\lambda\sqrt{\varepsilon}} = \frac{c}{2w\sqrt{\varepsilon}} = \frac{2e}{h}\frac{V}{N},$$

where ν and λ are the frequency and the wave length of the EM wave, respectively, w the width of the mesa, V the voltage applied to the mesa, N the number of the intrinsic Josephson junctions, ε the dielectric constant in mesa, e the electric charge, h the Planck constant.

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CONTROL OF DIMENSIONALITY, STRUCTURE, AND REACTIVITY OF GOLD NANOCATALYSTS: 2-D OR NOT 2-D?

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Investigations of physical systems of small sizes and reduced dimensionalities, exhibiting discrete quantized energy level spectra and specific structures and morphologies, open avenues for systematic explorations of the physical factors that control the unique properties of nano-scale materials structures. Computationally-based theoretical modeling and simulations play an increasingly important role in modern materials science, chemistry, and biology, and they may be called "computational microscopies" [1]

In this talk we focus on factors that underlie and govern the emergent chemical catalytic activity of gold nanostructures [2]. Topics that will be discussed include [3]: (i) Structures of free and surface-supported gold clusters; (ii) Cluster-support interactions (anchoring) and the influence of surface defects; (iii) Electronic structure and charge-states of supported gold nanocatalysts, (iv) Water enhanced catalytic activity; ((v) Catalysis of CO oxidation by negatively charged gas-phase gold clusters (vi) Control of dimensionality, structure and reactivity of gold nanoclusters through metal-oxide support thickness and/or applied electric fields.

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SINGLE- AND MULTI-EXCITONS IN SEMICONDUCTOR NANOCRYSTAL QUANTUM DOTS

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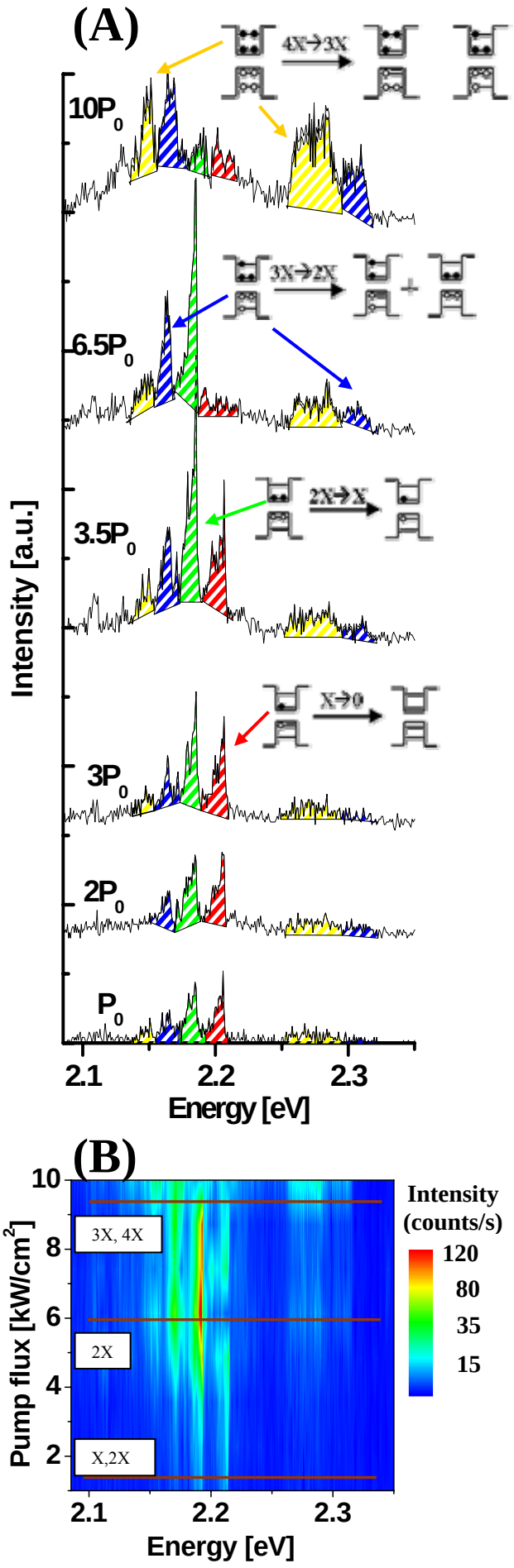
Multiexciton generation and recombination in colloidal semiconductor nanocrystals quantum dots (NQDs) have been the subject of a special scientific and technological interest in recent years due to their importance in gain devices, photovoltaic cells and single photon light sources. However, multi-excitons in core NQDs are "squeezed" into a volume comparable to a single bulk exciton, and experience low dielectric screening by the insulating surrounding ligands. Under those conditions, strong exciton-exciton (X-X) attractive Coulomb interaction takes place, leading to the so-called Auger relaxation. This process stimulates quenching of the multi-exciton radiation within a few ps, inhibiting their detection in time-integrated cw-PL experiments, and generates luminescence intermittency (blinking) in a single NQD detection. Alternatively, NQDs hetero-structures, characterized by the inclusion of additional semiconductor epitaxial layer between the core and the surfactants (named core-shell NQDs), may be pre-engineered to facilitate a unique condition that would control the Auger process and extend the multi-excitons' lifetime to the ns scale. Here we show, for the first time, well-resolved tetraexciton, triexciton, biexciton and a single exciton bands in the micro-photoluminescence spectrum of a blinking-free (90%) single CdTe/CdSe core-shell semiconductor nanocrystal quantum dot. The multiexcitons were generated by a continuous-wave laser with $\hbar\omega<2E_g$, sequentially filling the *s*-shell and *p*-shell. The *s*-shell (*p*-shell) recombination emission was red (blue)-shifted with respect to that of a single-exciton, and showed additional splitting in the presence of an external magnetic field. Representative example of the shell filling with the increase of the laser power is giving in the Figure below. The blinking free condition was achieved by a structural and dielectric matching and a partial carriers' delocalization at the core-shell interface. This investigation supplied information that was previously obscured in ensemble measurements, with tremendous benefit for future use in NQDs-based technologies.

Figure: A sequence of μ-PL spectra of a single CdTe/CdSe core-shell NQD, excited with a variable laser power (when P_0 = 10 μW). The spectra consist of 4-6 bands, shaded in different colours, and their corresponding recombination transitions are drawn schematically in the adjacent diagrams (notations are explained in the text). **Inset:** A contour plot of the μ-PL intensity (see side ruler) versus the emission energy and the laser power, *P*.



COLLOID CHEMISTRY – BASED NANOPHOTONICS

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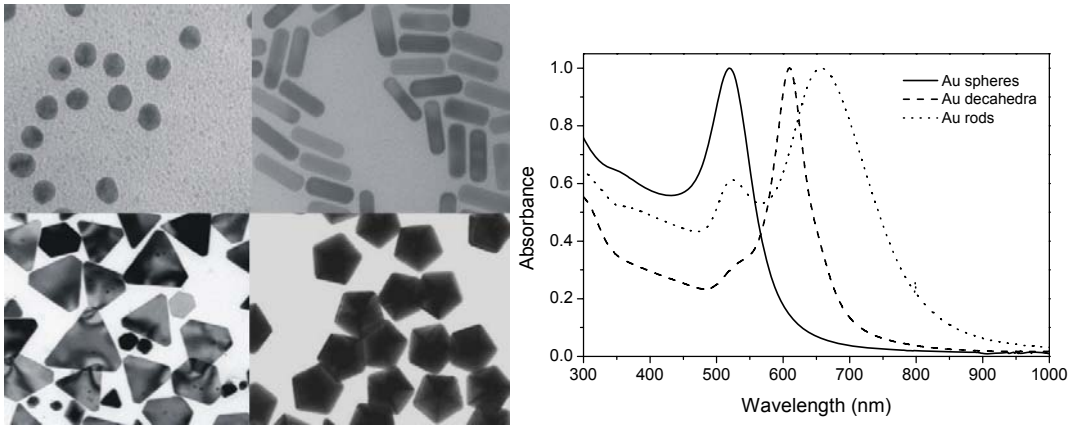
In this talk, a survey will be given of wet-chemistry based techniques recently developed to synthesize noble metal nanoparticles with controlled size and shape. The shapes will include spheres, core-shells, rods, flat prisms and other polyhedra, which can be prepared in a wide (nano)size range. The resulting optical properties, which are mainly influenced by the surface plasmon resonance of conduction electrons, will be discussed for the various shapes and sizes, using several theoretical models, increasing in complexity when the particles deviate from the spherical shape.

Examples of the various shapes are shown in Figure 1, and characteristic extinction spectra are shown in Figure 2 for gold spheres, decahedra and rods of selected sizes, showing that the localized surface plasmon can be tuned to basically any position within the visible spectrum.



Among the various selected shapes, anisometric nanoparticles have been found particularly appealing, since they display various resonance conditions as a function of orientation, resulting in an anisotropic response toward incoming light, which allows for further manipulation of the optical effects, through alignment.

All these shapes are strongly sensitive toward the refractive index of the environment, which makes them suitable candidates for biosensing applications.

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PHOTONIC GLASSES AS MATRICES FOR RANDOM LASERS

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Self assembly, the bottom up technique to fabricate complex materials architectures, has revealed as a powerful means for the fabrication of photonic crystals. This made artificial opals a playground to test numerous optical properties of photonic crystals both linear and non linear and also to create various applications. Infiltration of opals with guest materials, a technique known as templating, is an excellent tool to provide additional functionality to bare opals to enhance their photonic properties. The most commonly used techniques involve chemical synthesis in the interior of the pores of the opals. They can be combined to produce several morphologies -conformal growth standing out for its quality- of different materials and can also be combined with physical ones where the guest material is introduced rather than synthesized in situ. The principal characteristic of PBG materials is their periodicity from which all their optical properties stem. When the order inherent to photonic crystals is eliminated a new category of photonic materials can be conceived that may, in analogy, be dubbed photonic glasses. In this new scenario, where diffusion substitutes wave propagation, new phenomena can be expected like random lasing, localization etc. Strict monodispersity and sphericity of the colloidal particles results in a resonant behaviour that shows up in the relevant light transport magnitudes like mean free path and velocity.
The special care needed to produce high quality photonic crystals is, surprisingly, also needed to produce photonic glasses because, upon sedimentation, certain colloidal particles show a strong tendency to order which has to be broken. Only conscientious attempts to fully remove order lead to structures fully devoid of any remnants of order as evidenced by optical properties or microscopy. With this material it is possible to create random lasers in which the lasing wavelength can be decoupled from gain profile and selected at will.

OPTICAL DETECTION AND SPECTROSCOPY OF INDIVIDUAL NANO-OBJECTS

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In the fast evolving field of nanoscience, where size is crucial for the properties of the objects, simple and sensitive methods for the detection and characterization of single nano-objects are needed. The most commonly used optical techniques are based on luminescence. Single fluorescent nanoobjects have been studied on their own and are now routinely applied in various research domains ranging from quantum optics to life science. Yet, fluorescence methods allow only for short observation times due to inherent photo-bleaching. An interesting alternative relies solely on the absorptive properties of the object. In general, nanoparticles with large absorption cross sections and short time intervals between successive absorption events are likely candidates for detection with absorption methods. We have recently demonstrated a new two-color photothermal heterodyne technique for the detection of small absorbing nanoparticles. This photothermal method has been applied to the detection of individual metal nanoparticles, non-fluorescent quantum dots and single walled carbon nanotubes. The absorption spectroscopy of these systems at the single particle level is performed for the first time.

COMPETING RATCHETS AND MEMORY EFFECTS FOR DOMAIN WALL MOTION IN MAGNETIC FILMS WITH ASYMMETRIC ARRAYS OF ANTIDOTS

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Patterned magnetic nanostructures have received much interest in recent years as they provide the ability to control and design the magnetic behavior for specific applications, as well as to study fundamental magnetic properties [1]. In particular, the study of domain wall (DW) propagation in these low dimensional magnetic systems has attracted a great interest since it provides both the basis for a wide number of magnetic devices [2], and a good experimental system to analyze the basic physics of an elastic interface in the presence of either ordered or random pinning defects [3,4].

When the pinning potential is asymmetric it can behave as a ratchet, so that DW propagation is favored in one direction. One of the first ratchet potentials that have been used are angelfish patterns that control the sense of propagation of bubble domains in shift registers [5]. Also, asymmetric motion of DWs in nanowires with triangular [6] or notched [7] shapes has been reported recently. However, up to now, in order to ensure a good control of the DW nucleation/propagation process, in all the cases DW motion has been confined to an essentially 1D path (either by narrow guide rails or by the nanowire geometry), so that its transverse wandering can be neglected. On the other hand, in a thin extended film with a 2D array of asymmetric pinning centers, novel ratchet phenomena can appear since a DW behaves as an elastic line that can distort all along its length in response to the 2D pinning potential.

In this work, we have studied both experimentally and theoretically the propagation of DWs in extended uniaxial magnetic films that have been patterned with a periodic array of asymmetric holes by electron beam lithography and plasma etching (see Fig. 1). For the first time, we have found the existence of two crossed ratchet effects of opposite sign that change the preferred sense for domain wall propagation, depending on whether a flat or a kinked wall is moving [8]. This implies a change in the rectification effect on DW motion as a function of the magnetic field that has an interesting consequence from the applied point of view: the system keeps memory of the sign of the last saturating state even in a zero magnetization configuration. Thus, it is possible to record several magnetic states introducing the DWs in the array and to read them with a low amplitude AC field (see Fig. 2). By solving numerically a simple ϕ^4 model we show (see Fig. 3) that the essential physical ingredients for this effect are quite generic [8] and could be realized in other experimental systems involving elastic interfaces moving in multidimensional ratchet potentials. Also, this asymmetric pinning has been confirmed by micromagnetic simulations with the OOMMF code.

Work supported by Spanish CICYT (grants NAN2004-09087, FIS2005-07392, and MOSAICO).

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Figures:

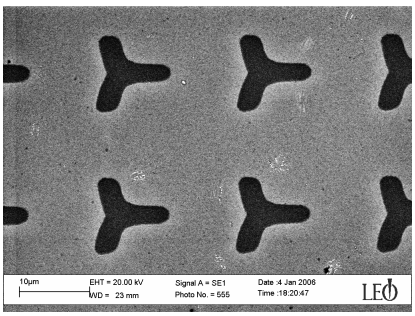

Fig. 1: SEM image of the array of asymmetric holes

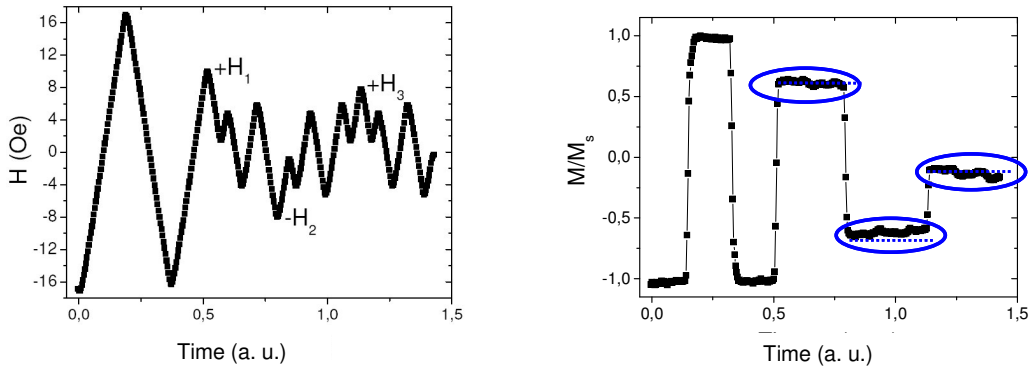

Fig.2: (Left) Field time evolution in order to record three magnetic states in the array. (Right) Corresponding magnetization vs. time evolution, where it can be seen how the reduction of the absolute magnetization due to the DW kinks movement keeps memory of the magnetic state.

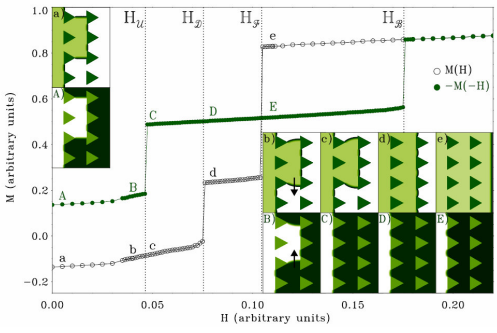

Fig. 3: Numerical simulations of the switching fields for DW motion in an array of asymmetric holes for the cases of a flat DW and a kinked DW, that present opposite ratchet effects.

TRANSFORMATION OF SPIN INFORMATION INTO LARGE ELECTRICAL SIGNALS USING CARBON NANOTUBES

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Spin electronics (spintronics) exploits the magnetic nature of the electron, and is commercially exploited in the spin valves of disc-drive read heads. There is currently widespread interest in using industrially relevant semiconductors in new types of spintronic devices based on the transport of a spin current in a lateral semiconducting channel between a spin-polarized source and drain. However, the transformation of spin information into large electrical signals is limited by spin relaxation such that the magnetoresistive signals are below 1%. This long-standing problem in spintronics is overcome by demonstrating large magnetoresistance effects of 61% at 5 K in devices where the non-magnetic channel is a multiwall carbon nanotube that spans a 1.5 μm gap between epitaxial electrodes of the highly spin polarized manganite $La_{0.7}Sr_{0.3}MnO_3$. This improvement permits large output signals of 65 mV, and arises because the spin lifetime in nanotubes is long due the small spin-orbit coupling of carbon, because the high nanotube Fermi velocity permits the carrier dwell time to not significantly exceed this spin lifetime, because the manganite remains highly spin polarized up to the manganite-nanotube interface, and because the interfacial barrier is of an appropriate height. These latter statements regarding the interface are supported using density functional theory calculations. The success of these experiments with such chemically and geometrically different materials should inspire adventure in materials selection for some future spintronics.

LE Hueso, JMA Pruneda, V Ferrari, G Burnell, JP Valdés-Herrera, BD Simons, PB Littlewood, E Artacho, A Fert and ND Mathur, *Nature* **445** (2007) 410

ELECTRONIC NOISE IN NANOSTRUCTURES

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One of the main drivers of the current interest in nanoscience is the potential for designing electronic devices that consume less power, operate at higher speed, and can be arranged in arrays even more dense than current ones. The ultimate goal is to develop *molecular electronics*, in which individual molecules function as electronic devices (e.g., switches) coupled to metallic wires (or atomic-resolution metallic tips) that act as electrodes or electronic gates. Other schemes envision using a variety of nanoscale structures, including semiconducting quantum dots or wires and others that exploit the extraordinary properties of graphene, for electronic devices and systems.

Key to realizing those schemes is a previous knowledge of the electronic transport mechanisms involved, including ballistic transport, hopping or tunneling. If the experience in mesoscopic physics is any guide, that knowledge cannot be fully derived from the electrical conductance alone. In the last few years, the inherent fluctuations (*noise*) of the current have received increasing attention, on the realization that when a system is out of equilibrium these fluctuations, especially those that arise from the discrete nature of the charge itself (*shot noise*), can convey information complementary to that provided by conductance. In addition, because of its intrinsic character, shot noise sets limits to the ultimate performance of an electronic device.

Here we review recent experimental studies of shot noise in two-dimensional (2D) semiconductor heterostructures, in which at least one of their dimensions is at the nanoscale. The control and perfection with which these nanostructures are nowadays prepared (by epitaxial growth on a crystalline substrate), together with the extensive knowledge (both theoretical and experimental) accumulated in the last thirty years, makes them ideal to correlate shot noise with electron-transport mechanisms. The obtained results can serve as a "catalog" or "library" to identify those mechanisms in other, not so well characterized nanostructures. For instance, we have shown that in semiconductor nanostructures that exhibit negative differential conductance (NDC) the amount of shot noise is determined by whether or not electrons are accumulated in confined regions. It will be possible to use this general conclusion (and others summarized below) in future studies aimed at elucidating the electronic transport in a wide spectrum of nanostructures.

1. Shot Noise in the Hopping Regime of 2D Systems[1]

In spite of the regained interest in hopping conduction, an electron-transport mechanism associated with the metal-insulator transition observed in Si MOSFETs and other 2D systems, until recently little was known about the shot noise properties in the hopping regime.

Our study on a 2D hole system confined in a SiGe quantum well has showed that in the hopping regime shot noise is suppressed relative to its "classical" value $2eI$ by an amount that depends on the length of the sample and its gate-controlled carrier density. We have found that the suppression factor, F, is about 1/2 for a 2μm long sample, and of 1/5 for a 5μm sample[1], which we have explained in terms of the characteristic length (≅1μm in our case) of the inherent non-homogeneity of hopping transport, obtained from percolation theory.

We have done subsequent measurements in a 2D electron gas in a Si-doped GaAs structure whose carrier density and localization length, ξ, were controlled by a gate voltage[1]. We have confirmed that F is inversely proportional to the sample length, L, and that it changes as the conductivity changes with gate voltage. We have discovered that the proportionality factor, L_0^*, between F and L^{-1} can be identified with the length L_0 given by percolation theory only when $\xi/L_0^* << 1$. On the other hand, when $\xi \approx L_0^*$, we have found that L_0^* is much smaller than L_0 obtained from the percolation model of hopping, thus signaling a reconstruction of the hopping paths[1].

2. Shot Noise in Semiconductor Superlattice Tunnel Diodes[2]

One of the major questions about shot noise in NDC devices is its universality, that is, whether or not the noise properties of all NDC systems are similar regardless of the mechanism that causes their multi-stability. We have addressed this question by studying the shot noise of two GaAs-GaAlAs devices with NDC of very different physical origin: a superlattice tunnel diode and a double-barrier resonant tunneling diode[2]. In the former, the NDC is caused by an energy gap in the collector electrode, while in the latter diode the NDC results from momentum conservation and is accompanied by charge accumulation in the well between the two potential barriers.

Our results have shown that in NDC devices in which transport proceeds via tunneling and and there is no charge accumulation, the electronic motion is uncorrelated and the noise is Poissonian. On the other hand, when the transport is such that charge is accumulated, charging effects correlate electron motion, either negatively or positively, and shot noise deviates from the $2eI$ Poissonian value[2]. These results contradict a previous calculation that predicted that shot-noise would be enhanced over $2eI$ in any device with NDC, regardless of the mechanism that caused it.

3. Shot Noise of Triple-barrier Resonant-tunneling Diodes[3]

As a first step toward the goal of measuring the shot noise of strongly coupled quantum wells, we studied the noise of thick triple-barrier resonant-tunneling diodes in both the positive- and negative-differential-conductance regions, and compared it with that of a double-barrier diode[3]. The diodes were prepared using lattice-matched $In_{0.53}Ga_{0.47}As$-$In_{0.48}A_{0.52}As$ epitaxial layers grown by metal-organic chemical-vapor deposition on InP substrates.

We found that in triple-barrier diodes the shot noise was reduced over $2eI$ whenever the differential conductance was positive, and enhanced when the differential conductance was negative[3]. This behavior is qualitatively similar to that found in double-barrier diodes, but it differs from it in important details. First, the noise reduction was considerably greater than predicted by a semiclassical model, and, second, the enhancement did not always correlate with the strength of the NDC, in contrast with what is found experimentally in double-barrier diodes.

4. Shot Noise of Strongly Coupled Quantum Wells[4]

Very recently, we have measured the shot noise of three GaAs-GaAlAs nanostructures, each consisting of two quantum wells separated by a central barrier of thickness d. We have found that in nanostructures in which d is small enough (≤ 2.0 nm) as to allow for coherent coupling of the wells' electronic wavefunctions, the characteristic noise reduction of the positive-conductance region (see above) is less pronounced that in structures in which that coupling is negligible ($d = 6.0$ nm). This result, which qualitatively can be explained in terms of an "effective" disappearance of the central barrier in case of coherent coupling, casts some shadow on calculations that predict a larger suppression of noise when tunneling is coherent than when it is sequential.

This work has been financially supported by the US National Science Foundation.

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NANOIMPRINT LITHOGRAPHY:
FROM TECHNOLOGICAL EXPLORATIVE RESEARCH TO AN INDUSTRIAL TECHNOLOGY

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Recent years have seen a large interest in development of new lithographic techniques. One of these that have quickly reached a level of maturity that makes it useful for practical applications is nanoimprint lithography (NIL). This cost-efficient, high throughput method opens new avenues for nano-scale research in general and for nano-bio in particular where often a need for many samples exists in order to probe the variability that characterizes biological systems. In the first part of this paper I will discuss the development of the NIL-technology and show major characteristics of a NIL-system. Further, I will discuss the techniques pro and cons for fabrication of nanostructures. In the second part in my talk I will discuss about some applications-mainly in the nano-mechanical area. Mechanics at the nano-scale is becoming increasingly important. In this talk I will therefore highlight a number of nano-mechanical issues. I will discuss about extremely efficient nano-motors based on molecular motors derived from muscle tissue. Here we have explored various nanostructures (topographical as well as chemical) in order to guide, rectify, and direct nano-mechanical movement with uttermost precision and high efficiency. Then I will discuss about nanomechanical structures having the ability to detect few molecular reactions on its surfaces by monitoring the resulting change of resonance frequencies. The structure of the nano-mechanical device is a laterally deformable double-finger interdigitated cantilevers array (**Fig 1**), which is made on SiO_2/Si surface and evaporated with a metal layer. When a bias is applied, the cantilevers of the device will bend to each other due to electrostatic force. After deposition of a silane layer, the resonance frequency shows 25 kHz shift corresponding to a weight of 6 fg indicating that the device could be applied as a mass sensor with a 0,2 ag/Hz sensitivity. As a further extension of these nano-gratings we have employed nano-wires defined by Nanoimprint lithography and epitaxial growth. Surfaces containing such nano-wires have been used to study neuronal outgrowth, cellular response and cellular survival (**Fig 2**. We show that peripheral nerve cells can survive and grow on gallium phosphide (GaP) nano-wire surfaces and that cells are activated by the nano-topography. Then as a concluding remark, I will give an outlook and discuss about NIL´s role as a very versatile alternative for future nano-science based production.

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Acknowledgement: This work is partly performed within the Nanometer Consortium at Lund University supported by several FP5, 6 & 7 projects and by the Swedish Science Council, the Swedish Strategic Research Council and by the Swedish Agency for Innovation Systems in co-operation with Obducat AB, Malmo, Sweden.

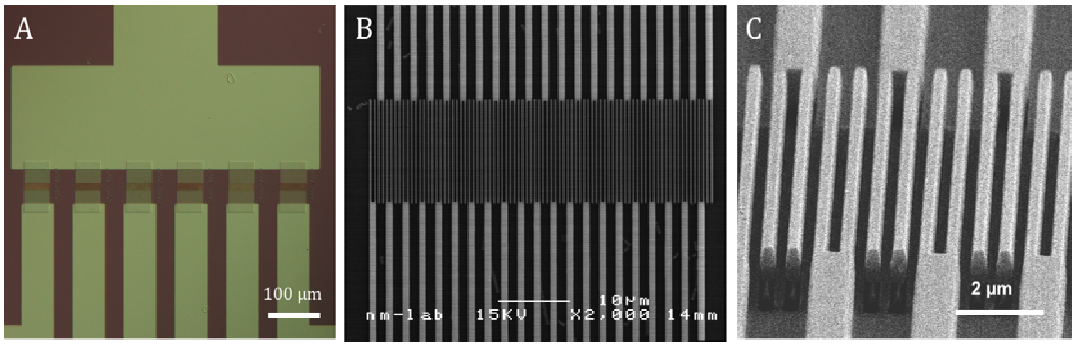
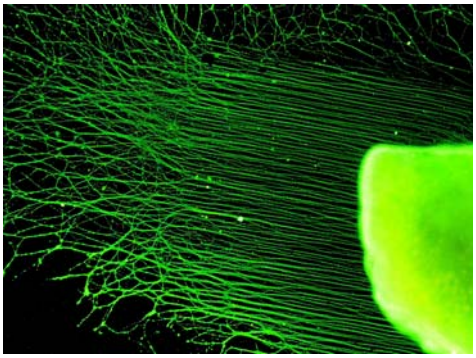


Fig. 1 (A) An optical microscope image of the device pattern;
(B) SEM image of a cantilever array; (C) Side view of the cantilevers.



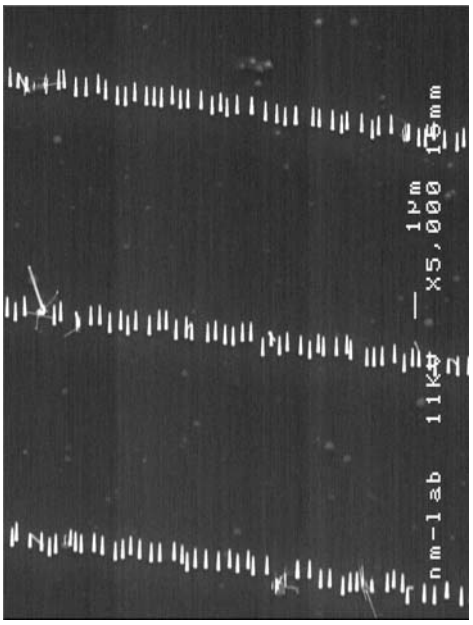


Fig. 2 a) Fluorescence microscopy image of the axons from superior cervical ganglia on a 1 by 1 mm nanowire-patterned surface (parallel rows of nanowires) b) SEM of the surface showing the aligned parallel rows of nanowires.

SYNTHESIS OF COMPLEX NANOSTRUCTURES BY ATOMIC LAYER DEPOSITION

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Atomic layer deposition (ALD) has recently become the method of choice for the semiconductor industry to conformally process extremely thin insulating layers (high-k oxides) onto large-area silicon substrates. ALD is also a key technology for the surface modification of complex nanostructured materials. After briefly introducing ALD, this talk will focus on the various aspects of nanomaterials and their processing by ALD, including nanopores, nanowires and -tubes, nanopatterning and nanolaminates as well as low-temperature ALD for organic nanostructures and biomaterials [1]. The following application area will be emphasised during this presentation:

1) **Low-Temperature ALD and Biomaterials [2]**: In this work we show the application of atomic layer deposition, a gas-phase thin film deposition process, to biological macromolecules, which are frequently used as templates in nanoscale science, and the possibility to fabricate metal oxide nanotubes and thin films with embedded biomolecules.

2) **Ferromagnetic Nanotubes in Ordered Alumina Membranes [3,4]:** Iron oxide nanotubes of 50-150 nm outer diameter and 2-20 nm wall thickness are prepared in ordered arrays. Atomic layer deposition (ALD) of Fe_2O_3 from the precursor iron(III) *tert*-butoxide at 130-180 °C yields very smooth coverage of the pore walls of anodic alumina templates, with thickness growth of 0.26(±0.04) Å per cycle. The reduced Fe_3O_4 tubes are hard ferromagnets, and variations of the wall thickness d_w have marked consequences on the magnetic response of the tube arrays. For 50 nm outer diameter, tubes of d_w = 13 nm yield the largest coercive field (H_c > 750 Oe), whereas lower coercivities are observed on both the thinner and thicker sides of this optimum. For the ALD of Ni and Co nanotubes metal oxide is initially deposited by a conventional two step ALD process. The precursors were nickelocene or cobaltocene, and H_2O or O_3. Subsequently, the sample is reduced under hydrogen atmosphere.

3) **Atomic Layer Deposition of SiO_2 thin films and nanotubes [5]:** Molecular self-attack: According to mythology, a scorpion may sting itself to death; similarly, 3-aminopropyltriethoxysilane catalyzes its own hydrolysis in the atomic layer deposition (ALD) of SiO_2 thin films and nanostructures. Between 120 and 200 °C, the growth rate is constant at 0.06 nm per ALD cycle. The SiO_2 films are chemically and optically pure. SiO_2 nanotubes of aspect ratio 500 exhibit smooth walls of accurately controlled thickness.

4) **Large-scale arrays of nanorings with sub-30 nm feature:** The approach is based on templates with periodic polymer holes structures on silicon substrate generated by laser interference lithography (LIL). A homogeneous TiO_2 layer was deposited on the relief of the substrate by atomic layer deposition (ALD) (ref) at room temperature. The unwanted parts of the TiO_2 layer were removed by anisotropic etching.

Financial support of the German Ministry of Education and Research (FKZ 03N8701 and FKZ 03X5519) is gratefully acknowledged.

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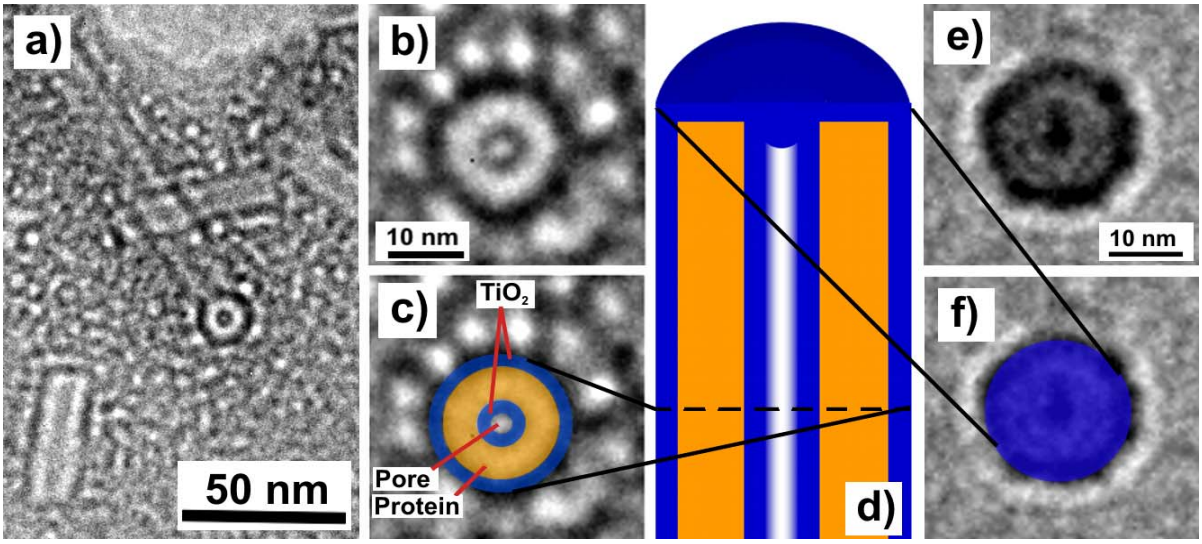

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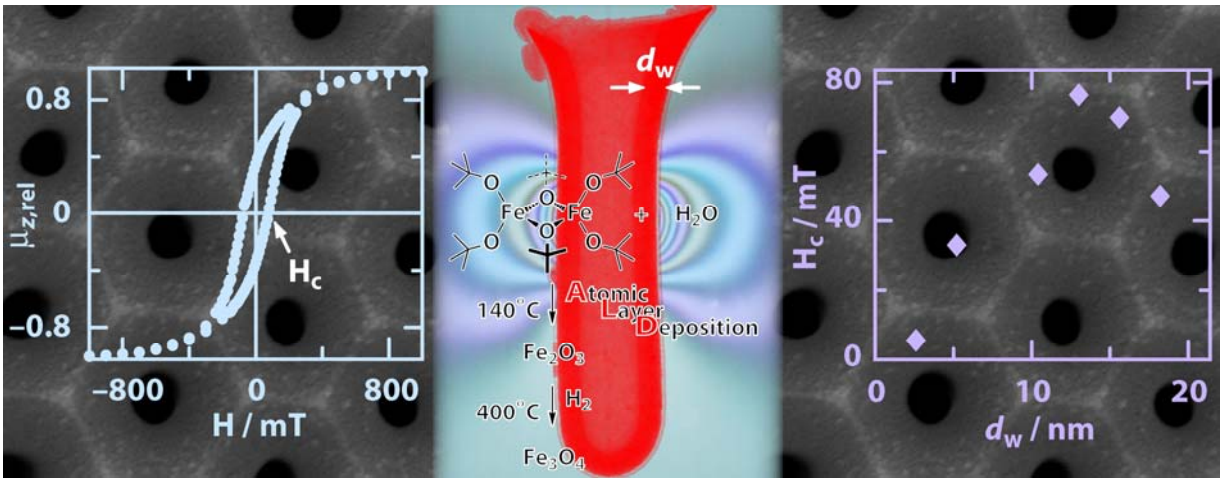

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DIRECT NANOSCALE MAGNETIC PATTERNING IN FEAL ALLOYS BY MEANS OF ION IRRADIATION

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$Fe_{60}Al_{40}$ (at. %) alloys show an interesting combination of magnetic and structural properties, where atomically ordered $Fe_{60}Al_{40}$ (B2-structure) is paramagnetic at room temperature, whereas disorder $Fe_{60}Al_{40}$ (i.e., atomically intermixed, A2-structure) becomes ferromagnetic [1]. The transformation from paramagnetic B2-phase to the ferromagnetic A2-phase can be accomplished by means of homogeneous ion irradiation procedures. The irradiation induced transformation depends on the irradiation dose and the type of ions [2]. Furthermore, local ion irradiation procedures (i.e., focused ion beam or ion irradiation through masks) have been also used in order to fabricate periodic arrays of ferromagnetic structures embedded in a paramagnetic matrix [3]. Patterned polymer layers defined by electron beam lithography and porous alumina templates were used as masks. While the e-beam lithography allows for a careful design of the patterns, alumina templates lead to fast processing of very large areas. Importantly, due to the low fluences used, this method does not induce any roughening of the surface, leading to topographically featureless magnetic dots. The fabricated entities exhibit a range of magnetic properties depending on the size and shape, which were investigated by means of magneto-optical Kerr effect magnetometry, while the local character of the induced ferromagnetism was examined by magnetic force microscopy. The smallest dots (sub-50 nm in size) exhibit coercivities in the range of $H_C \sim 500$ Oe and a large squareness, $M_R/M_S \sim 1$ (see Fig. 1). Interestingly, when the patterned sheets are annealed at sufficiently high temperatures, the ferromagnetic properties are removed due to the annealing-induced atomic reordering. Hence, these methods may lead to a novel type of patterned recording media free from tribological and exchange coupling effects. Moreover, these approaches can be easily extrapolated to a variety of other systems exhibiting disorder-induced magnetism.

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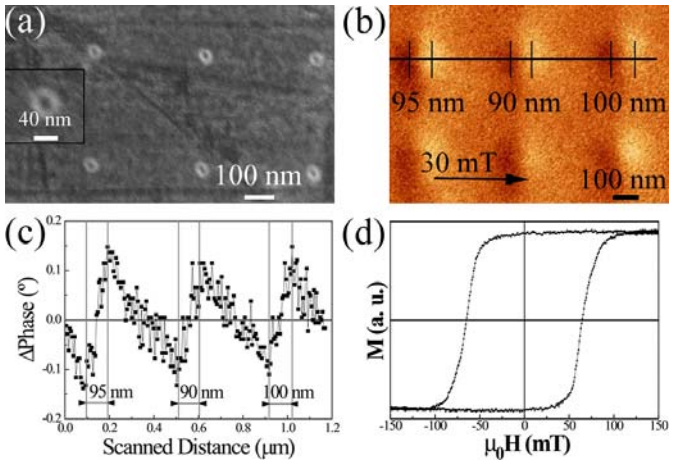

Figure 1. Sub-50 nm magnetic patterning by FIB. (a) SEM image obtained using secondary electrons of an array of circular dots, patterned by FIB. The inset in (a) shows an enlarged image of one of these entities. (b) MFM image of the circular dots taken in $\mu_0 H$ = 30 mT after saturation; (c) Phase profile line scan analysis at the position indicated in (b) and (d) MOKE hysteresis loop corresponding to these ferromagnetic features.

SP1 PROTEIN-NANOPARTICLE HYBRIDS AS BUILDING BLOCKS FOR NANOSTRUCTURES: MEMORY ARRAYS AND NANOWIRES

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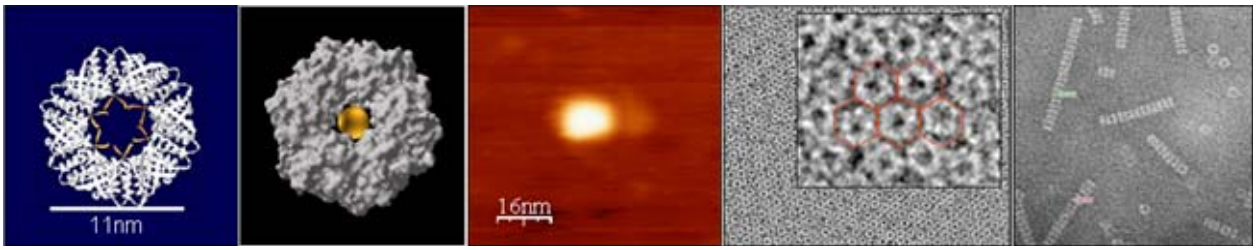
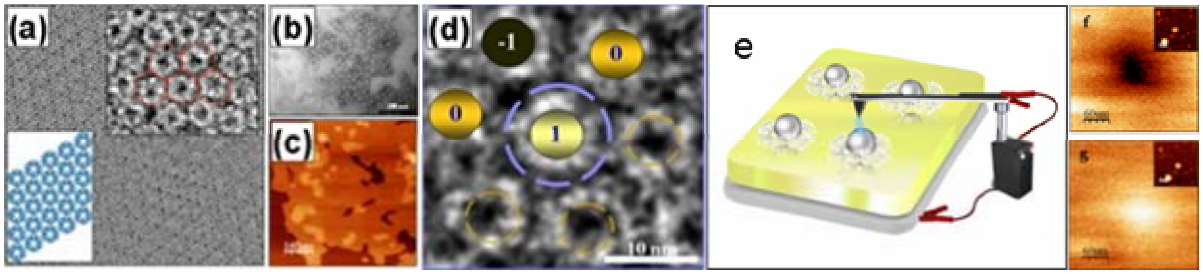


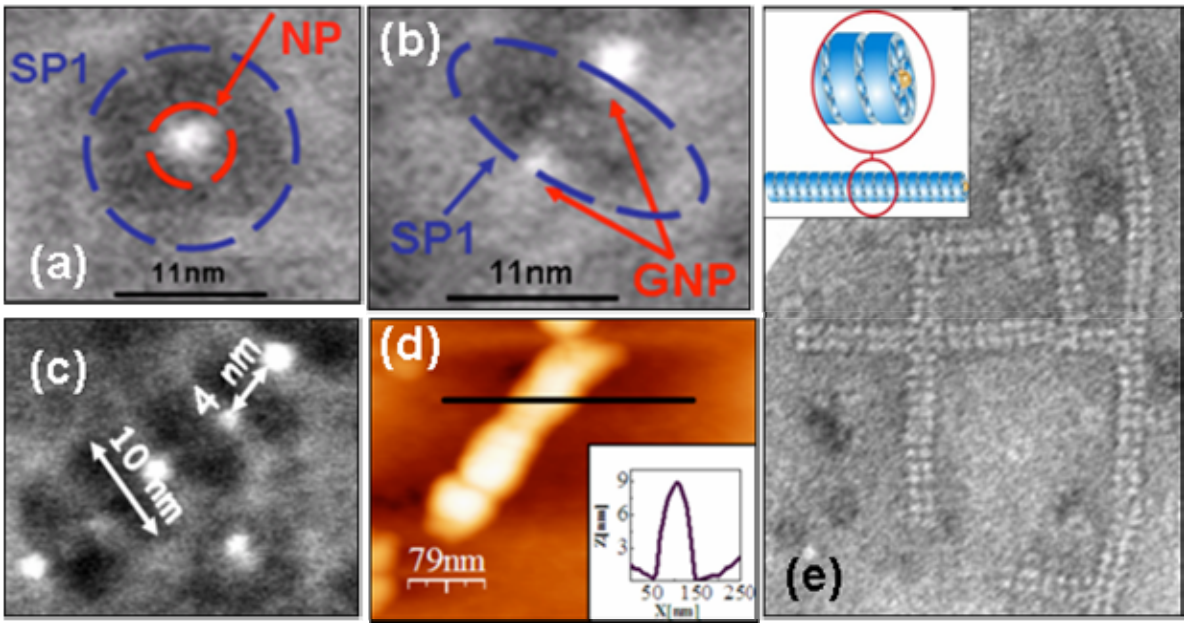
SP1 nanostructures: (a) The X-ray structure of the SP1. (b) A computer image of the SP1-nanpoparticle hybrid. (c) An AFM image of an SP1 molecule. (d) A close packed hexagonal SP1 array and enlargement. (e) TEM image of SP1 nanotubes (width 10 nm).

Controlled formation of complex nanostructures is one of the main goals of nanoscience and nanotechnology. SP1 (Stable Protein 1) is a boiling-stable ring protein complex, 11 nm in diameter, which self-assembles from 12 identical monomers. SP1 can be utilized to form large ordered arrays; it can be easily modified by genetic engineering to produce various mutants; it is also capable of binding gold nanoparticles (GNPs) and thus forming protein-GNP chains made of alternating SP1s and GNPs. We form those nanostructures and characterize them by transmission electron microscopy (TEM), atomic force microscopy (AFM) and electrostatic force microscopy (EFM). Further control over the GNP inter-distances within the protein-GNP chains may lead to the formation of nanowires and structures that may be useful for nanoelectronics.



SP1 array as a basis for a memory array: (a) 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. (b) An array of NP-binding SP1 mutants. (c) An AFM image of an array as in (b). (d) Overlaid scheme of the suggested memory, where the writing is by charging individual particles with AFM and reading by EFM. (e) The charging scheme. (f-g) Two charged states of the hybrid and topography (inset)

Proteins as a mean of a versatile isolating template on one hand and a nanoparticle (NP) as an electric storage device on the other hand have long been investigated as independent entities. The ability to combine the two species to form an addressable single nanoparticle isolated from a conductive surface and adjacent NPs gives rise to a wide range of nanoelectronic devices. For this purpose we have connected a 5 nm SiO_2 NP to the SP1, and investigated the electric storage capabilities of the hybrid using Conductive AFM (cAFM). Such memory unit is capable of storing at least 3 states (0, 1, -1). With storage time of over 10 min at room temperature this hybrid can be considered as a nanometric memory unit.



6His-SP1-GNP rings and tubes imaged with different microscopes. (a,b) HAADF-STEM images of an SP1-GNP hybrid (1.8 nm GNP), top view (a) and side view (b. (c) HAADF-STEM image of an SP1-GNP tube with 4 nm gap between consecutive GNPs. (d) AFM image SP1-GNP tube on mica: the inset shows the height measured on the black segment. (e) TEM image of more complex SP1-nanoparticles structures. The inset shows a scheme of the nanotubes.

The SP1-nanopartcle hybrids can form long nanotubes in which the SP1 protein serves as a template for a ordered chain of nanoparticles. This chain, when optimized, can serve as a conductive wire and potentially, by using a different nanoparticle in specific positions, as a chain of embedded devices. More complex architectures based on such wires may be very attractive for nanoelectronic applications.

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A TA_2O_5 SOLID-ELECTROLYTE SWITCH WITH IMPROVED RELIABILITY

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We present a novel solid-electrolyte switch for programmable LSI. We have used Ta_2O_5 solid electrolyte with very slow Cu^+ diffusion so that the turn-on voltage can be controlled to adapt to CMOS operation. Furthermore, we examined the ON-state reliability of the Ta_2O_5-switch and optimized the trade-off between turn-off current and ON-state reliability, both of which depend on the ON conductance. Ta_2O_5-switch achieves high durability against DC current (0.2mA, 105°C, 10years) and fair turn-off current (5mA). The novel switch can thus meet the requirements for programmable LSI.

The solid-electrolyte switch, composed of the solid electrolyte (CuS or AgS) sandwiched between oxidizable electrode (Ag or Cu) and indifferent electrode (Pt), has been reported by several groups [1]. When a positive or negative voltage is applied to the oxidizable electrode, the switch turns on or off. The switching presumably occurs when a nanometer-scale metallic bridge is created or annihilated inside the solid electrolyte. The switch has distinctive advantages of its small size ($4F^2$, F: minimum half line-pitch) and low ON-resistance (<100 Ω). When the novel switch is applied to a programmable LSI, the chip size can be reduced by 10 times and its performance (speed and power consumption) improves [2]. However, the switch with CuS or AgS has two difficulties on reliability. The turn-on voltage (V_{ON}) is too small (<0.2V) to maintain the OFF state during the normal logic operation [2]. And ON-state reliability should be improved for programmable switch. Here, we have demonstrated that the reliability is improved by reducing the diffusion rate of metal ions in the solid electrolyte.

An appropriate candidate for the solid electrolyte is a metal oxide, which has a smaller diffusion rate than CuS or AgS. We focus on Ta_2O_5 because of its process compatibility with Si-LSI [3]. Figure 1 shows current-voltage characteristics of the Ta_2O_5-switch composed of Cu/Ta_2O_5/Pt stack. Even if a positive voltage was applied to the Cu electrode, the switch maintained in OFF state within an operation voltage of CMOS (≈1V). The switch turned on at 2.5V and the ON resistance (R_{ON}) was around 50Ω. Here, the current was controlled to be below 100μA by the voltage source. Inversely, applying a negative voltage turned the switch off. Figure 2 (a) and (b) show TEM image of switch. After turning on, the dark region with a diameter of 30nm was observed between the two electrodes (Fig. 2 (b)). By means of EDX analysis, the current path was found to be made of Cu bridge (Fig. 2 (c)). These results show that Cu+ ions are extracted from the Cu electrode and the Cu is precipitated between the two electrodes by the electrical field. Localized and metallic conducting path allows the switch to scale down to tens of nanometer while maintaining the ON resistance low [4]. The turn-on/off time ranged from 10 to 100μsec (Fig. 3) and cycling endurance was more than 1×10^4 cycles (Fig. 4). The switching time and cycling endurance meet the demand for switch elements in programmable LSI.

To achieve a highly reliable ON-state, a higher ON conductance (G_{ON}) can be used. However, the turn-off current (I_{OFF}) becomes higher in turn [5]. As shown in Fig. 5, I_{OFF} linearly increased in according to $I_{OFF} = 0.2 \times G_{ON}$. To evaluate the reliability of the Cu bridge, we measured the duration time in ON state while biasing DC current (I_{DC}) (Fig. 6) and estimated the maximum current for duration of 10years. As shown in Fig. 7, the median of duration (t_{50}) did not depend on G_{ON} but rather linearly depended on V_0^{-N} (where $V_{ON} = R_{ON} \times I_{DC}$, and N=12). And t_{50} was thermally activated with an activation energy (E_A) of 0.48eV. Thus, t_{50} is empirically given by $A\times V_0^{-N}\exp(E_A/k_BT)$, where A is constant. When we consider the ON state duration of 10years ($=t_{50}$) at 105°C (=T), the allowable voltage V_0 can be estimated by the equation. Thus, the allowable current I_{MAX} ($= V_0\times G_{ON}$) can also be derived. Considering the trade-off between I_{MAX} and I_{OFF}, the optimal G_{ON} is estimated to be around 0.02S (=50Ω) (Fig. 8).

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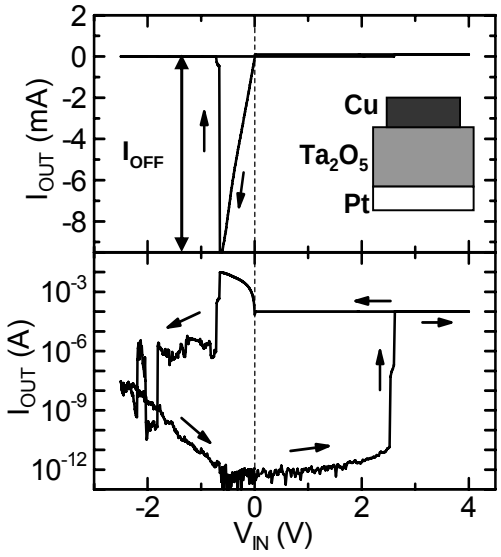

Fig. 1 Current-voltage (I_{OUT}-V_{IN}) characteristics of Cu/Ta2O5/Ta-solid electrolyte switch in linear and semi-log scales. Inset: Schematic of device structure.

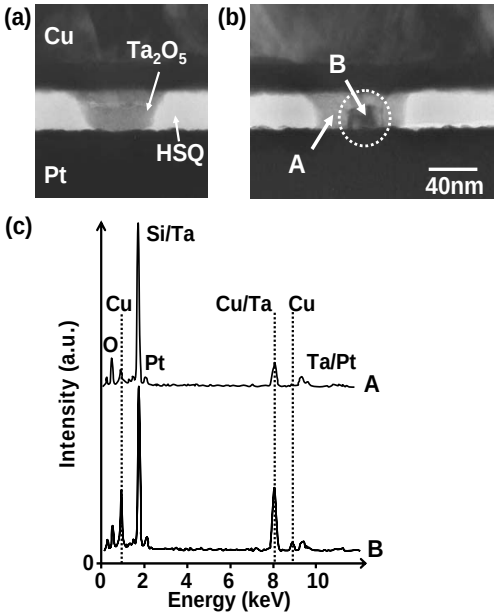

Fig. 2 TEM images of switch (a) before turning on and (b) after turning on. (c) Spectrum of energy dispersive X-ray spectrometer (EDX). EDX signals from points A and B in (b). Broken lines show Cu-related signals.

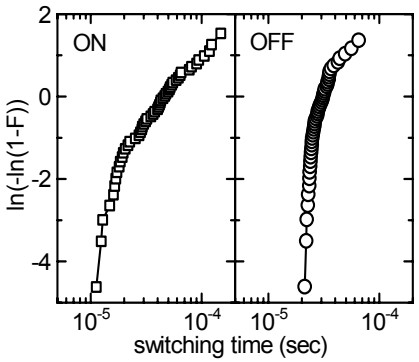

Fig. 3 Distribution of switching time for turn-on and turn-off.

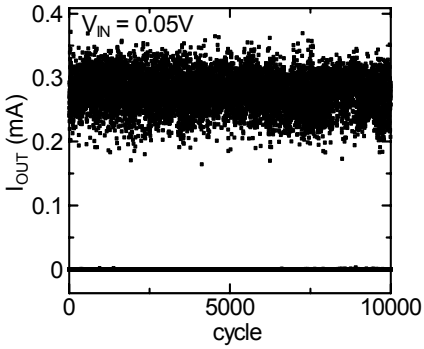

Fig. 4 Cycling endurance.

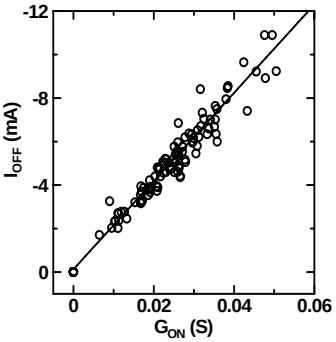

Fig. 5 Turn-off current (I_{OFF}) (shown in Fig. 1) versus ON conductance.

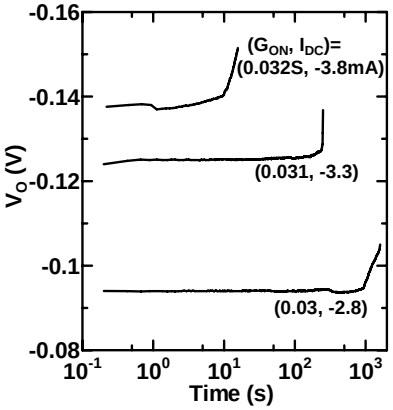

Fig. 6 Output voltage (V_O) versus time when negative DC current was applied to Cu electrode.

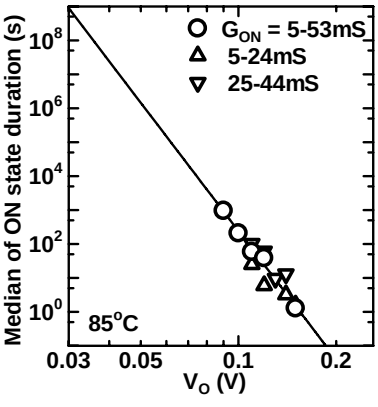

Fig. 7 Median of ON state duration (t_{50}) versus V_O for different ON conductance regimes in Fig. 6 at 85°C.

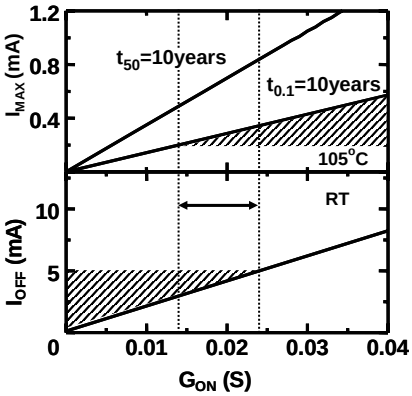

Fig. 8 Trade off between turn-off current (I_{OFF}) and allowable DC stress current (I_{MAX}) for 10 years and 105°C, which is compared with current in a single via in LSI interconncetion (~0.2mA).

GLASSY DYNAMICS AND ELASTICITY IN TEMPERATURE SENSITIVE NANOPARTICLE PASTES

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Nano- and mesoscopic colloidal particles with adjustable interaction potential have been of scientific and technological interest in recent years. Tuning the interaction between such particles opens the possibility to control bulk properties such as viscous flow or optical properties [1]. To achieve such behavior *thermo-sensitive hydrogels* have been widely used. These materials have also received attention due to their potential applications in drug delivery or as sensors. The majority of investigated systems are based on *poly(N-Isopropyl-Acrylamide)* (PNIPAM), a polymer which has a critical solution temperature of approximately 33°C [2]. Colloidal systems based on PNIPAM have been prepared by cross linking PNIPAM resulting in microgel particles with tunable softness, the latter depending on the cross link density [3,4]. PNIPAM Microgel particles thus display properties due to the tunable network combined with properties of classical colloids, e.g. crystallization or aggregation. This is very useful to tailor colloidal systems that can be kept close to the liquid solid transition thus having the possibility to "temper" these materials. This process is not possible using most "classical" colloidal systems that require a change in composition in order to cross a phase boundary.

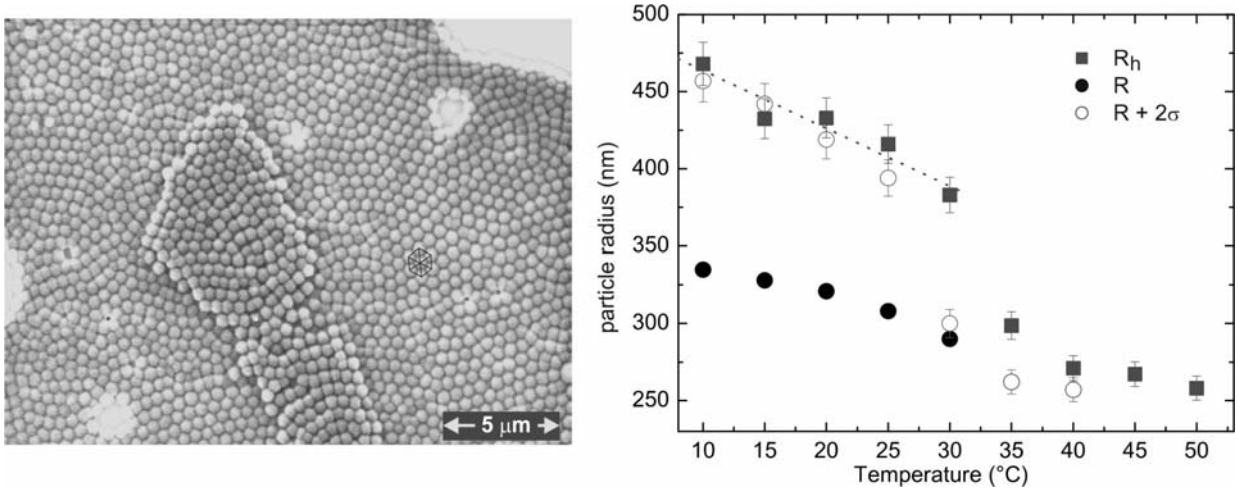

Figure: Left: Scanning electron microscopy picture of PNIPAM particles on a solid substrate. The particles are ordered in hexagonal arrays, giving us a qualitative idea about the rather low polydispersity of approximately 9-10% in the collapsed state. From the analysis of several dozen particle positions we obtain a SEM radius of 260 ± 5 nm. Right: Temperature dependence of the PNIPAM particle size from static and dynamic light scattering. Solid squares: hydrodynamic radius, Full circles: Mean radius R from a Rayleigh-Gans Debye fit assuming a radially inhomogeneous density profile [5]. Open circles: mean radius R plus diffuse layer 2 ∫.

We use the free radical cross-linking polymerization of the monomer *N-Isopropyl-Acrylamide* (NIPAM) from Acros Organics (Acros Organics BVBA, Geel, Belgium) and the (tetra-functional) cross-linker *N,N'-Methylene-Bis-Acrylamide* (BIS) from Fluka (Fluka Chemie GmbH, Buchs, Switzerland) to make highly cross-linked PNIPAM microgel particles. Since

NIPAM is not soluble in hot water [2] the cross-linked PNIPAM gels collapse at elevated temperatures whereas at room temperature and below, water is a good solvent leading to a strong swelling. This means we can control the hydrodynamic size of the particles simply by adjusting the temperature.

In this work we present a study of concentrated PNIPAM microgel particle suspensions using a combination of standard light scattering and Diffusing Wave Spectroscopy (DWS). In the expanded state the effective particle volume fraction reaches almost 100% and the system is a visco-elastic solid.

In our study we cover the microscopic dynamic and the rheological properties spanning the hard to the soft sphere regimes. We analyze in detail the particle morphology and the viscoelastic response of the dense particle assemblies over an extended range of temperatures. We show that existing models are insufficient to describe the behavior of these interesting tunable materials, and we discuss some central elements needed for a quantitative theoretical description [6].

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INDUCED MAGNETIC AND SUPERCONDUCTING PHENOMENA IN NANOSTRUCTURED HETERO MATERIALS

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The interaction between dissimilar magnetic and superconducting structures has produced much new physics in a variety of configuration. This includes new behavior when dissimilar magnetic materials (such as ferromagnets and antiferromagnets) are in contact with each other giving rise to Exchange Bias [1] or when nanostructured superconductors and magnets are in close proximity giving rise to collective pinning [2]. Particularly interesting behavior is obtained when one or both of the constituents have their dimensionality reduced to the nansocale in one or two dimensions. This gives rise to interesting effects such as the developments of bistable superconductivity[3], long-range fractal order [4], and quantum matching between the superconducting vortex lattice and the artificially prepared nanostructured arrays [5]. These systems also have important implications for the physics of epitaxial growth, and charged plasmas in confined geometries.

Work supported by US-DOE, NSF and AFOSR.

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ENGINEERED MATERIALS FOR ATOMIC-SCALE ARCHITECTURES FOR COMPUTATION

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One driving force behind the microelectronics industry is the ability to pack ever more features onto a silicon chip, by continually miniaturising the individual components. However, after 2015 there is no known technological route to reduce device sizes below 10nm. In this talk we outline a complete, directed self-assembly fabrication strategy towards atomic-scale device fabrication in silicon using scanning probe lithography and high purity silicon crystal growth.

A key aspect of being able to build single atom devices is the ability to distinguish single atoms on and in the silicon surface. We demonstrate a detailed understanding of the surface chemistry to identify and control the position of individual dopant atoms using gaseous dopant sources [1]. We demonstrate that we can place individual dopant atoms in silicon at precise locations [2] and encapsulate them in epitaxial silicon with minimal diffusion and segregation of the dopants [3].

Detailed studies have confirmed the range of electrical transport characteristics that can be achieved using highly doped, planar dopants from gaseous sources [4]. We demonstrate that we can pattern this dopant layer using STM lithography and relate the electrical device characteristics at low temperatures to the presence of the lithographic patterning [5].

Using this process we have fabricated conducting nanoscale wires with widths down to ~2nm, tunnel junctions, in plane gated single electron transistors and arrays of quantum dots in silicon [6]. We will present an overview of the devices that have been made with this technology and highlight some of the challenges to achieving truly atomically precise devices in all three spatial dimensions.

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AUTONOMOUS NANOTOOLS – SCANNING SUBMICRON PARTICLES ON MARS

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Scientific methods for investigating nanoscale objects have been advanced with a breathtaking pace during the last two decades. Key in this development of instrument was the plain concept of reducing structural forces and environmental influences by means of dimensional scaling as pioneered in the scanning force microscope. In the beginning, only specialized engineers or scientists could successfully run such instruments, tweaking and optimizing operational parameters during the experiment. Based on that experience, more robust control systems could be developed, reducing the amount of training needed for an operator to work with the instrument. The next step was the development of systems that could run in an automatic batch mode, for example inspecting predefined locations on a wafer for process development in the IC-industry. If we forecast a nanotool based manufacturing, where thousands of miniaturized instruments work in parallel, an even higher degree of autonomy is required. The instrument need to adapt their operational parameters based on information simultaneously collected by sensors and other, neighboring tools.

Our development of an AFM for a planetary mission allowed us taking one step in that direction. The concept of remote planetary exploration does not allow real-time interaction of any kind. A sequence of tasks that need to be executed is compiled on a daily base and up-loaded to the central computer of the space craft. Ideally, this computer then requests for example to collect a sample, deliver it to the AFM and take a series of images. Based on the results, next actions will be taken, e.g. a zoomed-in image of an area of interest. In current missions, this full autonomy has not yet been achieved. We are hampered by the tradition of strictly time based execution of the operation sequence and the potential risk that a fully autonomous operation bears.

Our remote operation AFM was integrated in the Phoenix payload of the current mission of NASA on Mars. The scientific goal of our experiments is to analyze dust and soil particles. This shall contribute to the understanding of the history of water, the gas exchange between the soil and the atmosphere, and the climate on Mars. The mission comprises several imagers that allow looking at Mars at different length scales and providing the context required for interpreting the individual measurements: The surface stereo imager (SSI) generates pictures, which are comparable to what a human explorer would see. It also produces images at different wave lengths. The robotic arm camera (RAC) is attached to the end of the tool that collects soil samples and can be compared to a magnifying lens in terms of its maximal resolution. It can, however, produce more and much different data products as well. The next step on the length scale is the optical microscope (OM) of the MECA instrument suite. It shares the sample stage with the AFM and allows taking images with a pixel resolution of 4 µm. This is sufficient overlap with the AFM scan range of up to 50 µm.

The environmental conditions for the instruments are quit harsh, especially during launch, cruise and landing. The storage temperature ranged from about -120 to +60 C and shocks of up to 2500g peaks had to be survived. We landed safely on Mars and could perform the first AFM measurements (Fig. 1) ever taken on another planet.

Figure 2 shows the MECA microscopy station with the OM on the left, the AFM in the center in front of the objective lens and the sample stage to the right. Figure 3 shows an OM image of

Martian soil. The AFM experiment started only late in the mission and up to now no measurements on real samples were conducted.

We acknowledge many important and fruitful discussions with the Phoenix science team lead by the principle investigator P. Smith, and financial support by the Wolfermann-Naegeli Foundation, the Swiss Priority Program MINAST, the Space Center at EPFL, the Canton et République de Neuchâtel, and the Phoenix project.

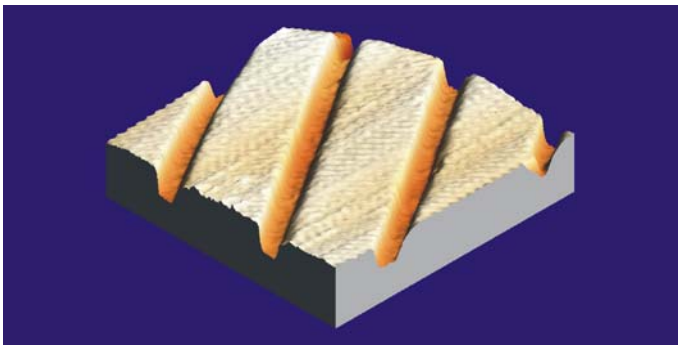

Figure 1 First AFM image of a calibration grid. The pitch is 12µm.

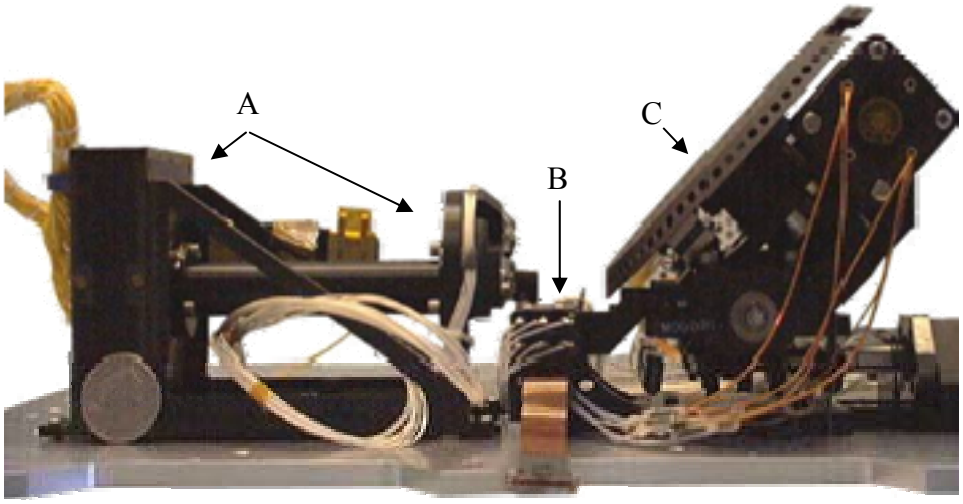

Figure 2 MECA microscopy station. A) optical microscope with from left the camera, tubus and objective lens, surrounded by LEDs for illumination. B) AFM scanner. C) Sample wheel and translation stage.

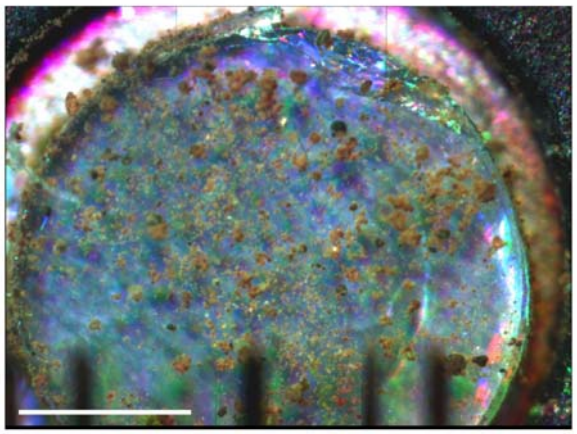

Figure 3 OM image of Martian soil sample. The scale bare is 1 mm long.

CONCEPTS OF MAGNETIC 3D AND MULTILAYER RECORDING MEDIA

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Hard disk media that support ultra high densities require small grains in order to obtain high signal to noise ratios. The use of high coercive materials such as alloys in the L10 phase allow for thermally stable grains at grain diameters in the order of 4nm . However, state of the art write heads produces too small fields to reverse these extremely hard magnetic grains. Recently composite media and exchange spring were proposed in order to decrease the write field requirements [1,2]. In exchange spring media an ultra hard magnetic storage layer is strongly exchange coupled to a softer magnetic nucleation host layer. The nucleation host decreases the switching field of the storage layer up to a factor of five without lowering the thermal stability of the entire structure. If the nucleation host is composed of multiple magnetic layers where the anisotropy increases from layer to layer it was shown that the resulting structure has a high thermal stability whereas at the same time the coercive field decreases with one over the total layer thickness [3]. Exchange spring media can be switched extremely fast due to precessional switching. Field pulses with a total length of 20 ps are sufficient to reproducibly reverse a grain.

In the second part of the talk a concept of 3-D recording, where multiple layers are addressed independently is investigated. The basic idea is to design a media in a way that the anisotropy in each layer is sufficient large so that the static head field can not reverse any of the layers. Since the head field decays with increasing head to media distance the previously mentioned requirement leads to smaller anisotropy values of the bottom recording layer. Writing is assisted by applying a linearly polarized microwave fields in the film plane [4]. Since the anisotropies in the bottom layer and the top layer are different, also different microwave frequencies are required in the top and bottom layer to meet the resonance condition. In resonance the largest reduction of the write field is observed.

Simulations on patterned elements with dimensions of 20 nm x 20 nm are investigated. The top layer thickness is 2.4 nm and the bottom layer thickness is 3.5 nm. The head to media distance of the top layer and bottom layer is 2 and 8 nm respectively. The distance between the two layers is 3.6 nm. A precomputed head field was used for the recording application. In the centre of the top layer (at a distance 3.2 nm away from the head) the head field is 1.3 T. In the centre of the bottom layer (10nm) the head field strength is 0.96 T. The magnetic polarization in both layers is $J_s = 0.2$ T and the exchange constant is $A = 10^{-11}$ J/m. The anisotropy in the top layer and bottom layer is 0.21 MJ/m³ and 0.142 MJ/m³, respectively.

Phase diagrams are calculated to design the dual layer patterned media. Fig. 1 (a) and Fig. 2 (a) show the regimes of switching (red) and not-switching (blue) for a field pulse with a field rise time of 0.1 ns. The damping constant is 0.05. Since the bottom layer is further away from the AC field source we have used a smaller magnitude of the AC field of 0.08 T at the bottom layer, whereas it is 0.12 T in the top layer. The phase diagrams indicate that the resonance frequency of the top layer and bottom layer is about 28 GHz and 16 GHz, respectively.

In a second step recording simulations are performed in the dual layer media. Initially, the magnetization in all elements is pointing up, indicated by the red color. A bit pattern with a sequence of 1010 was tried to record independently on the top layer and bottom layer on the centre track. As predicted by the phase diagrams, we could independently reverse the elements in the bottom layer and top layer.

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Figures:

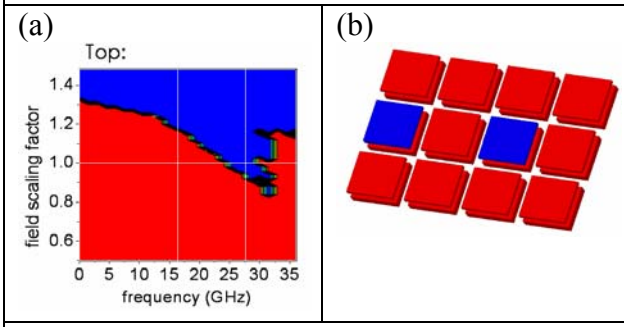

Fig 1: (a) Phase diagram of the top layer. The AC-field strength is 0.12T (b) For an AC-Frequency of 28 GHz only the top layer is addressed.

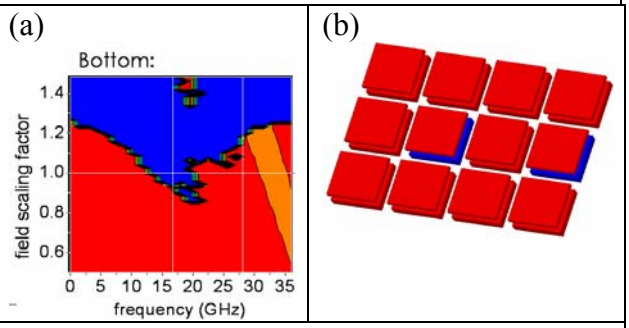

Fig 2: (a) Phase diagram of the bottom layer. The AC-field strength is 0.08T (b) For an AC-Frequency of 16 GHz only the bottom layer is addressed.

CONTROLLING ELECTRON TRANSPORT IN SINGLE MOLECULES

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Understanding and controlling charge transport in single molecules is a basic task in molecular electronics, and directly relevant to charge transfer in molecules, a phenomenon that plays critical roles in many chemical and biological processes. We have studied charge transport through single molecules attached to two electrodes in electrolytes. The molecules include benzene dithiol, perylene derivatives, and single layer graphene sheet, which share the same building block, aromatic ring. The HOMO-LUMO gap of the molecules decreases with the number of benzene rings and becomes zero in the case of graphene. We have measured transport current through the molecules as a function of electrochemical gate voltage. The gate effect is small (less than 50%) in the case of benzene dithiol, but it can change the conductance of the perylene derivatives by 2-3 orders of magnitude. Graphene is highly conductive with a remarkably high mobility but the gate effect is weak. We discuss the different charge transport mechanisms in these polycyclic aromatic hydrocarbons.

MAGNETORESISTANCE AND DOMAIN WALL DISPLACEMENT IN SUBMICROMETER PERMALLOY RING STRUCTURES

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Manipulation of magnetic domain walls in nanostructures by the use of magnetic fields and electric current has recently the focus of intense research due to its great potential for application to spintronics and also because of the basic physics involved in the phenomenon. [1–4] Magnetic nanorings are particularly apt geometry to investigate such an effect and this, together with their outstanding magnetic properties, makes them good candidates as building blocks for high density magnetic random access memories and magnetosensors. In the present investigation we measured and modelled the magnetoresistance in submicrometer Permalloy circular, square, and triangular ring structures. The conventional anisotropic magnetoresistance effect due to the presence of head-to-head type domain walls is the main source of magnetoresistance. Using an external field head-to-head domain walls can be placed at selected locations in the ring and their position sensed by magnetoresistance. The effects of nonplanarity of the magnetic structures as well as of shape defects and roughness on the domain walls structure and on the magnetoresistive behaviour are investigated. It is shown that a domain wall can be reversibly and controllably displaced between adjacent corners of the structure by current pulses of different polarity. These observations can be explained by a directional spin-torque effect. Finally we tested possible applications of devices based on this kind of structures to biomolecular recognition.

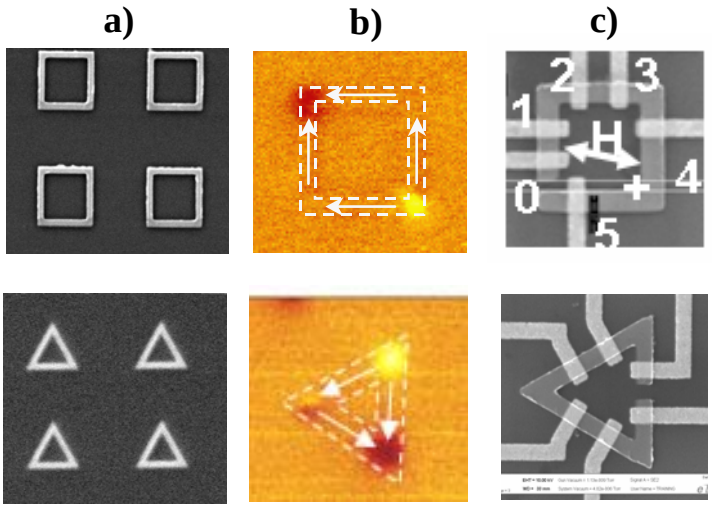

Fig. 1. Panel (a): scanning electron micrographs of square and triangular ring structures (image size 10 x 10 μm^2). Panel (b): magnetic force microscopy images showing domain walls pinned at corners of the structures. Panel (c): scanning electron images of the final devices used for magnetoresistance characterization (image size 1.5 x 1.5 μm^2).

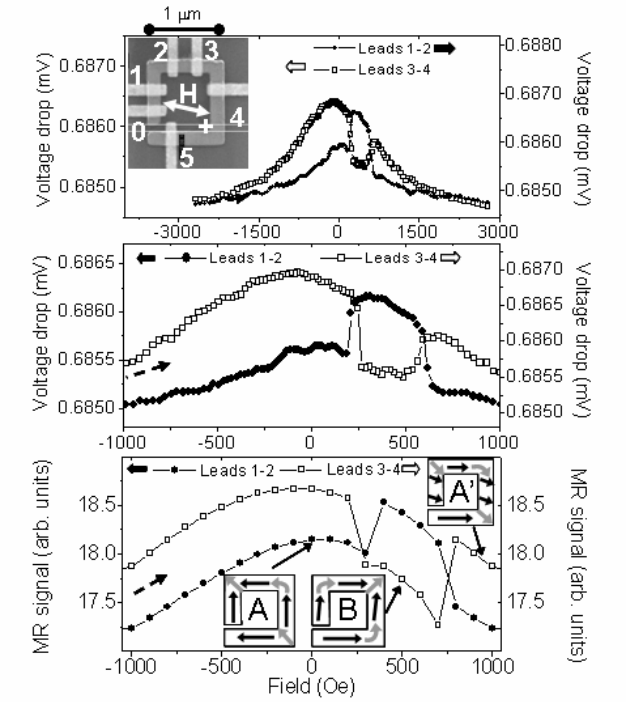

Fig. 2. Measured (topmost and middle panels) and calculated (bottom panel) magnetoresistance response of the square ring device.

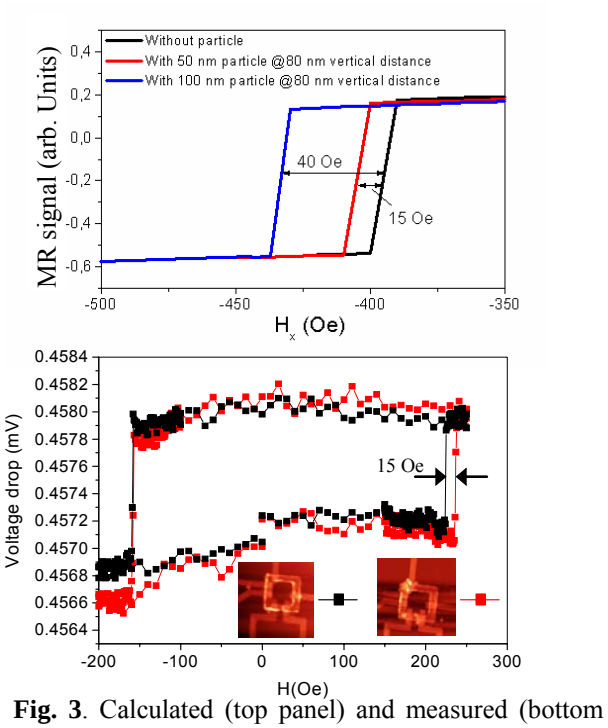

Fig. 3. Calculated (top panel) and measured (bottom panel) domain wall depinning field from one corner with (blue and red lines in top panel and red symbols in bottom panel) and without (black line and symbols in both panels) magnetic beads placed on top of one corner of the square ring device.

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NANOSTRUCTURED AND NANOPARTICLE BASED HYBRIDS

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Nanostructured and nanoparticle based hybrids self-assembled from blocked macromolecular architectures hold tremendous scientific as well as technological promise in areas ranging from microelectronics to energy generation and storage. By choice of the appropriate synthetic macromolecules as well as inorganic precursors unprecedented morphology control down to the nanoscale is achieved that may translate into improved property profiles including low dielectric constant, high strength, toughness or conductivity. For example, we recently demonstrated the first nanoporous bulk Pt metal structure directed by a block copolymer (Fig.1).[1] In another example for the first time we showed lithium ion transport in nanoscopic (10nm) domains of a bicontinous cubic block copolymer morphology.[2] In polymer–nanoparticle hybrids properties of polymers can be uniquely married with those of inorganic materials. Once the formation mechanisms and thermodynamics involving co-assembly of polymeric and nanoparticle species are better understood, morphologies across the entire phase space of blocked amphiphilic macromolecules can be produced.[3,4] A particularly fascinating bicontinuous cubic structure we discovered for silica-type hybrids is referred to as the 'Plumber's Nightmare'.[5] Completely novel property profiles are accessible through nanostructured self-assembled hybrids. For example, mesoporous materials with crystalline, superparamagnetic iron oxide nanoparticles in the walls open a way towards separation media exhibiting a combination of size exclusion and separation based on magnetic interactions. The approach can be extended from linear to dendritic, and from AB to ABC-type architectures. On the inorganic side besides amorphous/crystalline oxide materials[6] and metals novel systems toward nanostructured high temperature SiCN and SiC can be introduced.[7]

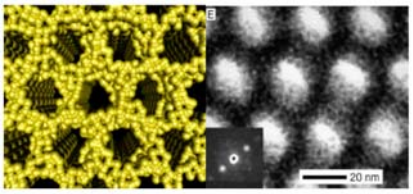

Figure 1. Illustration (left) and TEM image (right) of nano-porous Pt metal structure directed by block copolymers (BCs).

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ORAL CONTRIBUTIONS

(Plenary Session)

(Only those abstracts received before August 25, 2008 will be included in the abstracts' booklet)

DIGITAL STRESS COMPENSATION FOR STACKED INAS/GAAS QUANTUM DOTS SOLAR CELLS

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III-V semiconductor quantum dots (QD) receive great interest at present due to their advantages and unique properties as zero dimensional systems. Most of their applications require stacking multiple QDs layers to increase the gain of the devices. However, this strategy also increases the accumulated stress in the material during growth generating dislocations and nonradiative recombination centers [1]. The introduction of stress compensation (SC) layers to reduce the accumulated stress is a promising way to improve material quality and efficiency of devices based on QDs.

In this work we report the stacking of 50 InAs QDs layers using 2 GaP monolayers (ML) for SC and a stack period of only 18 nm on GaAs (001) substrates. We chose a "digital" stress compensation method by the introduction of single monolayers of GaP instead of a GaAsP alloy due to the difficulty to control the phosphorus to arsenic incorporation ratio during MBE growth of the stacked QDs structure.

The stacking of this large number of QDs layers have already been achieved in other systems with limited lattice mismatch, with and without SC. However, the lattice mismatch between the QDs and the substrate is 6.7 % for the InAs/GaAs QDs system. Since the accumulated strain energy density depends on the square of this mismatch, the stacking of closely spaced InAs/GaAs QDs layers with good crystalline and optical quality becomes a very challenging task.

We fabricated a GaAs based solar cell with fifty such QDs layers in its active region using the described scheme. The goal of this study is to demonstrate the quantum dot intermediate band solar cell (IBSC) principles as proposed by Marti et al [2]. The structure of the sample can be seen in figure 1 and includes an AlGaAs top layer and a back surface field layer to prevent minority carrier recombination in the top and bottom interfaces respectively. A field damping layer has been inserted between the emitter and the intrinsic region, which contains the dots, to screen the electric field generated by the former and to keep all the QDs layers partly filled with electrons.

The structural quality of the sample has been tested by means of cross-section transmission electron microscopy (XTEM) (figure 2). As it can be seen, the structure is almost defect-free with only some planar defects in the very last few layers. These defects seem to be produced by the interaction of very close or especially large QDs. The image also reveals columnar growth of the QDs along the structure. The direction of the column is not vertical, but forms an angle of 7º with the growth direction. The stacking behavior suggests the existence of residual stress around the nanostructures that propagates to the following layer creating sites of preferential nucleation. This behavior has already been observed and predicted by *ad-hoc* simulations in other nanostructures [3,4]

In conclusion, we have studied the effect of "digital" stress compensation with GaP monolayers of stacked InAs/GaAs layers. Very good structural quality has been found by XRD and AFM, and PL measurements have shown thermal activation energy of 431 meV. A solar cell including 50 QDs layers with SC has been fabricated with exceptional structural quality, as revealed by the TEM images. The nanostructures have extended the absorption range of the sample up to 1.2 μm although an excessive trapping in the QD region has also being found, to the detriment of the short wavelength response of the device

The authors gratefully acknowledge financial support by the Spanish MEC and CAM through projects 200560M089, S-05050/ENE-0310, TEC-2005-05781-C03-01-02, CONSOLIDER_INGENIO 2010 CSD2006-0004, Junta de Andalucia (project TEP383, group TEP120) and the European Commission through the SANDIE Network of Excellence (NMP4-CT-2004-500101).

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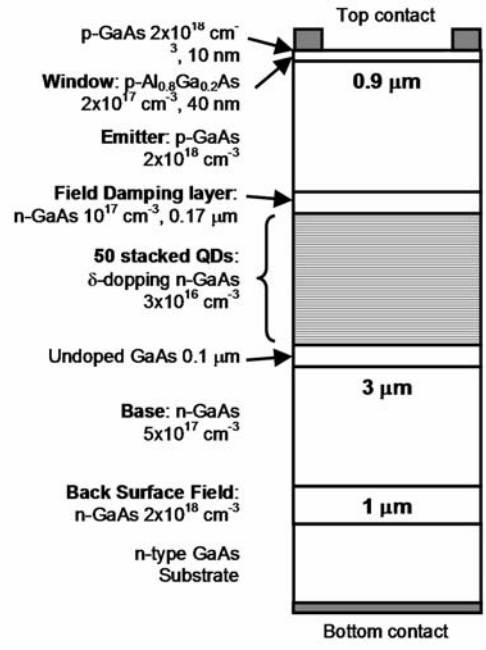

Figure 1: Scheme of the MBE fabricated QDs solar cell

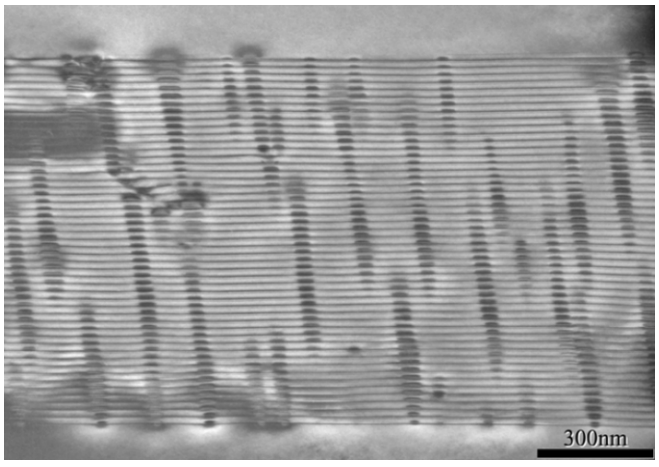

Figure 2: Cross-section TEM image of the stress compensated 50 stacked QDs.

FUNCTIONALIZATION OF ZnO NANOWIRES FOR SENSING APPLICATIONS

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There is an increasing demand for portable, reliable and cost effective integrated systems for chemical sensing and biosensing usage. This type of sensor has the potential to provide immediate analysis of blood samples so allowing early detection of diseases. Nanostructures offer novel and unique properties to fabricate such sensors, because the dimension of such structures are similar to those of the target chemical and biological molecules. Biological macromolecules, such as nucleic acids and proteins, are generally charged in aqueous solution and can be selectively detected when sensor molecules are linked to the nanowire surfaces. On the other hand, ZnO is a well known bio-friendly semiconductor with potential applications in electronics and optoelectronics including sensors, field effect transistors, photodetectors and nanolasers. Well-ordered ZnO nanowire arrays with hexagonalcan be grown, making them promising for future multi-functional devices. In this work we employ density functional theory to investigate ZnO nanowires and nanotubes. Bare wires are found to be semiconducting, with band gaps larger than that in bulk ZnO. The band gap decreases as the size of the nanowire increases, revealing strong quantum confinement effects [1,3]. As a first step towards biosensing applications, we have investigated ZnO nanowires functionalized with H and OH groups [5]. We find that the conductivity of these wires can be tuned from semiconductor to metallic, depending on how hydrogen and functional groups adsorb on the nanowire surfaces, thus leading to drastic changes in the ZnO nanowires electrical properties. The size-dependency of atomic relaxations, formation energies, and electronic structures in hexagonal non-passivated ZnO nanotubes was also investigated. The formation energies of thich-walled ZnO hexagonal ZnO nanotubes are mainly dependent on the thickness of the wall and almost independent of tube diameter [2,4]. Thick-walled ZnO nanotubes are energetically more favorable than single-walled ZnO nanotubes. We also show that for ZnO nanotubes confinement strongly affects the shape and energies of the conduction bands, while the valence band maximum seems to be not sensitive to a change of the thickness of the tube.

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SELF-ORGANISED HEXAGONAL PATTERNS OF INDEPENDENT MAGNETIC NANODOTS

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An alternative approach to the fabrication of high-density patterned magnetic media by nanolithography is the formation of nanostructures by self-organization, where spontaneously ordered, large-area patterns of nanometric objects appear. This fabrication method potentially represents a new parallel patterning technology, much advantageous regarding speed and efficiency with respect to serial procedures.

Two different nanofabrication methods are demonstrated. The first one takes advantage of the formation of self-organized patterns on a semiconductor surface by ion erosion [1] to produce large-scale arrays of uniformly-sized, hexagonally-arranged magnetic nanodots. A special sample design has been used in which a magnetic layer was epitaxially grown by magnetron sputtering on a GaSb substrate; this film was subsequently covered with another GaSb layer, 1000 nm thick. The erosion of this sacrificial layer with Ar^+ ions leads to the formation of a periodic dot pattern which eventually intersects the buried thin magnetic film. By interrupting this process at the appropriate moment, isolated magnetic nanodiscs can be generated. By using an intercalated Co layer and 400 eV Ar^+ ions, arrays of dots 25-30 nm in diameter, 5 nm thickness and 40 nm nearest-neighbor separation have been obtained. Figure 1 shows the final surface morphology as determined by Atomic Force Microscopy after completing the erosion process.

The system's magnetic behavior was characterized by means of vectorial Kerr magnetometry. The saturation intensity for the dotted sample is approximately 3 times smaller than for the continuous film, confirming the partial removal of material during the patterning process. Furthermore, the coercive field increases by almost one order of magnitude upon patterning, up to ~15 mT. This effect can be explained by a change in the mechanism of magnetization reversal, which in the 2-dimensional film must be achieved by domain wall propagation. The dots, in contrast, have sizes of the order of the domain wall width and can therefore be expected to be single-domain. Their magnetization reversal must hence take place by coherent rotation. These observations are confirmed by numerical simulations based on the Stoner-Wohlfarth model, which successfully reproduce the the shape of the experimental hysteresis loops [2].

These results thus confirm that arrays of magnetically independent nanodots can be produced by this efficient patterning method; if used as a magnetic storage material, a density as high as 0.4 Tbit per square inch could be attained. Furthermore, the patterning process depends only on the semiconductor capping, and different intercalated magnetic materials can be used with the only limitation that their thickness remains below ca. 10 nm, so that the ordered pattern is preserved. This opens up the possibility to tailor the dots' magnetic properties, such as coercivity or anisotropy, to suit different applications.

The second approach uses grazing-incidence deposition of the magnetic material in Ultra-High Vacuum onto self-organized SiGe substrates [3] consisting of an arrangement of truncated pyramids with approximately square base and lateral faces forming an angle of ~25 deg. with respect to the base plane. When the magnetic material is obliquely deposited onto this template, facets oriented towards the incoming beam receive the highest flux, while those in the back of the pyramids remain shadowed and unexposed. (Pt/Co/Pt) trilayers have been chosen as the evaporation material in order to enhance the magnetic anisotropy of the nanodots.

Fig. 2 displays an XMCD-PEEM image obtained from a (4 ML Pt/4.5 ML Co/4 ML Pt) sample prepared in-situ by this method; the field-of-view is 5 microns. The dichroic contrast obtained by utilizing circularly polarized X-rays reveals nanoparticles with in-plane magnetization, separated by perpendicularly magnetized areas depicted in gray. The nanoparticles show remanent magnetization at room temperature, and their magnetization directions are uncorrelated with those of their neighbors.

In summary, both nanofabrication methods described are quite general, and can be used with different substrates and deposited materials.

This work has been supported by the European Commission through the NAMASOS STRP-NMP2-CT-2003-505854 contract.

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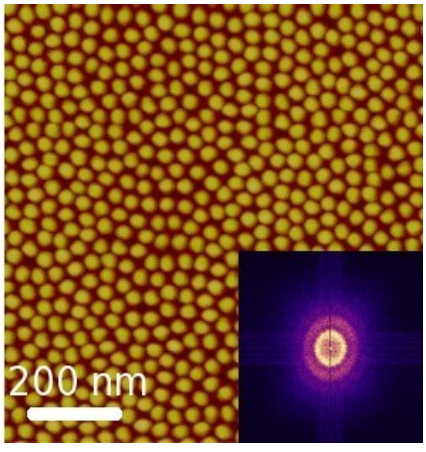

Figure 1

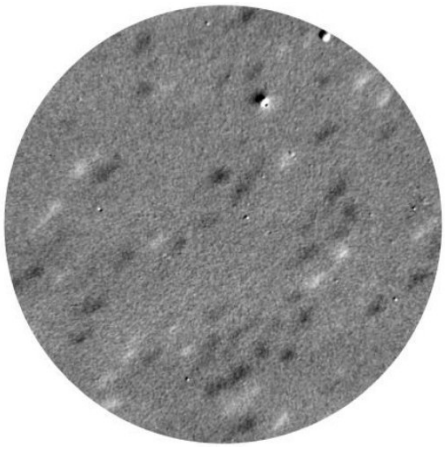

Figure 2.

ENHANCING THE MAGNETIC ANISOTROPY AND ANISOTROPIC MAGNETORRESISTANCE OF ATOMIC CLUSTERS, CHAINS AND MOLECULAR MAGNETS

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The ability to enhance and tailor the magnetic anisotropy and magneto-resistance of atomic-sized magnetic bits and junctions will determine whether nanospintronics will be a viable technology. Atomic structures made of cobalt and other 3d elements have recently been shown to have large magnetic anisotropies due to the enhanced role of the Spin-Orbit interaction[1,2]. Furthermore, several recent theoretical predictions have pointed out that atomic clusters and chains made of 4d elements should have even higher magnetic anisotropy barriers than Co chains[3,4,5]. We will discuss here a way to overcome the superparamagnetic limit problem, using 5d atoms like Ir or Pt as the heart of atomic or molecular spin nanostructures. Some of these nanostructures also show significant magnetorresistive ratios[6,7,8].

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SELF-ASSEMBLED QUANTUM RINGS

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Self-assembled semiconductor quantum dots (QD), formed via lattice-mismatched heteroepitaxy, are currently being used for developing optoelectronic technologies and devices due to their high optical quality. Due to their 0D strong confinement of carriers and unique optical and electric properties2, these nanostructures rapidly became a perfect benchmark for fundamental physic research. Recently, they have been considered also as promising candidates for information storage and quantum computing applications implemented in solid state devices.

A precise control over the nanostructure height, width and shape is of crucial importance since these structural properties influence the quantum confinement of the charge carriers and therefore determine their optoelectronic properties. Unfortunately, QD do not have the flexibility of band gap engineering that quantum wells have. Commonly the size of the dots is critically determined by the optimal growing conditions employed to obtain narrow size distributions. In the particular case of InAs on GaAs(001) growth using molecular beam epitaxy (MBE), on which this work is focused, employing different growing parameters may produce variations in the sizes of the dots, but also broadens the size distribution. This is one of the major problems if we aim to employ ensembles of these nanostructures in useful devices. A possible strategy for overcoming this problem consists in growing the QD under optimal conditions and modifying its vertical size during capping. A technique which is especially useful for reducing the vertical size, i.e. for obtaining shorter wavelengths, consists in partially covering the InAs islands with a thin cap of GaAs and letting the original islands 'melt' and re-shape. This process can be used to reduce the original vertical size of the QD in a controlled way with atomic height accuracy. The possibility of tailoring the potential confinement in each layer of dots is also of great significance if we aim to achieve application in solar cells.

In particular, under specific growing conditions [1], a drastic change occurs, as can be seen in figure 1, which allows to obtain from each QD a self-assembled 'nanovolcano', or Quantum Ring (QR). Unlike mesoscopic lithography-defined rings, these QR, once embedded in a GaAs matrix, function in the true quantum limit, free of quantum de-coherence due to scattering processes, with a reduced Anisotropy Energy Splitting (AES) [2]: ideal for real quantum computing devices. A review on the structural, optical and energy level characterization will be shown. But what really differentiates these nanostructures from QD is their behavior under magnetic fields, which allows us to call them truly Quantum Rings.

As artificial atoms, the discrete energy levels of both QD and QR are affected by magnetic fields (Zeeman effect, i.e.). But only in the Quantum Rings, it is possible to observe effects associated with one of the most intriguing quantum phenomena, the Aharonov-Bohm effect (AB). Magnetization AB-related oscillations have been measured [3] at 14T in a specially designed sample with 30 stacked layers of ensembles of QR charged with one electron. The experimental data are in good agreement with theoretical calculations based on Cross section STM (X-STM) measurements which

show the surviving of the AB effect even when some asymmetry in the ring shape is present.
We also will show very recent results on micro-photoluminescence measurements (μPL) under magnetic fields up to 10T. Using a confocal microscope we were able to measure the μPL signal of a single QR with a spectral resolution of 15μeV. Zeeman splitting appears at low field, which breaks the spin degeneration (fig. 2). At a certain field another splitting appears, giving rise to four circular polarized light lines coming from each individual ring. The field at which this behaviour appears is dependent on each nanostructure (for the QR under test in figure 1 this happens at 4.4T). Interestingly, the intensity ratio between the lines with the same polarization shows that this is not a heavy hole-light hole mixing behaviour. We relate this effect with a magnetically-induced decoupling of the QR into two QDs.
This work has been supported by the European Commission SANDIE Network of Excellence Contract No. NMP4-CT-2004-500101 and by Spanish projects: NANOSELF II (TEC-2005-05781-C03-01), Consolider Ingenio 2010 QOIT (CSD2006-00019) and NANOCOMIC (CAM S 0505ESP 0200).

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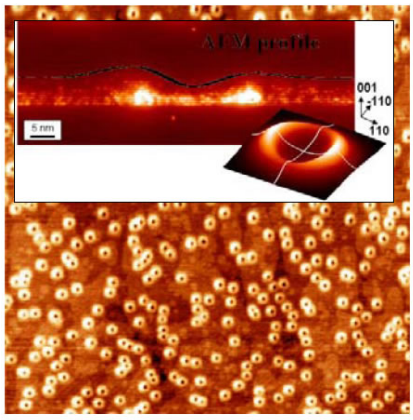

Figure 1: AFM image 2x2 micron2. Ensemble of Quantum Rings before capped. Inset shows X-STM of capped ring with a schematic view of the In profile and the measured AFM profile.

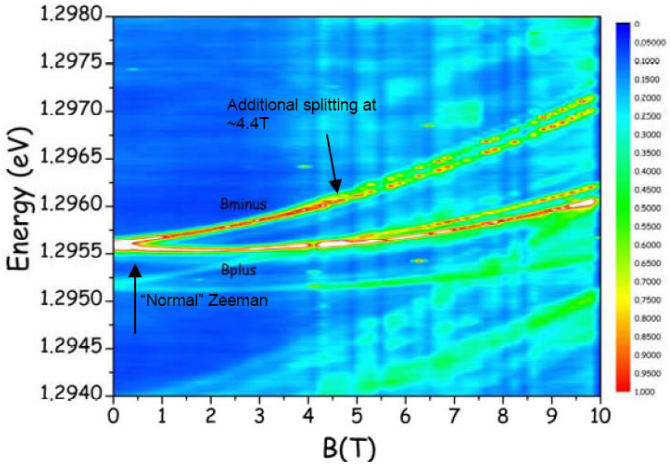

Figure 2: Micro Photoluminescence map of one single Quantum Ring. The color scale represent microPL intensity (white higher, blue lower). An anomalous splitting is observed at 4.4T, where four branches ares clearly splitted from the original two Zeeman splitting.

TAILORING THE FERMI LEVEL OF THE LEADS IN MOLECULAR-ELECTRONIC DEVICES

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The dependence of the transport properties on the specific location of the Fermi level in molecular electronics devices is studied by using electrodes of different materials. The zero-bias transport properties, which are obtained by using a combination of density functional theory and non-equilibrium Green's functions [1], are shown to depend dramatically on the elemental composition of the electrodes, even though the shape of the transmission coefficients is very similar. By using alkaline materials, an idea well known in the organic LEDs community [2], it is possible to move the Fermi level from the HOMO-LUMO gap to the LUMO resonance and change dramatically the length dependence of the conductance of molecular wires, which opens the possibility of using molecules with different lengths and very similar conductances in nanoscale circuits. This method shows how to dramatically increase the conductance of molecular devices and alter qualitatively and quantitatively their electronic and transport properties.

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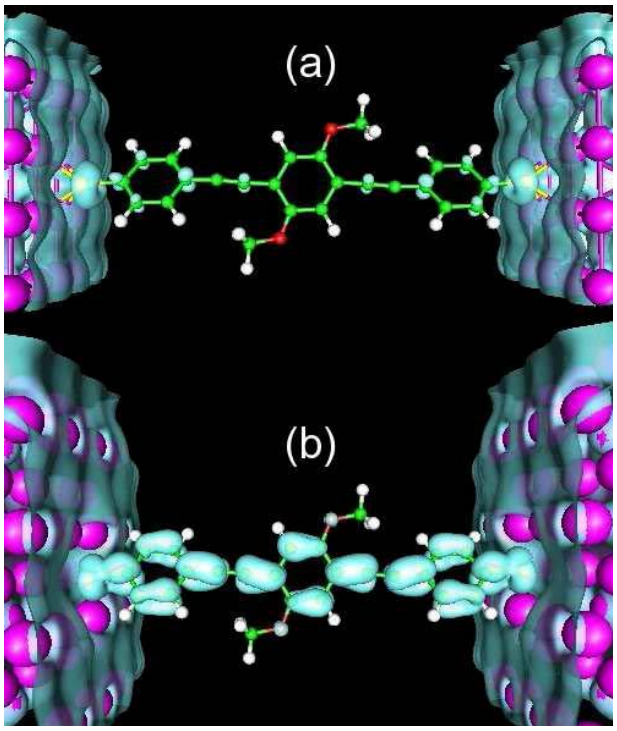
Figures: Real space projection of the density of states on an interval of 0.2 eV around the Fermi level of a molecule between (a) gold leads and (b) sodium leads.



THE INTERIOR INTERFACES OF A SEMICONDUCTOR/METAL NANOCOMPOSITE AND THEIR INFLUENCE ON ITS PHYSICAL PROPERTIES

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A semiconductor/metal hybrid system with silicon as base material is fabricated in two steps by electrochemical methods. First the silicon substrate is anodized in an aqueous hydrofluoric acid solution to achieve a nanostructured porous medium offering oriented pores perpendicular to the surface arranged in a quasi regular pattern. Second the deposition of ferromagnetic metals during a subsequent galvanic process is used to embed metal nanostructures within the pores of the silicon matrix. The achieved nanoscopic hybrid system consists of a quasi-regular 3-dimensional arrangement of metal nanostructures embedded within the pores of the silicon matrix. The used metals are Ni, Co, Fe, Cu and their alloys.
The physical properties (e.g. magnetic, optical) of nanostructured semiconductors or metals change drastically compared to their bulk materials. The investigated system combines both, nanostructured silicon and nanostructured metal. In such a hybrid system the interface between metal and silicon nanostructures is of interest in correlation with the properties of the material and can be influenced by different fabrication conditions.
If the matrices are aged in ambient air before filling with a metal the porous silicon template offers a native SiO_x layer due to the oxidation of the hydrogen terminated surface of the pore-walls. Using as-etched samples for deposition of the metal into the pores leads to the formation of a more complex interface during the cathodic deposition procedure which is observed by FTIR-spectroscopy. The correspondingly occurring absorption peaks can be attributed to O-Si-H modes (2250 cm^{-1}), Si-OH bending modes (1635 cm^{-1}) and SiO_3 (1368 cm^{-1}) which is shown in Fig.1. Investigations by electron microscopy (SEM, TEM) also show the presence of SiO_x-species along the pores.
Magnetic characterizations of Ni-filled porous silicon samples carried out by SQUID-magnetometry do not show an exchange bias effect [1] which indicates that the embedded Ni-nanostructures are not covered by an oxide layer and the oxygen observed by EDX-spectroscopy can be attributed to SiO_x. In contrast Co-filled samples show a small exchange bias effect.
The fabricated nanocomposites are versatile systems which are applicable in magnetic sensor technology, as magnetooptical devices, in nanobiology due to the biodegradability of porous silicon (drug delivery, targeting of magnetic particles) and as a great advantage these materials are integrable in today's microtechnology. Furthermore the formation of a defined oxygen-layer covering the surface of the pores could act as tunnel-barrier to perform spin-injection experiments to detect spin-polarized electrons.

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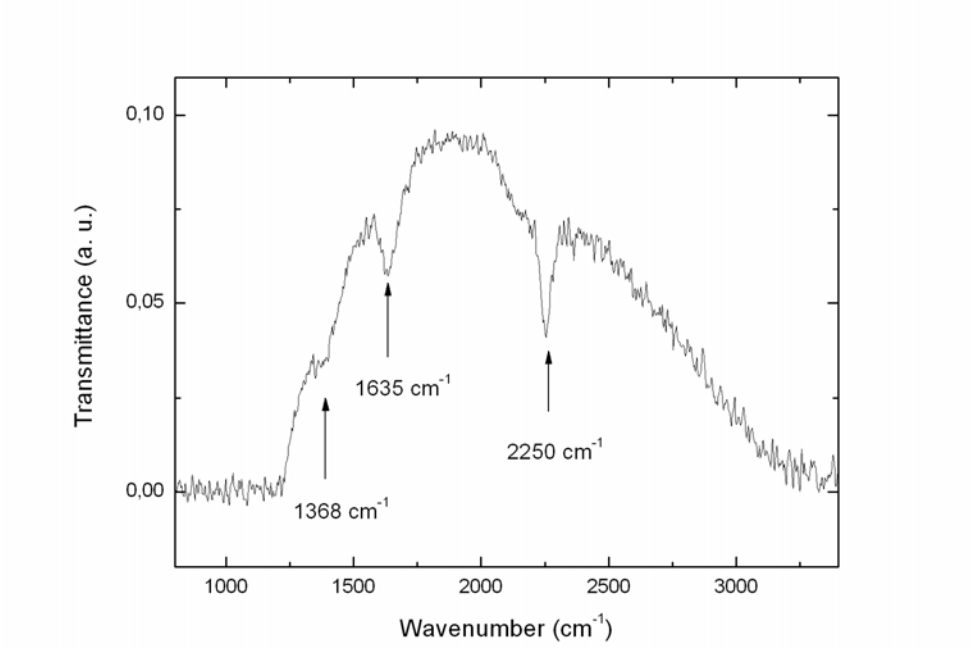

Figure 1: FTIR transmission spectrum of a Ni-filled porous silicon sample showing absorption peaks around 1368 cm^{-1} (SiO_3), 1635 cm^{-1} (Si-OH) and 2250 cm^{-1} (O-Si-H).

David Guedj
EU-ICT/FET-nanoICT proactive initiative
Belgium

This presentation will give an overview of the Commission's 7th Framework Programme (FP7), specifically the ICT program. It will address the big research and technological issues that are covered in the Future and Emerging Technologies – Proactive (FET-Proactive) part of this programme.

Starting with the Nano-ICT Devices and Systems initiative (FP7 - Call 1), the emphasis will be on the Coordination Action, also called "Nano-ICT" Coordination Action, a non-research instrument meant to a.o. organise and cluster the activities of the set of projects grouped under the Nano-ICT Devices and Systems. The working groups set up by Nano-ICT will be briefly described.

Further to this ongoing activity, future initiatives scheduled for FET-Proactive in years 2009-2010, will be presented. The two most relevant to TNT are definitely "Toward Zero-Power ICT", that will be addressing energy conversion approaches and techniques in order to overcome the growing energy dissipation at the smaller scales, and "Molecular-Scale Information Systems" that will address the ability for a single molecule and small collection of molecules to perform information processing and computing. The latter initiative takes advantage of the current possibilities to position and control single atoms.

Finally, we will highlight the main drivers for FET-Proactive and illustrate by one or two examples, the unique nature and the assets of a european collaborative research programme for future and long-term ICT.

OPTICALLY ENCODED PARTICLES AND FLOW CYTOMETRY AS A HIGH-THROUGHPUT PLATFORM FOR THE ANALYSIS OF PROTEIN RESISTANT SURFACES, PROTEASE EFFICACY AND BIOMARKER DETECTION

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The assessment of physiological conditions and events at the molecular level is increasingly seen as the future of medical diagnosis for the early detection and more effective treatment of diseases.[1] The development of molecular diagnostics based upon mixed (multiplexed) suspensions of distinguishable particles gives rise to the posibility of creating libraries of chemical and biological moities which can be anaylised simultaneously and competitively in a high-throughput format not prevoiusly possible.[2] In this study, fluorescently doped, optically encoded organosilica particles have been syntheised and surface functionalised for the multiplexed analysis of - i) protein resistant surfaces,[3, 4] ii) the enzymatic degredation of a focused random peptide library[5] and, iii) the detection of genetic[6] and proteomic biomarkers. Organosilica particles offer the advantages of chemical stability under a range of conditions and of being capable of acting as both a synthetic support for the organic synthesis of polymers, peptides and DNA along as well as serving as a high-throughput biological assay platform, Figure 1. Flow cytometric analysis of particle based assays offers the advantage of interogating multiple parameters on an individual particle basis using small volumes. This enables flow cytometry to distinguish between the individual encoded particles whilst monitoring biologicaly mediated changes to those particles.

In this study, the high-throughput multiplexed and multicomponent screening of protein resistive surfaces was examined by the adsorption of three proteins: bovine serum albumin (BSA), bovine immunoglobulin gamma (IgG) and fibrinogen, onto five encoded and surface modified particle populations. By uniquely labeling each protein and particle polulation with spectrally distinguishable fluorescent dyes, the adsorption process was ‘multiplexed’ allowing for simultaneous screening of multiple adsorbent (particle surface) and adsorbate (protein) interactions, Figure 2. This in turn enabled the characterisation of both competitve and cooperative protein adsorption, along with assessing the relative adsorption affinities of different modified surfaces. The combitorial, small volume analysis of this technique allowed for not only the rapid examination of a number of surface modificatons, but also for the inexpensive analysis of otherwise costly or exotic proteins or surfaces.

The enzymatic activity of the closely related NS3 proteases of West Nile and Dengue viruses were screened against a small, focused random peptide library immobilized on 14 optically distinguishable particle populations. Characterisation of the peptide substrate specificity of these and all viral proteases has been seen as a key step in the design of inhibitors and strategies toward their successful treatment. WNV and Den proteases both displayed fast kinetic activity and a narrow substrate specificity toward basic amino acids. It was observed that WNV preferentially cleaved the substrate containing lysine whereas Den favoured the substrate with arginine. The assay platform presented here is easily scalable and consequently has a broad potential application in the mapping of any biological site-specific peptide interactions.

Encoded multiplexed suspensions of chemical and biological libraries offer a unique high-throughput analysis platform with advantages not rivaled by other more common analysis techniques. It offers great potential in the screening and detection of biologically significant

conditions and events, specifically for the early diagnosis of diseases. However, these platforms and methodologies can be easily transferred to other systems or disciplines where the interaction of moieties of interest against libraries of complementary moieties is required.

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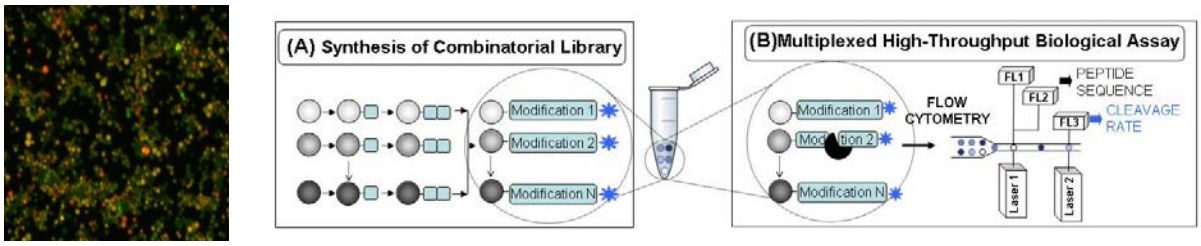

Figure 1: Dual purpose optically encoded organosilica particles for the organic synthesis of chemical and biological libraries for multiplexed high-throughput biological assay analysis

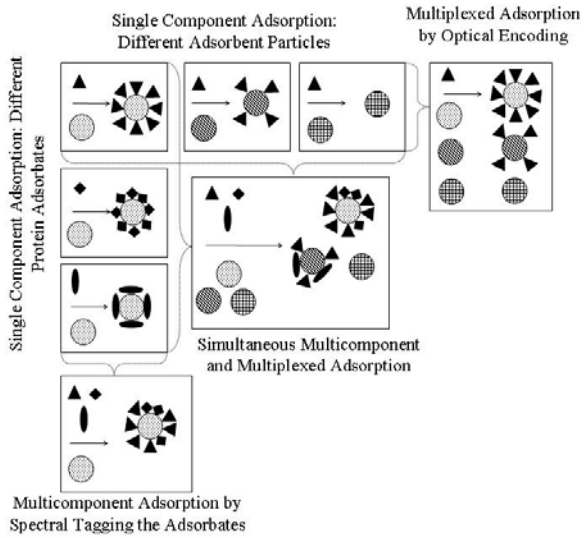

Figure 2: Flow cytometry analysis of multicomponent and multiplexed adsorption of proteins (▲), (♦) and (ו) onto surface modified adsorbent particles (O) in a high-throughput simultaneous and competitive manner.

THERMALLY INDUCED SURFACE POLYMERIZATION OF A PERYLENE DERIVATIVE ON Cu(111)

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The fundamental size limits for the fabrication methods of the microelectronic industry will soon be reached. Molecular and atomic self-assembly is a promising alternative route to overcome these mid-term problems with the aim to produce even smaller functional systems with nanometer dimensions on atomically well-defined surfaces. The concepts of supramolecular chemistry have been successfully applied to obtain impressive results for molecular self-assembly on surfaces. Mostly, non-covalent interactions like metal coordination, hydrogen bonding or dipolar coupling have been exploited to create extended supramolecular patterns in variable dimensions. The most common approach to "control" these structures relies mainly on the sophisticated design of the molecular functional groups, which make use of the properties inherent to the molecules.

In this work we present a different approach. A thermally-induced surface-assisted reaction is reported which modifies the endgroups of a perylene derivative (TAPP) [1] (*Figure 1a*). These changes result in different surface assemblies where the following molecular interactions are observed [2]:

i) At room temperature, TAPP forms a closed-packed assembly on Cu(111), where the intermolecular interactions are based upon van-der-Waals forces (*Figure 1b*).

ii) After annealing to 150°C, the molecular interactions are changed into a metal coordinated rectangular network. The obtained porous network is commensurate to the underlying Cu surface, where the organic molecules coordinate to Cu atoms through the lone pairs of their nitrogen atoms (*Figure 1c*).

iii) Higher annealing tempertures (above 240°C) conspicuously modifies the molecules on the surface and a surface induced tautomerization process leads to covalently linked polyaromatic chains (*Figure 1d*). It will be shown that these chains are extremely stable and can be laterally manipulated by the STM tip.

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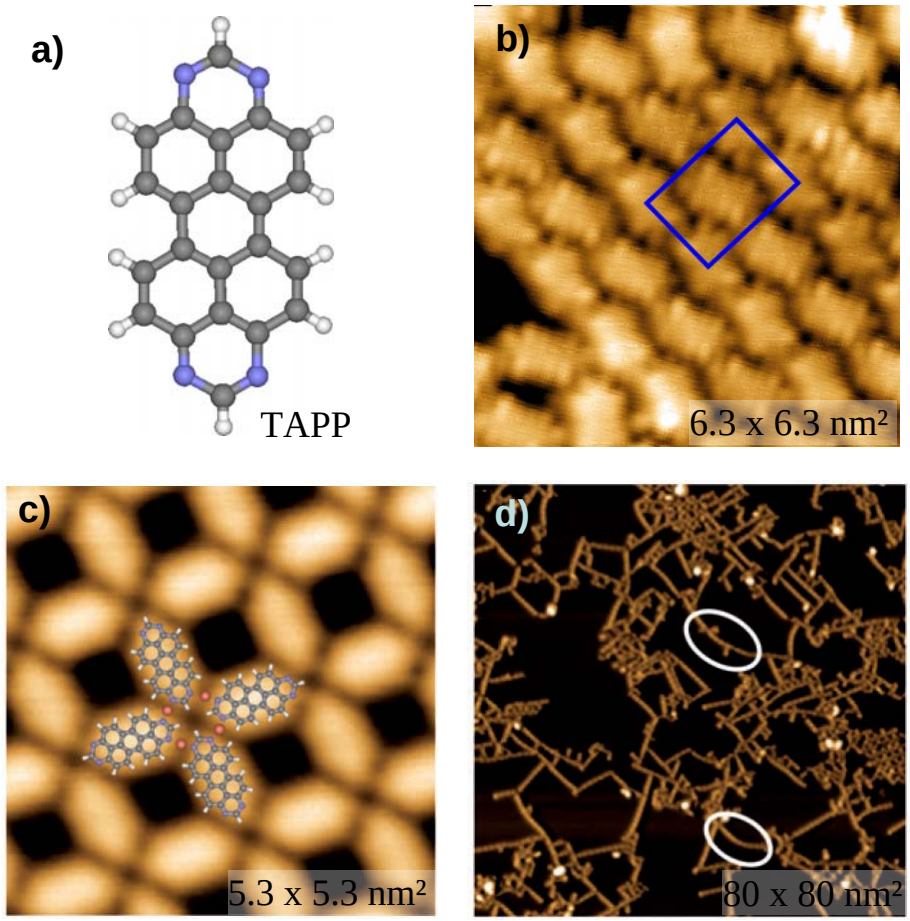

Figure 1: Different molecular assemblies of TAPP deposited on Cu(111) obtained by annealing to different substrate temperatures. **a)** Scheme of the TAPP molecule**. b)** Closed packed assembly formed at RT assembly. **c)** Porous network after annealing to 150ºC. **d)** Covalent chains formed after annealing to 240ºC. All STM images have been acquired at 77 K. The image size is indicated in each picture.

TRANSPORT THROUGH ORGANIC MOLECULES CONTAINING MAGNETIC ATOMS: EFFECTS OF SYMMETRY AND COULOMB INTERACTION

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Recent STM experimental studies on transport through CoPc and TBrPP-Co molecules adsorbed on metallic surfaces have reported several interesting results[1,2,3]: i) A high Kondo temperature as compared to those of adsorbed undressed magnetic atoms, ii) the Kondo resonance shows up either as a Kondo peak (CoPc) or as a Fano dip (TBrPP-Co), iii) the Kondo temperature depends strongly on the molecule conformation and can be manipulated experimentally, iv) in the case of TBrPP-Co two conductance peaks well below and above the Fermi level are observed, whose existence depends on molecule conformation.

In this work we discuss a simple model (Fig. 1) that, capturing the main features of the inner structure of the molecule, offers a physical interpretation for most of the main observations of those experiments[4]. In addition, it allows predicting the behavior of the system upon other symmetry or conformational changes, or when the STM tip is moved away from the Co atom (the usual point at which measurements were taken). The most relevant model parameters are the lobe-lobe hopping, the Co-tip hopping and the lobe-tip hopping.

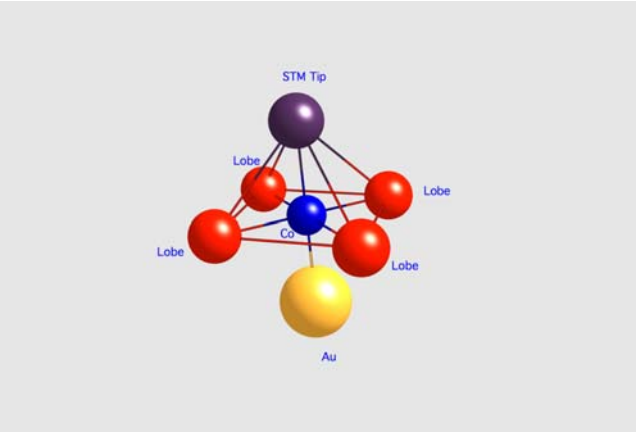

Fig. 1. Scheme of the small system used to describe the molecules here investigated. Lobes are also connected to the metal surface (through a self-energy) but this connection is not explicitlyshown for the sake of clarity.

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CHARGE TRANSPORT PROPERTY OF ONE DIMENSIONAL GOLD-POLYANILINE COMPOSITE NETWORKS

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Over the last two decades considerable efforts have been focused on fabricating nanostructures. Mechanisms to organize inorganic nanoparticles into diverse structures for their use in optical, electronic, magnetic and catalytic applications have been of special interest. Metal nanoparticles have been assembled into one-, two- and three-dimensional architectures and the colloidal aggregates have been used in diverse applications such as sensing and imaging.

The incorporation of the metal nanoparticles in polymers has attracted much attention and research interest over the last few years. Composite architectures of polymer and metal nanoparticles synergistically provide both useful functionality and mechanical integrity. Such composites show various properties directly relevant and of benefit to dielectrics, energy storage and catalytic activity. We have employed a coupled redox synthesis system with molecular pre-cursors for the synthesis of nanometal-polymers, specifically employing gold [1], copper [2] or palladium [3] compounds with various anilines and substituted anilines as starting materials. The resulting nanometal-polyaniline structures can be controlled at the nanoscale by manipulation of the synthesis variables.

A facile synthesis route is described for the preparation of a gold-polyaniline nanocomposite material by polymerization of aniline hydrochloride using $HAuCl_4$ as the oxidant. The oxidative polymerization of aniline hydrochloride leads to the formation of polyaniline with a fiber-like morphology, while the reduction of $HAuCl_4$ results in the formation of gold nanoparticles (2-7 nm). The gold nanoparticles were highly dispersed and stabilized throughout the polyaniline fibers that formed a metal-polymer composite material. The resultant composite material was characterized by means of different techniques, such as UV-vis, IR and Raman spectroscopy, which offered information about the chemical structure of the polymer, whereas electron microscopy images provided information regarding the morphology of the composite material and the distribution of the metal particles in the composite material. We furthermore performed temperature-dependent measurements of the electrical conductivity of the metal-polymer composite material. We obtained conductivity values supportive of a thorough dispersion of metallic conducting centers within the composite, while the interpretation of the temperature dependence of the conductivity is commensurate with the 1-dimentional geometry of the polymer matrix. The temperature dependence of the Hall coefficient of the metal-polymer composite is evidence of a possible contribution of a charge carrier deficit and a temperature dependent mobility in this material.

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FULLERENES FORMATION FROM AROMATIC PRECURSORS BY A SURFACE CATALYSED CYCLODEHYDROGENATION PROCESS.

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Controlled synthesis of fullerenes and heterofullerenes on surfaces is a preceding step towards the development of a true fullerene-based molecular electronics. New methods are required for the rational, size-controlled synthesis of fullerenes, heterofullerenes, and endohedral fullerenes that cannot be accessed by the current method of graphite vaporization. Recently, pioneering experiments have shown that C_{60} fullerene can be formed by flash vacuum pyrolysis of a trichlorinated precursor $C_{60}H_{57}Cl_3$. However, this precursor was prepared in 11 steps from commercially available materials and the final dehydrogenation/dehydrochlorination proceeds in the gas phase in ca. 0.1-1.0% yield[1]. Here we report a highly efficient (<100%) dehydrogenation mechanism leading to the formation of fullerene C_{60} and the first triazafullerene $C_{57}N_3$ in a one-step from the corresponding planar polycyclic aromatic precursors by a surface catalysed process[2]. We have visualized the whole process by in-situ Scanning Tunneling Microscopy (STM) and X-Ray Photoemission spectroscopy (XPS). The cyclodehydrogenation has been confirmed by the thermal desorption of HD and D_2 from hexadeuterated 1-d6 precursors, by the mass-spectrometric detection of C_{60} in the platinum-catalysed dehydrogenation, and the whole process followed by first principles DFT calculations.

The process is catalysed by reactive substrates, as Pt, which favour strong surface-molecule interactions. The mechanism we describe opens the door to size-controlled production of fullerenes and heterofullerenes, it could allow the encapsulation of different atomic and molecular species to form endohedral fullerenes and to the formation of different carbon-based nanostructures, such as doped graphene, which nowadays are not readily available on surfaces by other methods.

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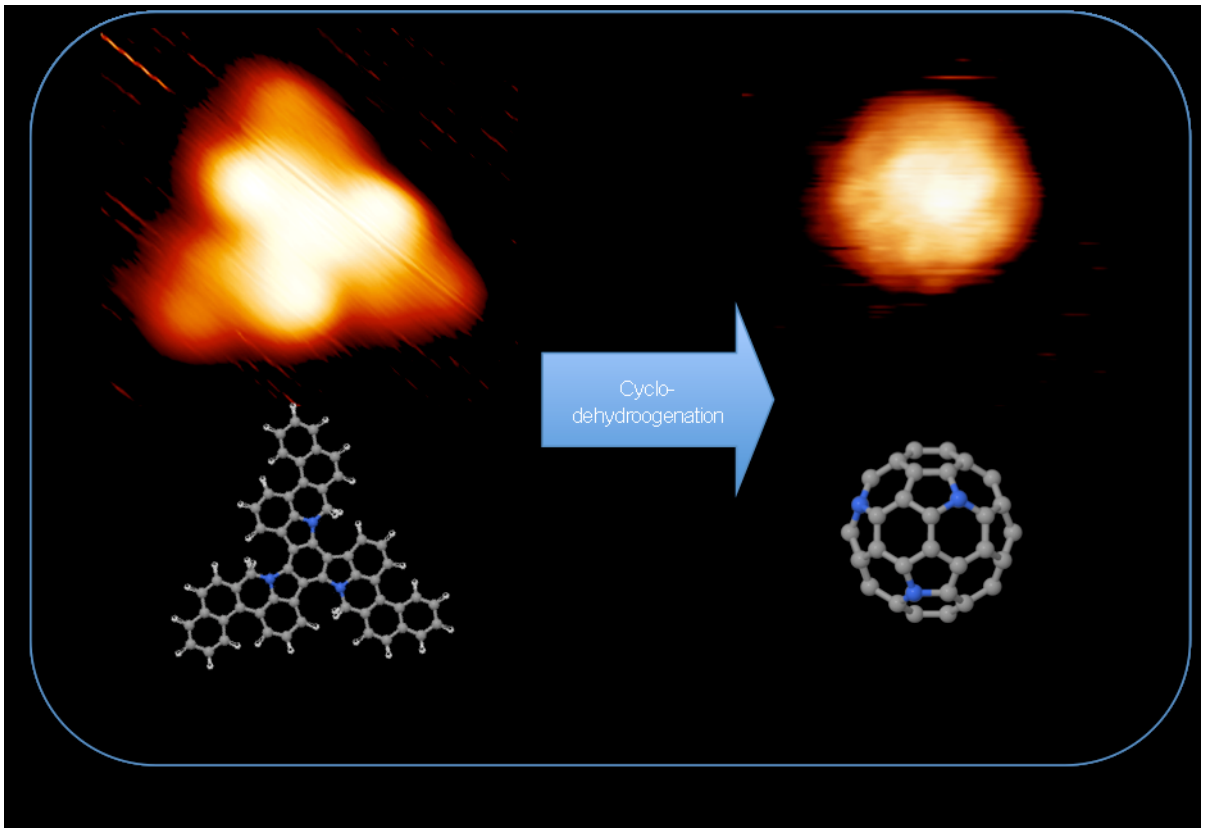

MAGNETIC PROPERTIES OF OXIDE INTERFACES

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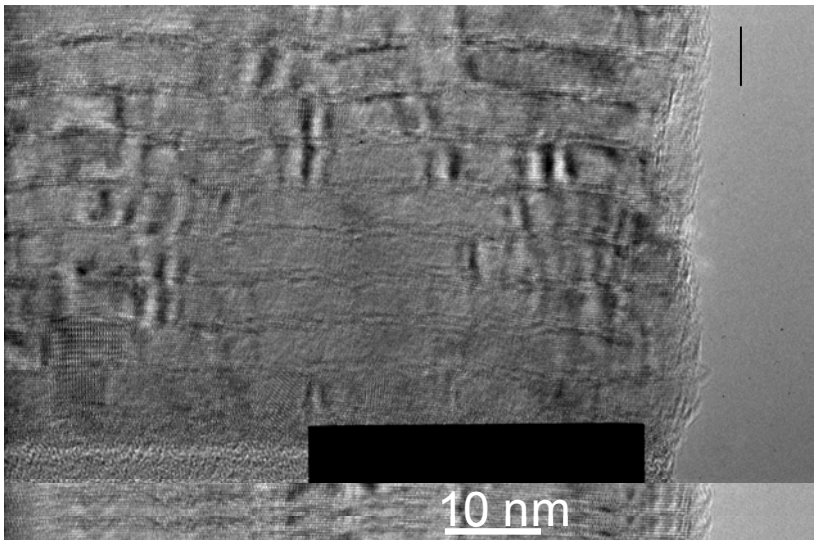
Introduction

The appearance and control of magnetism in traditionally non-magnetic oxides is nowadays one of the most active and pursued goals of material physics [i]. In the last years the research has been focussed mainly on oxides doped with magnetic ions (the so called Diluted Magnetic semiconductors). Recent results [ii, iii, iv, v] indicate that the appearance of magnetism in these oxides (mainly ZnO, and TiO2) is related to the presence of defects and surface/interface effects [vi, vii] but the origin of most of the experimental results is still unclear. Actually, results are hardly reproducible and findings from different groups are commonly contradictory. Understanding this lack of reproducibility is a challenge and will help in determining the origin of this magnetism. A common feature of all the experimental observations of magnetism is that signals are weak, suggesting that only few atoms are involved in the magnetic response. Thus, it has been proposed that the emerging magnetism in oxides correspond to surface/interface magnetism. We have recently demonstrated that ferromagnetism at room temperature can be observed in mixtures of ZnO/MnO_2 [viii, ix] and ZnO/Co_3O_4 [x] in powder form after a partial reaction of both oxides leading to certain interfaces. We have grown and characterized extensively, oxide thin films and multilayers.

It is really difficult to understand the origin of this magnetism based only on magnetic measurements, since signals are very weak and effects from the rest of the material such as impurities could mask the signals coming from interfaces. In this framework, correlating the magnetic properties with other measurements sensitive to the electronic structure can help to clarify its magnetic properties. This has been done for optical XPS,



transport, XANES, EPR…. measurements. This work studies the magnetic properties of oxide interfaces, among them, ZnO, Al_2O_3, SiO_2, MnO_2, CCTO, TiO_2 and Co_3O_4. Both thin film, multilayers, and mixed powders are studied. Special attention is paid to optical and transport measurements, quite useful to identify the origin of the observed room temperature magnetism. The difficulty to reproduce experiments in this kind of materials is also addressed.

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HIGH MAGNETIZATION PARTICLES COATED WITH INORGANIC MAGNESIA FOR BIOMEDICINE, CATALYSIS AND SPINTRONICS APPLICATIONS

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Magnetic nanoparticles are a very active scientific arena since they offer abundant attractive possibilities in fields as diverse as catalysis, spintronics or biotechnology. But in spite of the encouraging progress in the recent years expectations have not been fully accomplished. For instance, the development of really useful magnetic nanoparticles remains challenging for applications in drug delivery or magnetic resonance imaging. Among the multiple hurdles that must be overcome, the provision of a sufficiently high magnetic response, good chemical stability and an adequate degree of biocompatibility are of major relevance. One promising solution for overcoming these problems is the development of core-shell structured nanoparticles in which the shell will provide chemical stability and biocompatibility while maintaining the magnetic properties of the core.

Here we report on a new nanostructured system, made of crystalline $Fe_{1-x}Co_x$ particles covered by a uniform 3 nm thick MgO epitaxial shell that has proved to be very promising for both biomedical and spintronic applications. Either by using the simple and scalable gas-aggregation method in a solar furnace, or by means of laser ablation techniques in liquid, spherical nanoparticles with high saturation magnetization (over 200 emu/g at room temperature) and sharp core/shell interfaces were obtained.

Studies of biocompatibility of $Fe_{1-x}Co_x$ / MgO nanoparticles performed in cell cultures derived from mouse embryo fibroblasts and embryo neocortex will be presented in parallel with the analysis of the potential performances of nanoparticles for hyperthermia applications.

Worthy, the exceptional properties of the Fe/MgO system, with its spin-filtering effect, have ensured a rapid growth of interest in this epitaxial structure for spintronic applications. We reported pioneering results on tunnelling magnetoresistance (TMR) in this system in 2001 [J. Cryst. Growth 226, 223 & Appl. Phys. Lett. 79, 1655], in a multilayered structure. Since then, TMR values have been substantially improved reaching values

above 500% at room temperature [J. Phys. D: Appl. Phys. 40 (2007) R337]. Nevertheless, controlling the interfaces quality and pillar dimensions of these multilayered magnetic tunnelling junctions are key issues for technology commercialization. With these results in mind, we have investigated magnetotransport properties of both cold isostatic pressed assemblies of nanoparticles and isolated nanoparticles. On the one hand, we introduce here tunnelling conductance measurements of a single Fe island enclosed by the epitaxial MgO shell, showing clear oscillations in the I(V) curves as a function of the bias voltage that enables an accurate determination of the electronic density of states (DOS) of the iron core. In addition, magnetoresistance measurements at room temperature of assemblies of nanoparticles will be also presented.

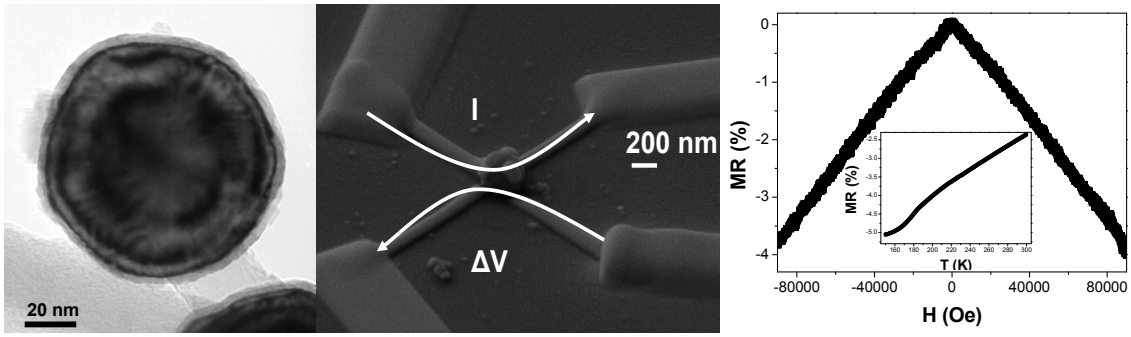

Fig. Electron microscopy images of core/shell particles and magnetotransport characterization. Left: TEM of a single Fe coated particle. Epitaxial relationship follows $[001]_{MgO} \parallel [001]_{Fe}$ and $[110]_{MgO} \parallel [100]_{Fe}$. Middle: SEM of the lead-particle-lead device used in the I-V spectroscopy measurements. Right: Magnetoresistance dependence on temperature and field.

NANOSCALE SPIN-FILTERS BASED ON MAGNETIC $CoPt_3$-Au HETERODIMERS

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Modern electronics has to face fundamental and technological limitations approaching the nanoscale [1]. In this respect, an interesting strategy to enhance the computational capabilities is to exploit novel phenomena and degrees of freedom and the intrinsic "binary" nature of the electron spin makes spintronic devices [2, 3] the ultimate candidate for ultra-dense data storage since they are expected to be smaller, more versatile, more robust and less power consuming than conventional charge-based electronic devices in addition to the important advantage of nonvolatility. Nevertheless, nearly all nanoelectronic applications neglect the spin, while so far spintronics mainly focused on bulk and typically involved ferromagnetic layers or diluted magnetic semiconductors. Here we proceed a "step forward" and miniaturize spin devices at the nanoscale, building them from elementary functional units.

More in detail, we realized tunnel junctions with magnetic nanoparticles as bridge, specifically heterodimers consisting of two inorganic $CoPt_3$ and Au domains joined together through a small interfacial area [4]. To fabricate the nanodevices, we employed a method we recently demonstrated for the simultaneous fabrication (without the need of expensive e-beam systems) of large arrays of nanojunctions working at room temperature [5]. The electrode gap is defined by optical lithography and a selective wet-etching of a AlGaAs/GaAs quantum well structure and controlled with nanometer precision by the thickness of the quantum well and of the deposited metal layer. A selective oxidation of the Al rich barrier reduces the bulk leakage current by six orders of magnitude and extends the applicability of the produced devices to room temperature functionality.

To interconnect the NPs, we functionalized the electrodes by hexane-1,6-dithiols and then immobilized the nanoparticles by incubation of the substrate in a diluted NP solution. After each deposition step, the devices were rinsed with the respective solvent. This procedure led to an immobilization and a stable attachment of nanoparticles. By diluting the colloidal solution (from 10^{-6}M to 10^{-11}M), we were able to control the number of NPs in the gap until to have single/few nanoparticles participating in the electrical transport. SEM images (not shown) confirm the immobilization of few nanoparticles. **Figure 1c** shows typical I-V and dI/dV spectra at 1.6 K of $CoPt_3$-Au heterodimers interconnected in the mesa nanojunctions. A number of steps are visible in the characteristics and different evenly spaced dI/dV peaks are observed with typical separation between adjacent peaks around 100 mV, a value close to that expected for NPs of similar dimensions.

The evolution of the differential conductance curves with the magnetic field is shown in **Figure 2a**, where a two dimensional map of the differential conductance as a function of the bias and the magnetic field is reported. We did not observe a clear Zeeman spin splitting nor a significant shift of the peaks when the magnetic field is increased from 0 T to 12 T. However, we observed a clear spin-filter effect [6]. In fact, we observed an increase of the magnetoresistance (MR) of the nanojunction as a function of the magnetic field (**Figure 2b)** as a consequence of the spin-dependent scattering of the not spin-polarized electrical carriers from the normal electrodes with those of the magnetic nanoparticles that have a preferential direction of the spin. Recently a similar spin-filter effect was reported by Liao et al. in nanodevices based on single magnetite (Fe_3O_4) nanowires [6]. We observed positive MR with a maximum value

around 10-12% at 0.4 T and 1.7 K (as a reference Liao et al. reported positive MR with a maximum value around 15% at 8 T and 120 K, decreasing at lower fields and higher temperatures). The lower dimentionality of our heterodimers, resulting in SET processes, adds further advantage to our system and allows to investigate the interplay between single electron tunneling and spin dependent tunneling. As a consequence, our approach opens the way to fabricate spintronic nanodevices, where the spin degree of freedom is employed to store, transfer and read information.

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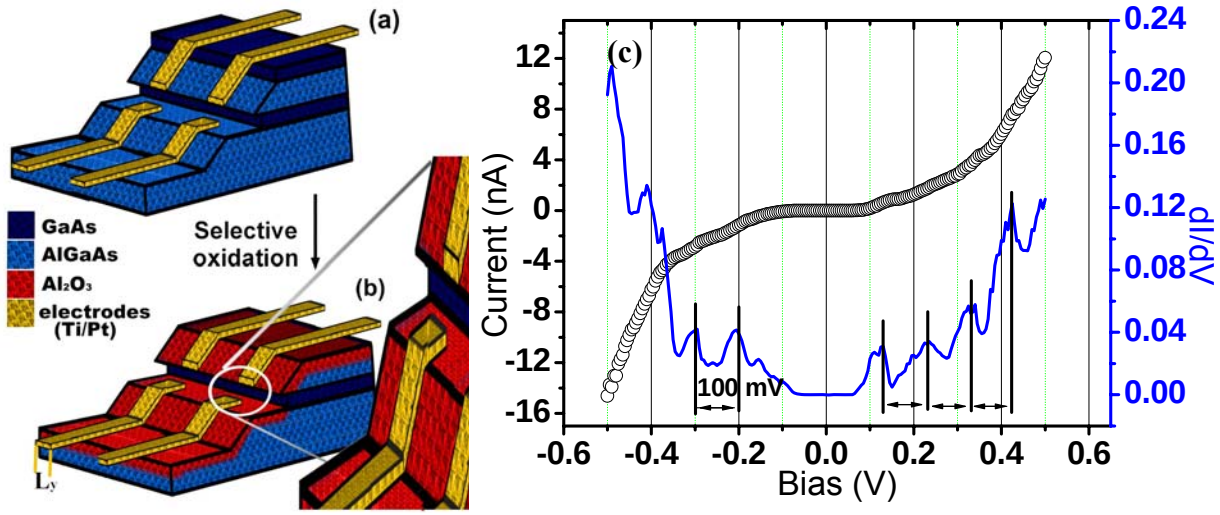

Figure 1. Schematics of the **(a)** unoxidized and **(b)** oxidized mesa nanojunctions used to fabricate the spin filter nanodevices. **(c)** Typical I-V characteristics and differential conductance spectra acquired at 1.6 K in devices consisting of mesa tunnel junctions bridged by $CoPt_3$-Au heterodimers.

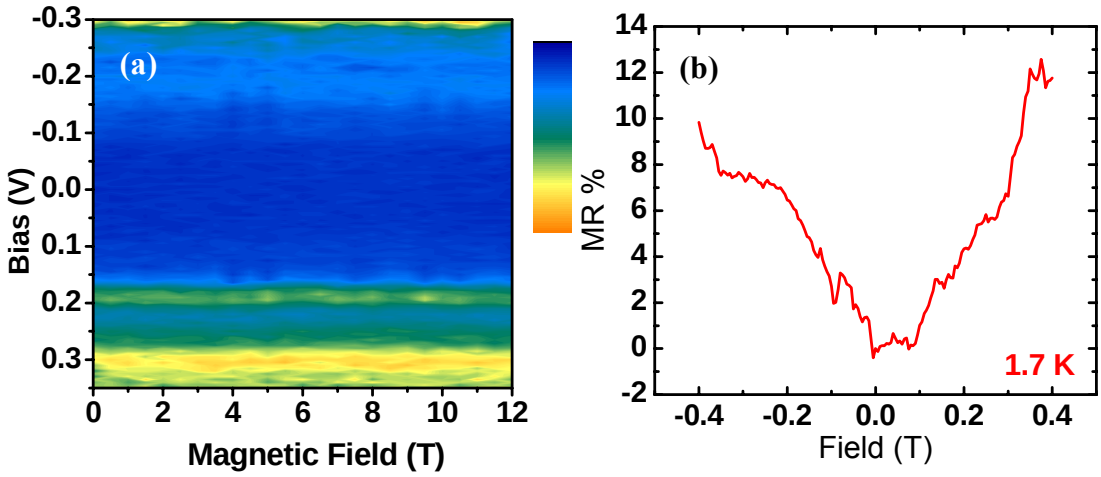

Figure 2 (a) Two dimensional plot showing the evolution of the differential conductance with the magnetic field. (b) Spin filter effect (magnetoresistance as a function of the magnetic field at 1.7 K) in nanodevices based on $CoPt_3$-Au heterodimers.

EXTENDING ELECTRON AND ION BEAM LITHOGRAPHY SCHEMES TO INNOVATIVE NANOFABRICATION PROCESSES

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Keywords: Nanofabrication, Electron beam lithography, Ion beam lithography, Advanced exposure strategies, electron beam induced deposition, Nanomanipulation

One of the main drivers of new trends in nanotechnology is the improvement and customization of commercially available instrumentation. These tools serve as enabling technologies for nanofabrication with minimum feature sizes in the nm-regime.
That is why in today's research and development based laboratories – of various disciplines – both electron beam lithography (EBL) and focused ion beam (FIB) based technologies are regarded as a "must have". Providing resolution in the 10 nm regime and below, these techniques are cost effective, flexible and therefore well suited for nanoresearch. Nanoscale integration of devices is already challenging and becoming more complex. That is why tool requirements are changing dramatically towards the simple, but more versatile provision of innovative schemes for efficient and reliable fabrication of (0D- to 3D-) nanostructures, and particularly their connection to the macroscopic world.

Apart from system nanofabrication capabilities which use standard lithography or milling techniques, it is increasingly desirable to have additional infrastructure and functionality embedded in the very same system – preferentially in situ.
Direct patterning techniques like electron beam induced deposition (EBID), ion beam induced deposition (IBID) and gas assisted etching (GAE), used in combination with analytical tools and highly precise nanomanipulators, are essential for in situ characterization or modification and thus rapid prototyping of nanodevices. In conjunction with suitable innovative patterning strategies, the system then allows for more than mere relocation and inspection of a nanostructure, which can be subsequent treatments like:
- shaping, indenting, adding or subtracting (tuning) features and materials
- analysis/characterization by determining chemical composition
- measuring topography and critical dimensions
- building contacts to macroscopic measures suitable for electrical probing
- in situ electrical probing

In this talk a few EBL and (low current) Focused Ion Beam Lithography techniques and applications will be illuminated in a little more detail, taking into account the specific benefits from various experimental setups e.g. including a gas injection system and nanomanipulators.
Innovative and unique exposure strategies using electrons or ions without stitching errors or in 3D will be described. These techniques find broad use in optoelectronic device prototyping but also in the exciting domain of exploration of Bose-Einstein condensates such as have been realized in atom chip arrangements e.g.

A new application domain for Ion beam patterning techniques will be presented: the combination of EBL and IBL lithography strategies for the uncompromised

production of devices while remaining compatible with established protocols (like GDSII design files) and using conventional production techniques.

Additionally, low dose applications for ions open new scenarios for research in the fields of nanomagnetism, selective epitaxy or defect engineering, just to name a few out of a broad bandwidth of applications.

MODELING OF ELECTRONIC AND TRANSPORT PROPERTIES OF SEMICONDUCTOR NANOWIRES

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Semiconductor nanowires have emerged as promising building blocks for nano- and opto-electronic devices. The physics of nanowires has proven to be both rich and complex contributing with both new physics and promising device properties. However, to properly understand and take advantage of the characteristics of the nanowire it is often helpful to do theory and modeling on the nanowire system. In this talk we will show examples of strain, doping and charge transport modeling in semiconductor nanowires.

It is well known that freestanding nanowires allows for a larger lattice mismatch compared to 2D systems. We have studied an InAs/InP nanowires with both longitudinal and lateral heterostructure analyzing the strain distributions as well as the piezoelectric potential.[1] We will show how the strain relaxes towards the surface of the nanowire and that the strain will create a significant barrier lowering between InAs and InP in short InP barriers and InAs quantum dots.

An important issue for many nanowire devices is the ability to introduce effective doping inside the nanowire. We have studied the effect of the dielectric environment on the dopant binding energies.[2] The binding energy is found to increase with decreasing nanowire radius. Already at R=10 nm the effect is large enough to seriously hinder the thermal excitation of the dopant electrons. We will also show that by changing the dielectric surrounding of the nanowire, i.e. the addition of a shell or an all around gate, the increase in binding energy can be reduced allowing for effective doping of small nanowires.

Silicon nanowires are considered as promising candidates for transistor downscaling since they can be manufactured with small radius (R ≈ 1nm) and since they allow for “all around gates”, which improves the gate efficiency compared to the classical planar technology. However, as the nanowire channel is scaled down effects from surface disorder will become important. We have studied the effect of surface roughness disorder on the intrinsic properties of the silicon nanowires.[3] Due to the band structure anisotropy of silicon the study have been carried out for three different nanowire orientations, [100], [110] and [111]. We will show that the [110] and [111] orientations have the best mobility for electrons and holes respectively. We will also show that our findings can be explained by the anisotropy of silicon and thus that the conclusions drawn for our particular surface roughness model likely holds for other kinds of disorder, e.g. trapped charges.

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NANOMETER LOCALIZATION AND IDENTIFICATION OF DNA REPAIR PROTEINS BY COMBINED AFM-FLUORESCENCE ANALYSIS

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Imaging of processes at the single-molecule level has revealed information otherwise inaccessible by "bulk" experiments. Atomic force microscopy is a powerful technique for studying biomolecular structures with nanometer resolution without necessity of external contrast agents. However, complex genetics transactions require the orchestrated action of different proteins, which would be undistinguishable by conventional AFM. On the other hand, fluorescence techniques can successfully localize proteins *in vivo* and *in vitro*, also for dynamic studies. However, optical resolution limits the details of structural studies in single molecule approaches. We show here the localization with nanometer resolution of recombination proteins using a combined atomic force and fluorescence microscope. Our experiments reveal the versatility of the system in the recognition and simultaneous localization of different fluorescent-tagged proteins on DNA. Moreover, we present the use of fluorescence polystyrene micro-spheres for a reliable alignment of the optical and the topographical images, which together with the DirectOverlay^{TM} system (JPK instruments) have allowed us to precisely localized different proteins with nanometer resolution.

MICROREVERSIBILITY BREAKING IN MESOSCOPIC SYSTEMS COUPLED TO NONEQUILIBRIUM ENVIRONMENTS

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The Onsager-Casimir symmetry relations [1,2] are crucial to understand the transport properties of mesoscopic conductors. These symmetries are fundamentally a consequence of microreversibility of the scattering matrix that describes the conductance of a phase-coherent conductor, dictating that the two-terminal linear conductance G must be symmetric under reversal of the external magnetic field B. However, breakings of this symmetry may take place. For instance, magneto-asymmetries were predicted to arise in the nonlinear regime of mesoscopic transport [3,4], this effect originating from the charge response of the system. For an experimental verification, see, e.g., Refs. [5,6].

Here, we discuss the developement of magneto-asymmetries already in the *linear* regime of mesoscopic transport when the system interacts with an environment which is driven out of equilibrium [7]. Our theory confirms why magnetic-field symmetries are preserved in existing experiments on two-terminal conductors despite the fact that they cannot avoid interactions with its environment.

We consider a mesoscopic conductor in close proximity with a second conductor, which acts an a tunable enviroment. There exists a Coulomb interaction coupling conductor and environment electrons but no particle exchange is permitted between the two subsystems. Experimentally, the environment can be a quantum point contact, a quantum Hall bar or any other system whose electron states depend on the electronic trajectory across the conductor. For instance, we consider resonant tunneling through a quantum dot which is capacitively coupled to the top edge of a quantum Hall conductor. We observe that the conductance G through the dot differs for opposite B orientations. The reason for the asymmetry is uniquely due to the asymmetry of the screening potential ΔU arising from the asymmetry of the Hall bar injectivity. The magneto-asymmetry is larger for stronger interaction coupling (C_μ) to the edge state. We recover the Onsager result for vanishing voltage bias across the Hall conductor, as expected. Importantly, we predict that the asymmetry is a function of the two-particle scattering matrix.

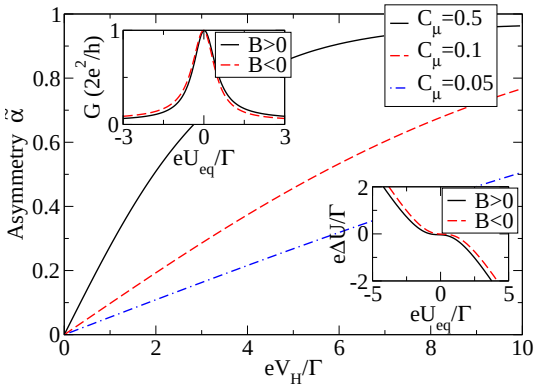

Fig. 1 Magnetic-field asymmetry of G through a quantum dot interacting with a quantum Hall bar. The asymmetry is stronger for larger voltages applied to the bar (V_H) and enhances for increasing values of the interaction coupling between the two conductors (C_μ).

We have also examined the case of a partinioned edge state and predict a magneto-asymmetry of *dephasing* when a quantum point contact is inserted in the Hall bar. In this case, dephasing in the dot is related to the possibility of extracting charge state information from the relative phase shift between the transmitted and reflected beams at the point contact.

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PRESSURE-INDUCED STRUCTURAL TRANSITIONS IN MULTIWALL CARBON NANOTUBES

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An important mechanical feature of carbon nanotubes is their high flexibility in the radial direction. It has been found that the magnitude of radial stiffness of an isolated carbon nanotube is considerably less than that of axial stiffness, which allows a reversible change in the cross-sectional shape on applying a hydrostatic pressure. Such a pressure-induced radial deformation yields significant changes in electronic [1] and optical [2] properties, indicating the relevance of radial deformations in carbon nanotube applications.

Thus far, many experimental and theoretical studies have been carried out on radial deformations of carbon nanotubes induced by hydrostatic pressures [3], most of which have focused on single-walled nanotubes (SWNTs) and their bundles. Successive investigations have revealed flattening and polygonalization in the cross section of SWNTs under pressures of the order a few GPa. As compared to the intensive studies carried on SWNTs, those on multiwalled nanotubes (MWNTs) are lagging behind. Intuitively, the core-shell structure of MWNTs is thought to enhance the radial stiffness of MWNTs. However, when the number of concentric walls is much greater than unity, outside walls have large diameters so that external pressure leads to a mechanical instability in the outer walls. The latter fact implies the possibility of a new cross-sectional shape transition of MWNTs induced by hydrostatic pressure.

In this presentation, we demonstrate theoretically a novel radial deformation, called the radial corrugation, of MWNTs under hydrostatic pressure [4]. Theoretical analyses based on the continuum elastic theory have revealed that MWNTs consisting of a large number of concentric walls undergo elastic deformations at critical pressure $p_C \sim 1$GPa, above which the cross-sectional circular shape becomes radially corrugated. We found various corrugation modes can be obtained by tuning the innermost tube diameter D and the number of constituent walls N, which is a direct consequence of the core-shell structure of MWNTs. A phase diagram has been established to obtain the requisite values of N and D for observing a desired corrugation mode. It is remarkable that in all corrugation modes, the cylindrical symmetry of the innermost tube is maintained even under high external pressures. This persistence of the cylindrical symmetry of the innermost tube of MWNTs is completely in contrast to the pressure-induced collapse of SWNTs. We hope that the present results provide useful information for developing nanofluidic or nanoelectrochemical devices whose performance depends on the geometry of the inner hollow cavity of nanotubes.

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LABEL-FREE BIOSENSING THROUGH NANOMECHANICAL TRANSDUCTION OF HYDRATION INDUCED TENSION IN NUCLEIC ACID FILMS

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The change in the structural and dynamic properties of water at nanoscale is crucial in a wide variety of phenomena, from the stability of a sandcastle[1] to the structure and function of nucleic acids and proteins[2]. Advances in nanotechnology, in particular those based in micro- and nanomechanical sensors, can potentially be used to analyze the role played by water molecules in macromolecular interactions[3]. Here we show that adsorption of water on a highly-packed self-assembled monolayer (SAM) of single stranded (ss) DNA has an extraordinary effect on the intermolecular interactions. We have followed the process by measuring the nano-scale bending of a silicon microcantilever, on which the ssDNA monolayer is attached, under controlled relative humidity. More importantly, the hydration-induced tension pattern undergoes dramatic changes when complementary and single mismatched DNA hybridizes with the ssDNA monolayer. To gain insight into the hydration-driven intermolecular interactions, the electrostatic contribution of the DNA backbone was studied by means of parallel experiments in which a SAM of the DNA analogue peptide nucleic acid (PNA) was used. In both cases, the features of the cantilever response to hydration and hybridization were qualitatively similar. This suggests that the tension of highly packed nucleic acid films is governed by hydration forces. Based on these new phenomena we have developed a novel nucleic acid biosensor with two key features: its optimal specificity (one mutation or single-nucleotide polymorphism, SNP) even at working temperatures much lower than the hybridization temperature of the probe-target pair, as well as its outstanding sensitivity (in the sub-picomolar range, at least ten times more sensitive than the label-dependent DNA microarrays)[4].

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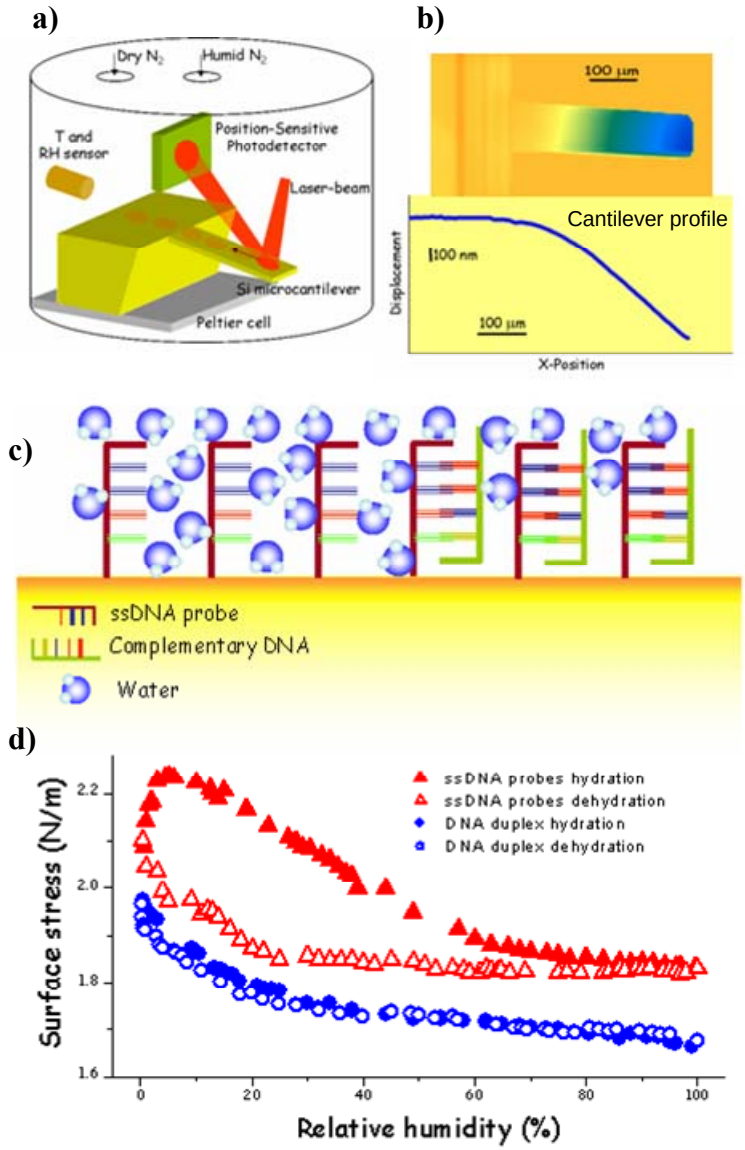

Fig. 1. **a)** Schematic depiction of the experimental set-up. The cantilever is placed in a humidity-controlled chamber. The relative humidity (RH) was controlled by adjusting the ratio between dry and water saturated nitrogen. **b)** The cantilever profile was obtained by scanning a laser beam over the cantilever and measuring the reflected beam deflection by a position-sensitive photodetector. A three dimensional image of the cantilever obtained by this technique is also shown. The Z dimension (deformation of the cantilever) is represented by a colour scale bar. **c)** A cartoon of the ssDNA oligonucleotides on the gold-coated side of the cantilever is shown. **d)** Surface stress measured under hydration and dehydration cycles for the cantilever sensitised with the ssDNA probes and for the same cantilever after hybridization upon exposure to a solution containing the complementary ssDNA target. We obtain a qualitatively distinct signal when hybridization occurs on the cantilever surface.

GOLD NANOPARTICLES AS CARRIERS OF CISPLATIN: A NEW APPROACH FOR CANCER TREATMENT

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At the nanoscale, materials exhibit unique optical, electronic and magnetic properties not seen at the bulk scale, which makes nanostructures attractive for a wide range of applications. The combination of these unique properties with the appropriate size scale has motivated the introduction of nanostructures into biology.[1] Cells and their constituent organelles lie on the sub-micron to micron size scale. Further, proteins and macromolecules found throughout the cell are on the nanometer scale. Thus nanoparticles ranging from a few to a hundred nanometers in size become ideal as labels and probes for incorporation into biological systems.[1] Furthermore, surface chemistry facilitates the functionalization and integration of nanoparticles. This opens the door to a wide variety of applications in molecular biology and biomedicine, such as drug[2] and gene delivery,[3] tissue engineering,[4] protein and DNA sensing[5] and detection-based diagnostics,[6] and biological/biomedical imaging.[7] Furthermore, noble metals, especially gold (Au), have a great potential for cancer diagnosis and therapy mainly due to their surface plasmon resonance (SPR) enhanced light scattering and absorption. One of the main challenges in cancer research is to minimize the side effects of chemotherapeutic drugs while maintaining their potency against cancer cells. In particular, cisplatin is widely used for the treatment of a variety of tumors, including lung, head and neck, testis, and ovarian cancers.[8-10] Chemotherapy is often associated with toxicity and/or severe side effects and damaging of healthy tissues at the vicinity of the tumors. Cisplatin is believed to kill cancer cells by binding to DNA and interfering with its repair mechanism,[11] eventually leading to cell death. Cisplatin has encountered the same fate as many other drugs used in cancer chemotherapy, namely drug resistance. When cells become resistant to cisplatin, the doses must be increased; a large dose escalation can lead to severe multiorgan toxicities (such as failures of the kidneys and bone marrow), intractable vomiting, and deafness. Therefore, it has been proposed the development of AuNP-cisplatin conjugates to overcome drug resistance while increasing the amount of drug inside malignant cells. The AuNP will act as transporters of the drug and delivery systems once they are at the tumor site. The generation of these new drugs involved the synthesis and characterization of water soluble-cisplatin derivatives as well as the preparation of the final conjugated molecules (AuNP-cisplatin conjugates) (Scheme 1). These conjugates are administrated to tumor cellular lines (HeLa, HEK and A459) to test their ability to decrease the side effects caused by the original drug.

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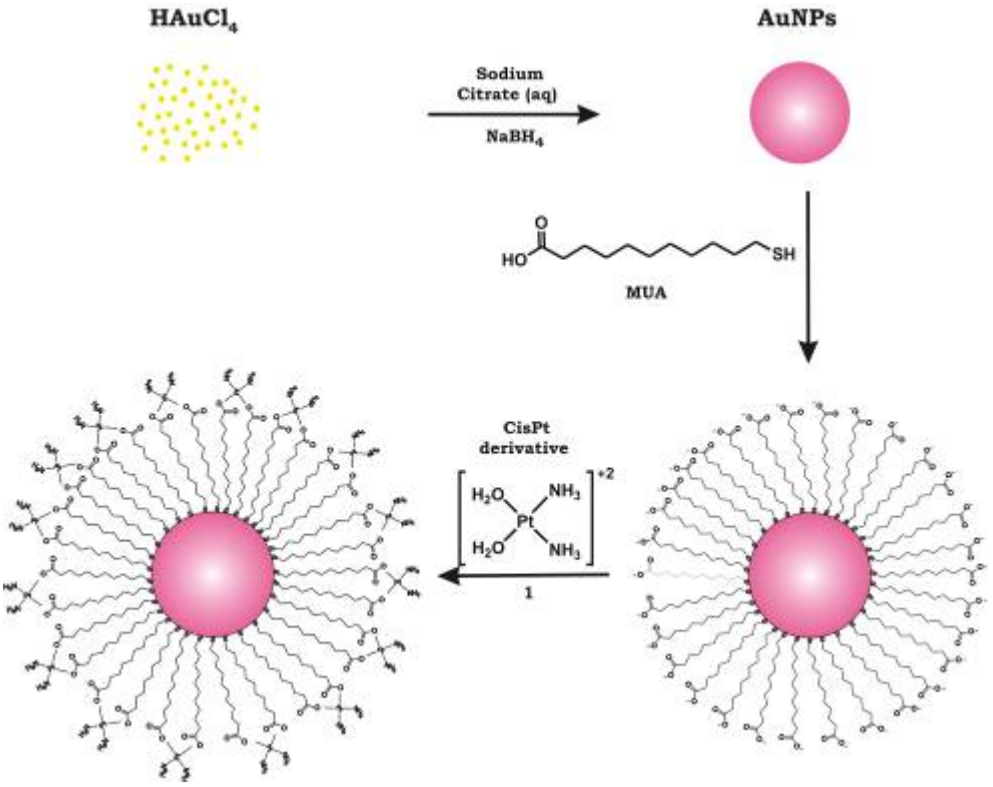
Figures:

Scheme 1: Schematic representation of the synthetic strategy to generate AuNP-Cisplatin conjugates



SINGLE ELECTRON COUNTING SPECTROSCOPY BASED ON CARBON NANOTUBE TRANSISTORS

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We carry out single-electron counting spectroscopy measurements to probe the electronic properties of semiconducting CdSe quantum dots. This measurement scheme is based on an original approach where the investigated particle is attached only to one electrode, a carbon nanotube [1] (see Fig. 1). This approach is particularly suitable for systems with a high contact resistance (up to 10^{19} Ohms). The nanotube is employed as a reservoir that supplies electrons to the particle, and as the detector for the transfer of single electrons to the particle. Counting individual electrons is achieved by measuring the conductance of the nanotube as it is ultra sensitive to the electrostatic environment. Our study shows that single-electron detection with nanotube transistors represents a powerful strategy to study the energy separation between the electronic discrete levels of highly-resistive particles. By studying electron transfer as a function of the gate voltage V_g applied on the backside of the wafer, we noticed that no electron transfer is observed for certain range of V_g. We show that the V_g gap is the result of the energy gap in the CdSe particle.

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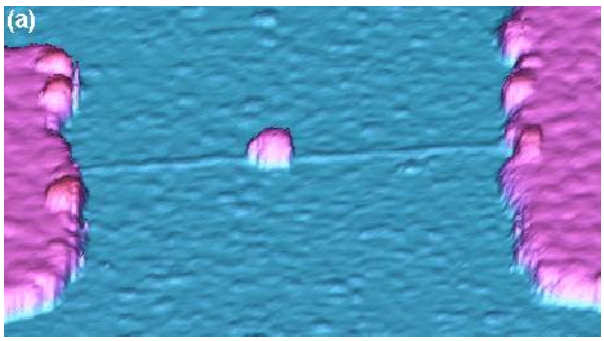
Figure 1



ORAL CONTRIBUTIONS

"PhD" Parallel Session

TIME-DEPENDENT ELECTRON DRIVEN TUNNELING PHENOMENA FOR MULTIPURPOSE TERAHERTZ APPLICATIONS: SELF-CONSISTENT COMPUTATION OF CONDUCTION AND DISPLACEMENT CURRENT IN MESOSCOPIC SYSTEMS

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Nowadays, systems for reaching the Terahertz (THz) electromagnetic gap are based on down-conversion of optical frequencies [1]. As alternative to these dominant strategies we propose a transistor-like tunneling electron device, that we named driven tunneling device (DTD), working at frequencies comparable to the inverse of the electron transit time (see Fig. 1). Our (single-device and room temperature) proposal provides future THz systems with reduced costs, sizes, and complexities. In this conference, we present several applications of the DTD for generating/manipulating signals at the THz gap (see Figs. 2, 3 and 4). For an accurate computation of tunneling transport through these DTDs at THz frequencies, a novel algorithm for the self-consistent computation of the time-dependent total (conduction plus displacement) current, $I(t)$, is presented.

The time-dependent evolution of a quantum system of N (coulomb and exchange) interacting electrons can be described by a many-particle Schrödinger equation [2]:

$$i\hbar\frac{\partial\Phi(\vec{r}_1,...,\vec{r}_N,t)}{\partial t}=\left\{\sum_{a=1}^{N}-\frac{\hbar^2}{2\cdot m}\nabla_a^2+U(\vec{r}_1,...,\vec{r}_N,t)\right\}\Phi(\vec{r}_1,...,\vec{r}_N,t) \quad (1)$$

However, from a computational point of view, the direct solution of equation (1) is inaccessible because (for a real space with N_L points) it implies manipulating matrixes of N_L^{3N} elements. We have recently shown [2] that many-particle Bohm trajectories associated to (1) can be computed from a (coupled) system of single-particle time-dependent Schrödinger equations whose numerical complexity is just $N\cdot N_L^3$:

$$i\hbar\frac{\partial\Psi_a(\vec{r}_a,t)}{\partial t}=\left\{-\frac{\hbar^2}{2\cdot m}\nabla_a^2+U(\vec{r}_1[t],.,\vec{r}_a,.,\vec{r}_N[t],t)+G_a(\vec{r}_a,t)+i\cdot J_a(\vec{r}_a,t)\right\}\Psi_a(\vec{r}_a,t) \quad (2)$$

The self-consistent coupling between the electron dynamics obtained from equation (2) and the electrostatic potential (obtained from the 3D Poisson solver) is achieved by using Bohm trajectories [2]. From a numerical point of view, we compute the total current, *I (t),* using a quantum version of Ramo-Shockley theorem [3], without numerical approximations, through a volume Ω limited by a surface S (See Fig. 1):

$$I(t)=-\int_{\Omega}\vec{F}(\vec{r})\cdot\vec{J}_p(\vec{r},t)\cdot d^3\vec{r}+\int_{S}\vec{F}(\vec{r})\cdot\varepsilon(\vec{r})\cdot\frac{\partial}{\partial t}A_o(\vec{r},t)\cdot d\vec{s} \quad (3)$$

In order to show the numerical viability of our approach and the great interest of the DTD at the THz gap, we develop three different THz applications: a rectifier, a harmonic generator, and an amplitude modulator [4]. In Fig. 2, we show a THz rectifier for a primary set of DTD parameters (i.e. the geometries of the barriers, quantum well, dielectric and contact shown in Fig. 1) with a input gate voltage $V_G(t)$ [see dashed line in Fig. 2]. The output voltage rectifies the signal [see solid line in Fig. 2] because negative gate voltages produce a very opaque barrier. In Fig. 3(a), we show a THz harmonic generator for a second set of DTD parameters and an input gate voltage $V_G(t)$ [see dashed line in Fig. 3(a)]. In this case, we accommodate three resonant energies inside the quantum well. The output voltage

[solid line in Fig. 3(a)] oscillates several times during a period of the input signal. The frequency multiplication is due to the fact that the DTD current acquires a maximum each time that a resonant energy of the quantum well crosses the Fermi energy. The power spectral density for output voltage is plotted in the solid line of Fig. 3(b) to show the harmonic generation. In Fig. 4(a), we show an amplitude modulator for THz frequencies for a third set of DTD parameters with a input gate voltage $V_G(t)$ and the input voltage $V_{in}(t)$ [see dashed and dotted lines, respectively, in Fig. 4(a)]. The output voltage [solid line in Fig. 4(a)] and its power spectral density [Fig. 4(b)] clearly show an amplitude modulator.

In conclusion, in this conference, we present a novel approach for the self-consistent simulation of the time-dependent total (conduction plus displacement) current in mesoscopic tunneling devices at THz frequencies [2]. This numerical approach is applied for the computation of tunneling currents in three different DTD configurations for developing (single-device and room temperature) THz applications [4].

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Figures

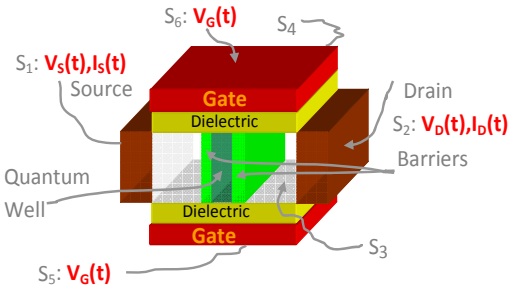

Fig. 1. 3D representation of the active region of the D. It consists in a double barrier structure inside a double-gate transistor-like tunneling electron device.

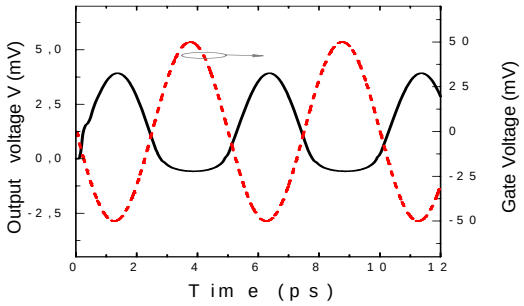

Fig. 2. (Solid line) Calculated output current for a THz rectifier. (Dashed line) input gate voltage $V_G(t)$.

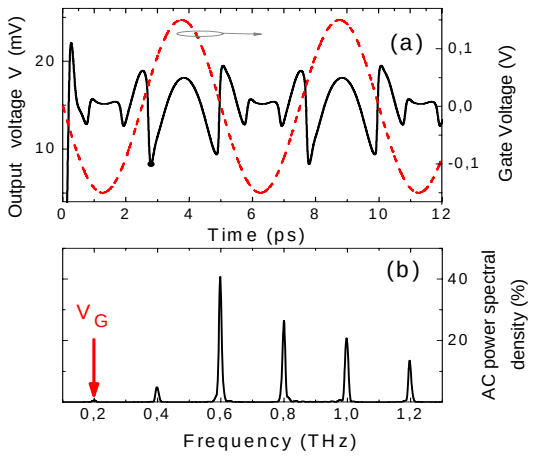

Fig. 3. *(a)* (Solid line) Calculated output current for a THz harmonic generation. *(b)* Calculated power spectral density.

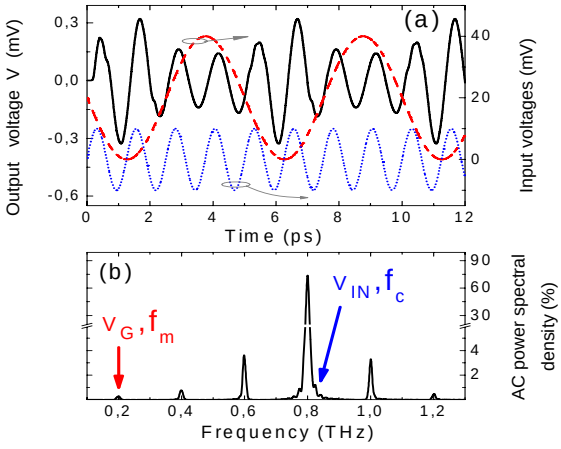

Fig. 4. *(a)* Amplitude modulated current (solid line), carrier input voltage (dotted line), and modulating gate voltage (dashed line) as a function of time. (*b*) Calculated power spectral density.

DETERMINATION OF MOLECULAR ORIENTATIONS IN SINGLE POLYFLUORENE NANOWIRES USING POLARISATION DEPENDENT NONLINEAR MICROSCOPY

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One-dimensional (1D) nanostructures based on molecular and polymeric materials are attracting significant research interest due to the many novel chemical, physical and electronic properties that may arise in such systems and the possibility for exploitation of their properties in a variety of applications. In terms of useful polymeric materials, polyfluorene based π-conjugated polymers are attractive due to their excellent charge transport properties, high photoluminescence (PL) quantum efficiencies and chemically tuneable emission wavelengths. Poly(9,9-dioctylfluorene) (PFO) is a prototypical main chain liquid crystalline homopolymer that emits in the blue and can exhibit a variety of different phases. Incorporation of PFO into 1D nanostructures would be an important advance since it would offer the potential to exploit the diverse benefits of this unique polymer in nanowire based photonic and electronic devices. To this end, we developed a novel way to synthesise PFO nanowires with semi-crystalline internal morphologies by exploiting the method of melt-assisted template wetting. The resulting wires exhibited regular cylindrical morphologies with well-defined end facets allowing nanowire active waveguiding, Fabry-Pérot microcavity behaviour and optically pumped lasing to be achieved [1-3].

More recently, we extended these studies to demonstrate that PFO nanowires can also be synthesized by solution-assisted template wetting and that these wires also exhibit attractive properties [4]. For example, investigation using linear optical methods revealed that the wires contained a significant fraction of β-phase PFO, in which polymer chain segments adopt a planarised and extended conformation, and that, as a consequence, the wires essentially acted as self-doped 1D nanostructures in which the β-phase dominated the luminescence behaviour following optical, electrochemical or electrical excitation. However, given the diverse range of potential applications available to these novel structures, one topic of great importance merits significant attention, namely, the development of an understanding of the effects of processing conditions on the extent of internal molecular organisation within PFO nanowires.

To address this challenge, we selected β-phase containing PFO nanowires as model 1D organic nanostructures and, for the first time, studied the internal molecular arrangements within single wires using a combination of third harmonic generation (3HG) and three photon excited luminescence (3PEL) imaging and spectroscopy. The dependence of three photon effects on the cube of the incident laser intensity provides for higher spatial resolution as compared with one photon methods and the use of a

near-IR laser as the excitation source (1064 nm) minimises both optical damage and scattering backround at the sample. These advantages are critical for imaging potentially fragile organic nanostructures. Another benefit is that three photon methods may show superior sensitivity to molecular anisotropy, relative to linear methods, as a result of the directionality induced by the multiphoton interaction.

In this talk, I will present results that demonstrate, for the first time, 3HG in single conjugated polymer, PFO, nanowires. Notably, by measuring polarisation dependent 3HG spectra, a pronounced dependence of excitation polarisation angle on 3HG signal intensity is observed. When the polarisation of the excitation beam is parallel to the long axis of a nanowire, the magnitude of the 3HG signal is found to be about 20 times greater than when the polarisation of the excitation beam and the nanowire long axis are mutually orthogonal. By assuming that $\chi_{\parallel}^{(3)}$, i.e., the component of the third-order susceptibility tensor with all indices parallel to the direction of the internal polymer molecular chains, dominates the 3HG signal response, a fit which incorporates a Gaussian distribution of polymer chain orientations about a net alignment direction may be made to the measured angular variation in 3HG signal intensity. A best fit to the data is found to correspond to a distribution of chain orientations about the long axis of the nanowires with a FWHM of 19° indicating that the polymer molecules within the wires are predominantly axially oriented.

I will also demonstrate 3PEL in PFO nanowires for the first time and show that, by analysing the dependence of 3PEL intensity images and spectra on both excitation and collection polarisations at the single nanowire level, values for the spread in molecular orientations about the nanowire long axis similar in magnitude to those obtained by 3HG methods, may be obtained. Importantly, by measuring both excitation and collection polarisation dependent data independently, it is possible to identify distinct orientation distributions for the populations of molecules that absorb the three photon excitation light and that subsequently emit the resulting luminescence, i.e., the nature of energy transfer processes within the wires may be probed. To conclude my talk, the implications of these results for the design of new optical methods to monitor nanowire internal structure and, also, for tailoring synthetic methods to achieve specific wire morphologies will be discussed.

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CONJUGATED POLYMER NANOFIBERS: EFFECTS OF NANOSTRUCTURATION ON PHOTOEMISSION PROPERTIES

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The controlled elaboration of well-defined nanostructures made of conjugated photo-electroluminescent organic polymers is very challenging for the fields of organic light emitting diodes (OLEDs), optoelectronics, photonics, and sensors. One of the most studied electroluminescent and photoconductive polymer in photonics is poly-(*p*-phenylene-vinylene) (PPV) which is the insoluble archetype of the π-conjugated polymers now used in OLEDs. The fabrication of thin films and the bulk optical properties of PPV and its related derivatives are at present quite well documented. Nanoscale systems make possible to integrate and tune desirable attributes of molecular and bulk regimes, through confinement effects, localization versus delocalization, exciton binding energy, exchange interaction and exciton fine structure, exciton-vibration coupling and dynamics of excitons.

Nanowires and nanotubes of poly-(*p*-phenylene-vinylene), a prototypical photo- and electroluminescent pi-conjugated polymer, have been prepared by the wetting template method in nanoporous membranes with an easy all-in-solution polymer precursor route. Both nanowires and nanotubes were obtained by varying the dilution of the polymer precursor in methanol prior to thermal conversion, as shown by a morphological study by scanning and transmission electron microscopies (fig.1). The effect of dilution has been addressed for PPV thin film in previous studies [1] and is compared to the case of PPV nanostructures. A polarized infra-red absorption spectroscopy (PIRAS) study indicated a preferential orientation of the PPV chains along the wire axis (fig.2). Nanofibers are highly luminescent (fig.3). Photoemission properties have been determined by steady-state and time-resolved photoluminescence (PL) spectroscopies. The time-resolved PL set-up is equipped with a confocal nanoprobe equipment, which results in a very small probe size. PPV nanotubes exhibit blue-shifted emission, higher quantum yield, and longer fluorescence lifetime with respect to PPV films. Interestingly, a new band appears at higher energy (447 nm) for the PPV nanotubes (fig.4) [2]. These effects are attributed to the cancellation of interchain interactions, that are consistent with nanoscale tubular structures formed from isolated short polymer chain segments.

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Figures:

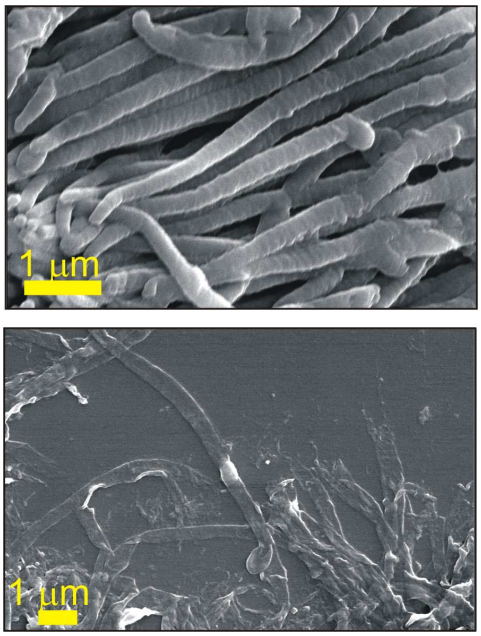

Figure 1: up: nanowires ; down : nanotubes.

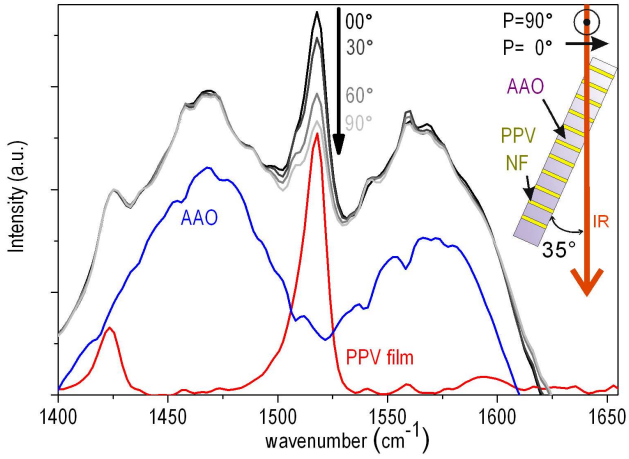

Figure 2: Micro-PIRAS recorded on PPV nanowires for different orientations of polarization.

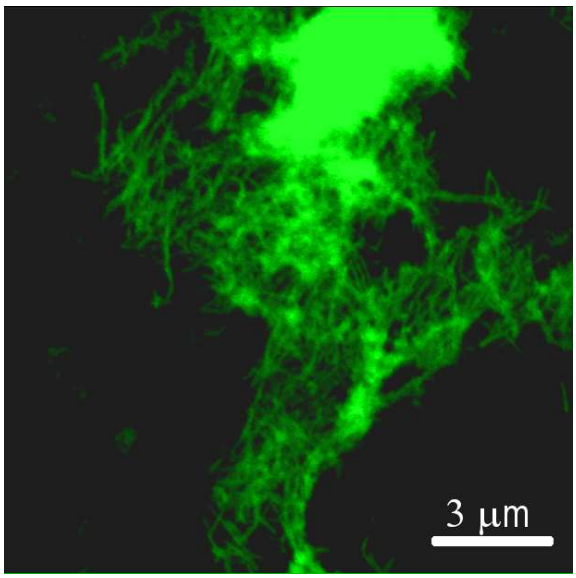

Figure 3 : Epifluorescence image of PPV nanowires.

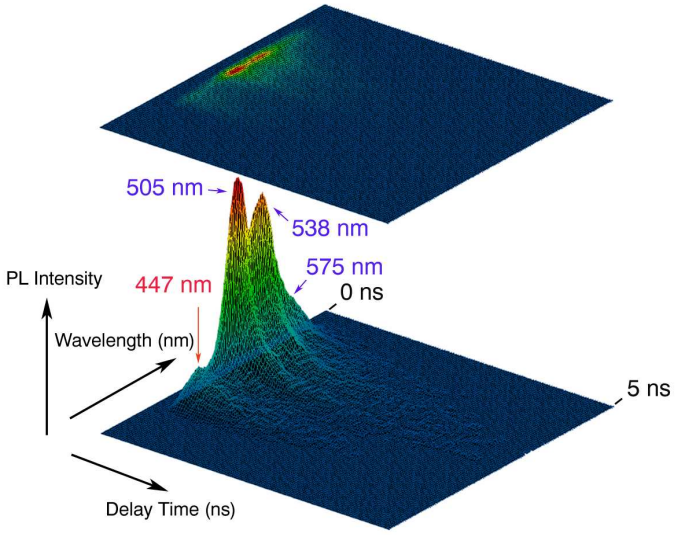

Figure 4: 3D time-resolved PL image of PPV nanotubes.

ON-LINE MONITORING OF CYTOTOXIC EFFECTS USING EIS BASED CELL-CHIPS

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An important goal of biomedical research is the development of tools for high throughput evaluation of drugs effects and cytotoxicity tests. In this respect, electrochemical impedance spectroscopy (EIS) is an emerging technique for the fabrication of sensitive and specific biosensors and lab-on-chips since the immobilization/adhesion of biomolecules or cells on biofunctionalized electrodes alters the capacitance C and interfacial electron transfer resistance R_{ET}. In particular, for cell layers, R_{ET} and C are correlated to cell viability, adhesion and cytoskeleton organization and this approach has been demonstrated to be a successfull strategy to monitor cell behaviour (cells micromotion, cells attachment and spreading, cell concentration and growth or apoptosis [1-5]). In the future such EIS devices are expected to replace *in vivo* tests on animals.

Here we demonstrate EIS cell chips able to monitor cell growth, morphology, adhesion and their changes as a consequence of treatment with drugs or toxic compounds. As a case study, we investigated the uptake of copper ions and its effect on HeLa cells. For further understanding, we also carried out in parallel an AFM characterization of cells and Cu effects and monitored them in real-time using an inverted microscope during the EIS experiments.

Specifically, our chips consist of a cell culture chamber made of PDMS with integrated interdigitated electrodes (with a line-space period of 40 μm and covering a 2 x 2.5 mm^2). ITO and Cr/Au (respectively 100 nm and 3/10 nm thick) electrodes were fabricated by optical lithography, lift-off and etching on glass substrates. The PDMS cell culture chamber was realized by replica molding from a hard master. The whole device is made using transparent (or semitransparent) and biocompatible materials (fig. 1) in order to be mounted on an inverted microscope for real-time monitoring of cells during measurements to correlate cell growth, status and detachment to changes in the EIS signal.

In fig. 2, we show typical AFM images of HeLa cells in physiological conditions **(a)** and after treatment with copper ions (500 μM) for 2h and 4h **(b-c)**. Experimental results indicate that at the beginning of the treatment the toxic effect of copper causes a spreading of cells (they become thinner, fig 2b). Then after a longer treatment some of them start to acquire a round shape (see for example the cell indicated by narrow) and detach as a consequence of cell death. These cytotoxic effects can be easily identified in our chips. Both the Nyquist and Bode plots reported in fig.3 change significantly. Cell attachment and growth onto the electrodes induces an increasing impedance compared with the empty device. Looking at EIS spectra (Nyquist plot in fig 3a) is possible to distinguish two different semicircles (not present in the empty device). The semicircle at higher frequencies can be ascribed to round shape cells, while the portion at lower frequencies to adhering and spreading cells into the same device. The equivalent circuit is shown in fig3b, where the Warburg impedance Z_W consists of a resistance R_W and a capacitance C_W in parallel. During the treatments R_W increases from 50 to 160 kΩ while C_W decreases from 330 nF to 180 nF.

In conclusion, these results reveal that our cell chips provide an easy and real-time tool to study cells attachment/spreading and to perform viability and cytotoxicity tests. They are cheap and reusable and join a great sensitivity and low cost both for fabrication and usage, since they do not require any additional reagent. Moreover, they can be easily multiplexed to monitor in parallel the effect of different drugs/compounds. In the future such devices will be useful to perform drug screening without animal sacrifice and to achieve this goal we are integrating in such devices new modules for temperature regulation and drug delivery.

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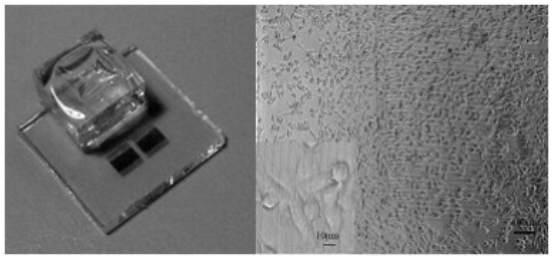

Fig. 1: Adhesion of Hela cells on ITO interdigitated electrodes on glass and picture of the whole device.

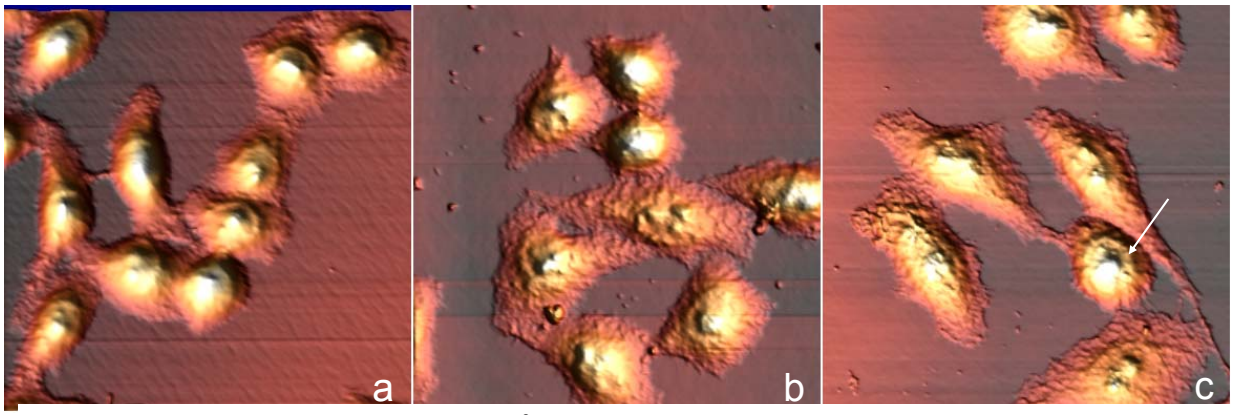

Fig.2: 3D AFM images (area 100 μm^2) of HeLa cells after different time of incubation with copper: **A**) control **B**) 2h at $CuCl_2$ 500µM **C**) 4h at $CuCl_2$ 500µM

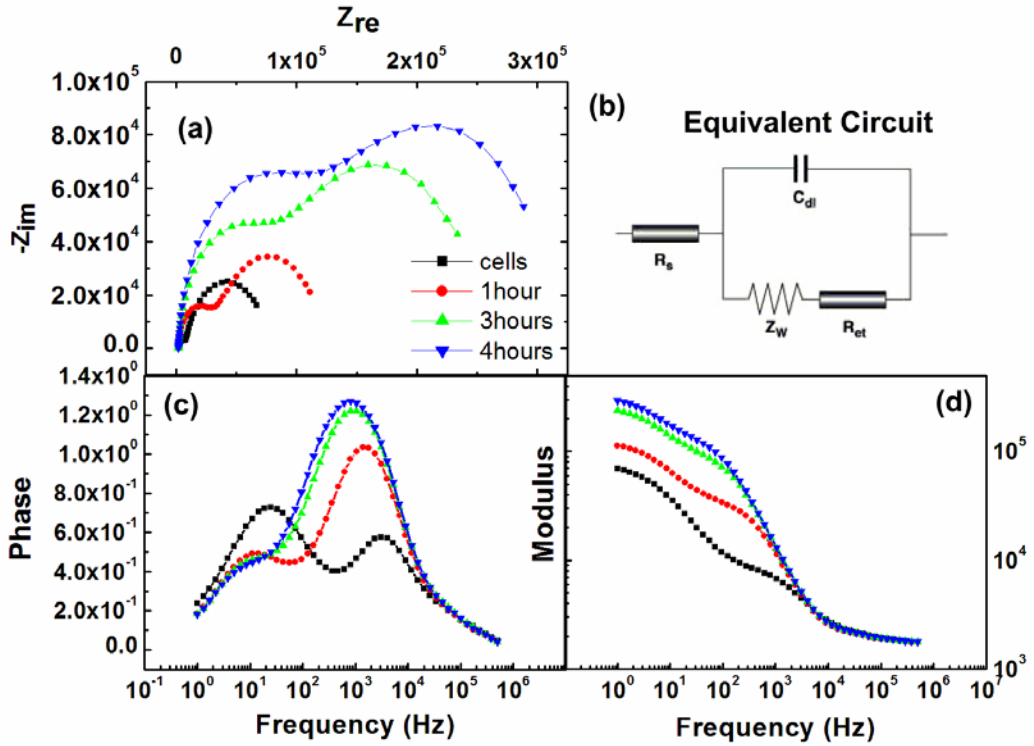

Fig. 3: Nyquist (Z_{re} vs Z_{im}) and Bode plots from chips with HeLa cells after treatment with copper for different time (0-4 hours). The data were recorded at 0V in culture medium in the presence of $K_3[Fe(CN)_6]/K_4[Fe(CN)_6]$ (1:1), 10 mM. The equivalent circuit is also reported in (b).

GROWTH STUDY OF SILICON NANOWIRES USING GOLD AND GALLIUM AS CATALYST BY IN SITU SCANNING ELECTRON MICROSCOPY

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We present a method that allows the synthesis, in a scanning electron microscope (SEM), of silicon nanowires (Si NWs) using Au or Ga as catalyst solvent. In situ SEM nanowire growth offers the ability to observe, film, and record events as they occur in real time. To get in situ growth conditions, we induced a localized heating by flowing current through a tungsten submicronic wire. The Vapor-Liquid-Solid (VLS) Si NWs synthesis is obtained by exposing the heated catalyst solvent to an atmosphere of silane[1-4]. For the two different catalyst solvents used (Au and Ga), we have studied the growth mechanism and determined the structure and the composition of the Si NW's by electron microscopies characterizations.

Experiments were carried out in a nanofabrication station and in a transmission electron microscope (TEM- 2000FX – Jeol) equipped with an energy dispersive x-ray (EDX) analyser. The nanofabrication station is a vacuum chamber containing a cross beam system coupling a scanning electron microscope (SEM -JSM 5910 - Jeol)) and a focused ion beam (FIB – Canion 31^+ - Orsay Physics). The nanofabrication station is also equipped with a gas injection system (GIS) and an in-situ electrical module (current-voltage source, picoammeter). For this study, we have developed two original sample devices suitable for in situ SEM localized growth of Si NWs. The first device is based on an Al pattern deposited on a SiO_2 substrate using conventional microelectronic processes (Figure 1.a.). The second device is based on four Au electrodes thermally evaporated, through a mask, on a Si_3N_4 auto supported membrane (Figure 1.b.c.). This membrane is transparent to high energy electrons (thickness 50nm) allowing subsequent analysis in a TEM. Conductive micronic tungsten wires are fabricated, on both sample devices between the macroscopic electrodes, by Focused Ion Beam Induced Deposition (FIBID) from organometallic precursor $W(CO)_6$. Structural, chemical and electrical properties of the tungsten wire deposited by FIBID as fully described in previous works[5,6]. The devices can be mounted on the in-situ electrical module allowing the heating of the tungsten wires by Joule effect. The local pressure of silane in the vicinity of the heated wire is obtained using the gas injection system while the base pressure in the chamber is in the $1.5.10^{-5}$ Torr range.

The reaction temperature is a key parameter in the VLS Si NWs synthesis. Based on recent results on nanoscale thermal properties in solid[7-9], we have developed a simulation method to get the temperature profile for different heating conditions of the tungsten wire (Figure 2). The results of temperature simulation can be compared with our experimental results obtained by SEM and TEM observations of Au nanoparticules evaporation. These profiles were useful to estimate the temperature condition for VLS Si NWs synthesis.

We have followed the nucleation and the growth of Si NWs and observed that two very different growth mechanisms are obtained depending on the catalyst solvent (Au or Ga). For Au as solvent (Figure 3-4), the growth mechanism is the classical VLS process, the catalytic droplet is on the top of the Si NW and the growth stops when the temperature of the droplet is below the eutectic temperature. For Ga as solvent (Figure 5-6), only one nanowire grows from its bottom in the vicinity of the gallium droplet, the decomposition of silane is induced by the high temperature of the tungsten wire providing silicon for the VLS synthesis. We have observed that the catalytic droplet remains at the base of the Si NW so that this particular growth mechanism leads to the formation of a unique and very long nanowire.

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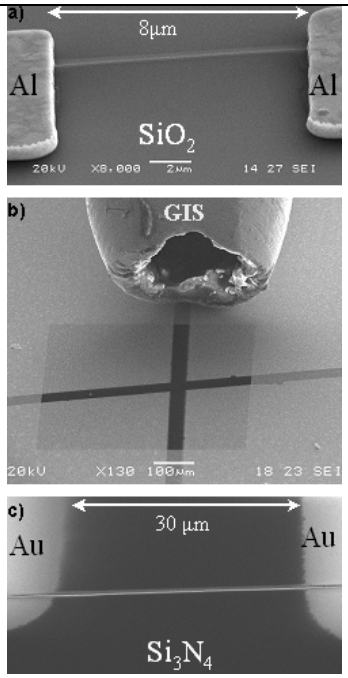

Figure 1. SEM images of the SiO_2 (a) and Si_3N_4 (b,c) sample devices

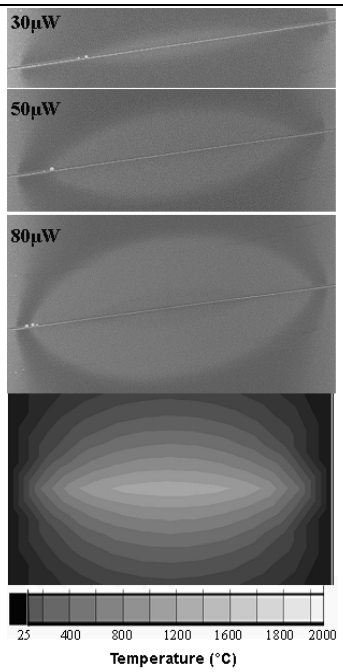

Figure 2. SEM images for different heating conditions and the associate temperature profile for a heating at 80µW.

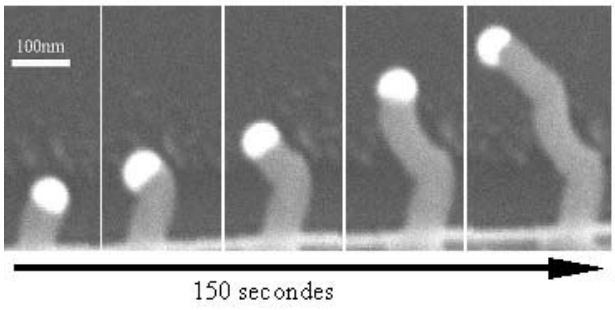

Figure 3. Sucessive SEM images of Si NWs on Si_3N_4 sample device using Au as catalyst solvent.

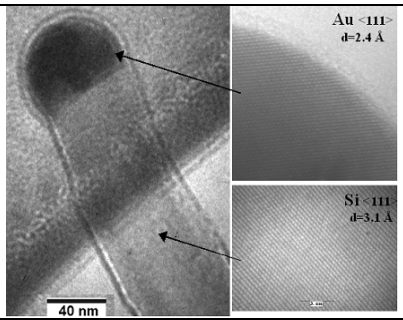

Figure 4. TEM images of Si NW on Si_3N_4 sample device

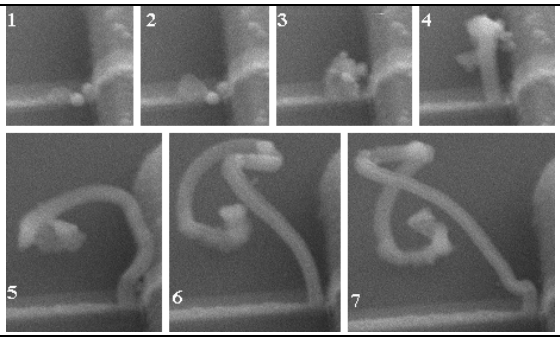

Figure 5. Successive SEM images of Si NW growth on SiO_2 sample device using Ga as catalyst solvent.

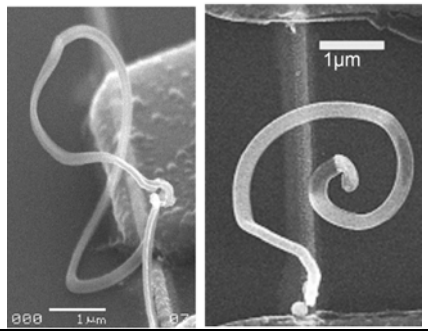

Figure 6. SEM images of Si NWs on SiO_2 sample device using Ga as catalyst solvent.

MANIPULATION, ASSEMBLY AND CHARACTERIZATION OF OPTICALLY FUNCTIONAL 1-D ORGANIC NANOSTRUCTURES

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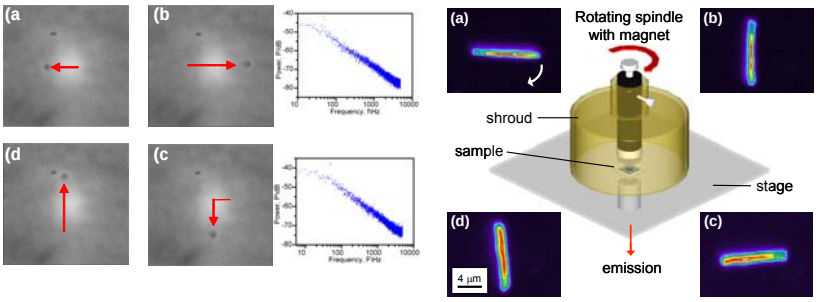
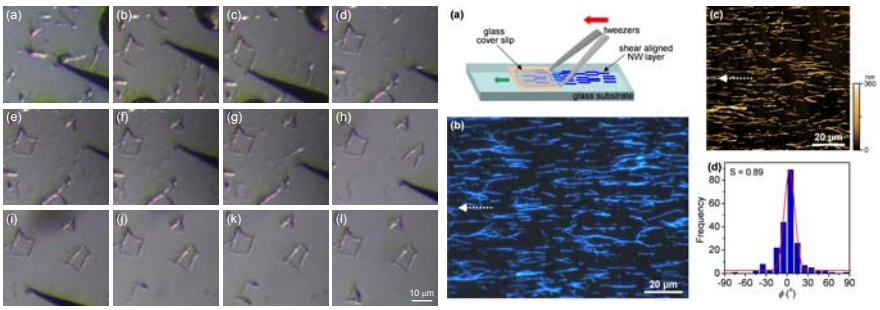
One-dimensional (1-D) nanostructures based on organic materials are attracting significant research interest due to the many novel chemical, physical and electronic properties that may arise in highly anisotropic systems and the possibility for exploitation of such properties in a wide variety of applications. In particular, the potential of semiconducting polymer nanowires and nanotubes is now being explored for realisation of sub-wavelength photonic devices such as photodetectors, lasers and electroluminescent diodes. Successful realisation of such devices relies upon the ability to precisely manipulate and assemble these nanostructures so they can be successfully interconnected and integrated onto chips. While there has been significant research published on the assembly of inorganic nanostructures[1-2] there has been very limited research carried out in relation to the assembly of organic nanostructures.[3-4] To this end, we have explored a range of manipulation and assembly methods. In this talk I will present recent results in our consortium concerning nanowire manipulation and assembly by probe manipulation, magnetic fields, optical trapping, and “shear alignment”.

A probe-based system was successfully developed to manipulate nanowires and assemble them into complex mesostructures for possible device applications as a step towards a nanostructure prototype test platform. AFM analysis was carried out to confirm minimal damage was done to the nanowires. Epi-fluorescence microscopic imaging indicated that the nanowires luminesced under UV excitation with intense blue light emission. Far-field fluorescence microscopy allowed for characterisation of the functionality of whole nanowires while polarized optical microscopic studies of nanowire birefringence indicated axial alignment of the polymer molecules within the wires.

To magnetically manipulate organic nanowires, 30 nm Fe_3O_4 nanocrystals were doped into the wires and were successfully aligned when placed in an external

magnetic field. A demonstration of a doped polymer nanowire as a nanoroter undergoing 360° rotation under the influence of a rotating NbFeB magnet while clocking its polarized flouresence will be presented. We will also introduce a novel optical trapping system using a Laguerre – Gaussian laser beam as a new tool for manipulation, assembly and characterization of organic nanostructures. We will demonstrate for the first time successful trapping of number of organic nanowires and nanotubes and present data concerning the nanostructures physical properties while in the beam. Finally a method to successfully align random nanowire mats has been developed by drop-depositing nanowires from suspension onto a substrate where aligned nanowire mats were achieved by the method of shear alignment.





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CARBON NANOTUBES AS ELECTRODES FOR MOLECULAR ELECTRONICS: FROM SAMs TO SINGLE-MOLECULE CONNECTION

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While the use of molecules as building blocks for the development of new electronic devices has attracted a lot of attention for the past 25 years, one of the main challenges of the molecular electronics field remains the efficient connection of small assemblies of organized molecules and, ultimately, of individual molecules. For fundamental studies, several techniques to address either self-assembled monolayers (SAMs) on a nanometer-scale or single molecules have demonstrated their high potential, in particular those with adjusting electrode distances such as STM, Conducting-Probe AFM and mechanical break-junctions. From a device point of view vertical structures (such as nanopores) have been used but suffer from severe limitations related to the top contact formation - direct metal evaporation on top of SAMs usually resulting in the deterioration of the molecules. Even if a few methods were derived to limit this problem (indirect evaporation, conducting polymer inter-layer deposition…), the spatial resolution of the final device is limited by the patterning technique, which implies the connection of a very large number of molecules. Horizontal structures have also been developed, in particular micro-fabricated nanogaps, which have lead to fascinating results. In this geometry, the challenges concern both the control of the inter-electrodes distance and the reliable insertion of a known number of molecules, ideally a single one.

In this context, using carbon nanotubes (CNTs) as electrodes to connect molecules is very attractive with respect to their intrinsic nanoscale size, exceptional electronic properties and compatibility with most fabrication processes and substrate types (including flexible ones). Our work demonstrates the use of individual CNTs as electrodes in two configurations.

In the first one, an individual single wall CNT is used as top electrode in nanoscale metal-SAM-nanotube junctions (Fig 1.a). We first use a metallic CNT and compare the transport properties of a simple octadecanethiol (ODT) SAM with the more complex case of sigma-pi-sigma molecules with a terthiophene core (T3). The simple tunnelling regime of the first case corresponds to a barrier height of ~2.4 eV in strong contrast with the structured I-Vs of the second type of SAM, which includes hysteretic Negative Differential Resistance (NDR) behaviour (Fig 1.b,c).
Most interestingly, when a semiconducting CNT is used, the proposed device geometry combined with the insulating character of the ODT SAM enables the study of carbon nanotube field-effect transistors, in which the SAM serves as ultrathin and organic gate dielectric. These p-type transistors display excellent performances (very steep subthreshold slope, greatly reduced hysteresis and band-to-band tunneling) and allow the direct and quantitative determination of the efficiency of such molecular gate dielectric (Fig 1.d). Moreover, when converted into n-type transistors, these devices show an absence of gate modulation, which emphasizes the key role of the electrical dipole of the SAM in controlling the device switching behavior [1]. The tunability of this parameter associated with the high level of performances open new ways towards the realization of fully organic nano-scale transistors.

Very recently, nanotubes were also used by the Nuckolls group as electrodes for single molecule devices [2]. However the oxygen-plasma cutting technique results in the statistical fabrication of

different gap sizes, which are difficult to adjust to a specific class of molecules.

In a second step, we have thus studied and optimized a quantitative and selective chemistry route to covalently connect single molecules between CNTs, with preferential connection at the end of the CNTs [3] (Fig 2.a). We then show that the CNT-molecule-CNT junctions produced in solution can withstand the following process steps all the way to the device realization. We perform electrical measurements in the case of ethylenediamine (EDA) (Fig 2.c), which give conductance values in reasonable agreement with previous results from the STM-break junction technique [4]. The richness of the nanotube electronic properties together with the possible choice of the connected molecules offers a wide range of possibilities to study self-assembled single-molecule devices.

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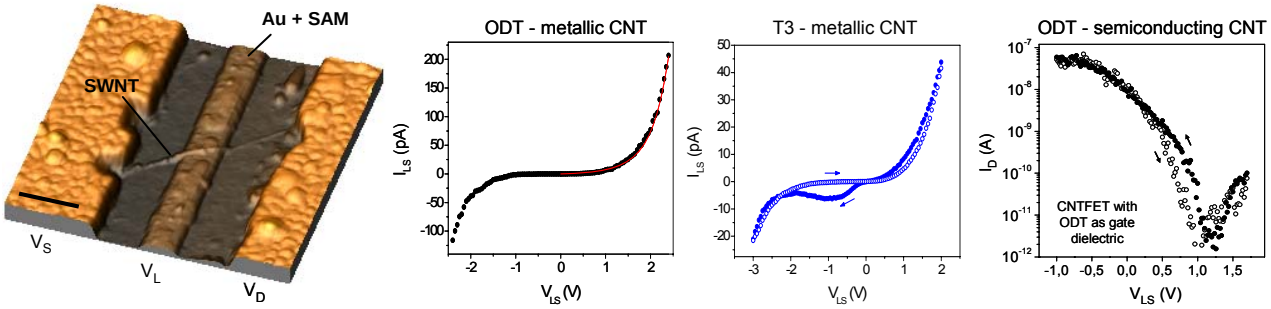

***Figure 1** : **a)** AFM picture of a CNT-SAM device (scale bar 200 nm). **b)** I(V) characteristic of a metallic nanotube-ODT SAM-gold junction and associated Simmons fit (red line). **c)** I(V) characteristic of a metallic nanotube-T3 SAM-gold junction, forward and backward sweeps. **d)** ODT-SAM CNFET: $I_D(V_{LS})$ characteristic through the tube in both sweep directions showing the reduced hysteresis.*

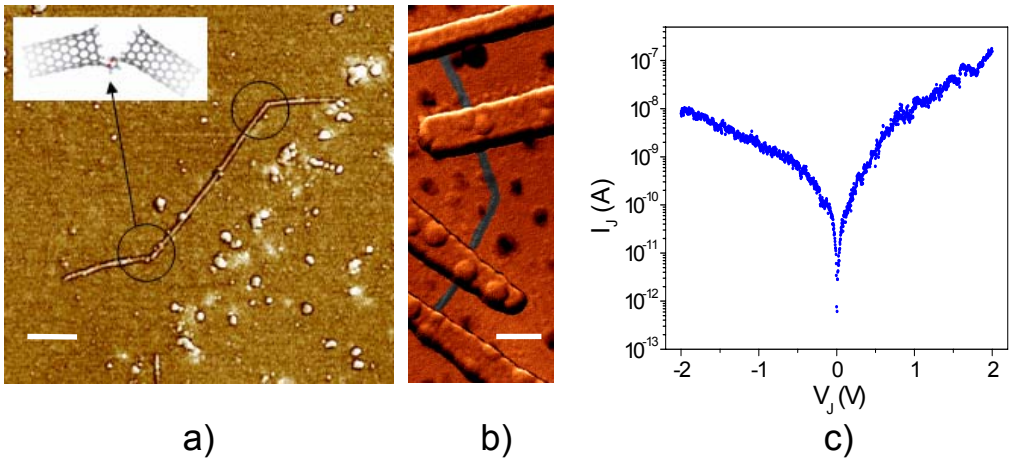

***Figure 2** : **a)** AFM picture of multiple CNT-EDA-CNT junctions (scale bar is 200 nm). **b)** AFM picture of a connected CNT-EDA-CNT junction (the tubes have been colored for clarity – scale bar is 200 nm). **c)** $I_J(V_J)$ characteristic through the CNT-EDA-CNT junction*

PHTHTALOCYANINE DERIVATIVES ON (111) NOBLE METAL SURFACES – MULTIPHASE BEHAVIOR AND CAPABILITY OF HOSTING OTHER MOLECULES

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Symmetrically substituted phthalocyanines (Pcs) with eight peripheral di-(tert-butyl)phenoxy (DTPO) groups[1] self-organize on (111) noble metal surfaces into various assembly structures (Fig. 1a). The rotational degrees of freedom allow all the DTPO substituents to be arranged above the plane of the Pc core, forming a bowl-like structure, which in turn enables the interaction of the Pc core with the metal substrate. The structural phases can coexist due to a significant retardation of the thermodynamic optimization of the conformations, caused by the proximity of the Pc core to the metal substrate together with the steric entanglement between neighbouring DTPO substituents.[2] Moreover, a substitution of a dipyrido[3,2-f:2',3'-h]quinoxaline (DPQ) in place of two adjacent DTPO groups results in an asymmetric structure of the Pc derivative.[1] Such a variation induces even more assembly structures by further expanding the plethora of conformational possibilities. (Fig. 1b)

The specific conformation with the DTPO groups arranged above the plane of the Pc core predetermines such assemblies to serve as hosts accommodating other guest molecules. This can be of great importance for the construction of possible future applications by the bottom-up approach. As an example, C_{60} molecules, upon deposition on the densest ordered layer of the symmetric Pc derivatives, bind to two clearly distinguishable sites (Fig. 2), exhibiting different morphologic and electronic properties. The electronic structure of the adsorbed C_{60} molecules, revealed by tunnelling spectroscopy investigations, are in good agreement with the proposed model of the adsorption and with the expected charge transfer in the Pc- C_{60} complex.

All measurements were carried out at various temperatures, with a scanning tunneling microscope housed in an ultra high vacuum system, consisting of different chambers for sample preparation and characterization.

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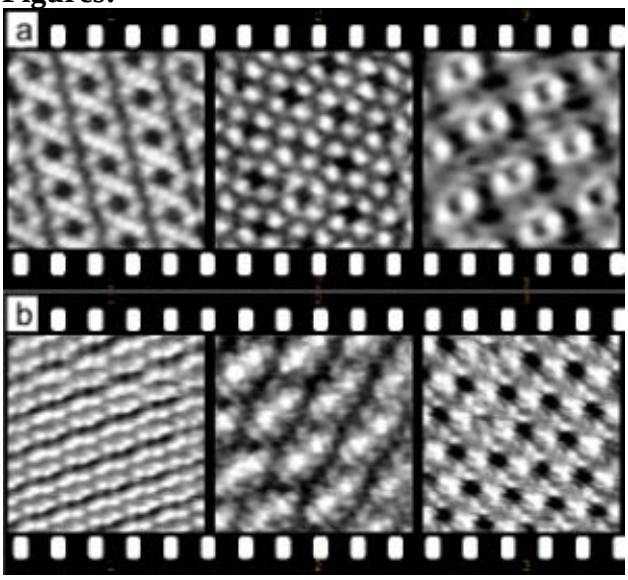

Figure 1 . STM images (10 x 10 nm^2) of Pc derivatives self-organized on (111) noble metal surfaces. a) Various assemblies of the symmetric DTPO-Pc b) Various assemblies of the asymmetric DTPO-DPQ-Pc

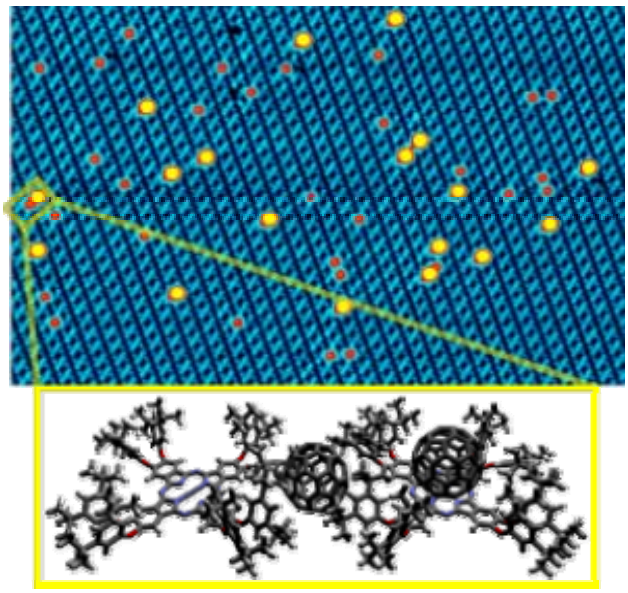

Figure 2. Top: STM image (80 x 50 nm^2) of C_{60} molecules adsorbed onto the densest ordered layer of the symmetric Pc derivatives. Bottom: 3D model of the molecules marked by the yellow rectangle in the STM image.

TEMPERATURE AND VOLTAGE TMR DEPENDENCIES FOR HIGH PERFORMANCE MAGNETIC JUNCTIONS

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Recent spintronics magnetic junctions with ultra-thin MgO barriers attained as high tunnel magnetoresistance (TMR) as ~600% [1] at room temperature which makes them ideal for non-volatile high-density memories. Amazingly, TMR even reached ~1200% at low temperatures, but it can be also sensibly degraded with voltage [2], hence a detailed study of its temperature and voltage dependencies is fundamental for future device applications.

For nano-size junctions, a fully quantum description is required to take a proper account of specific coherency effects. The commonly used Green's functions in the Kubo formula framework [3] are not easy enough to include the electrical field (E) effect in an analytic way [4]. Here a tight-binding dynamics [5] is generalized to describe this effect on the spin-dependent quantum transmission for magnetic junctions with ultrathin non-magnetic spacers. Starting from the n-site atomic chain with on-site energies ε_0, locally shifted under E, and nearest-neighbour hopping amplitudes t, we write down the Hamiltonian in terms of local Fermi operators $\hat{c}_i$ and $\hat{c}_i^{\dagger}$ as:

$$H = \sum_{i=1}^{n}(\varepsilon_0 - iE)\hat{c}_i^{\dagger}\hat{c}_i + t\sum_{i=1}^{n-1}\left(\hat{c}_i^{\dagger}\hat{c}_{i+1} + \hat{c}_{i+1}^{\dagger}\hat{c}_i\right), \qquad (1)$$

and obtain the local (non-normalized) amplitudes for the eigen-state with energy ε as:

$$p_i(x) = \xi^i \sum_{j=0}^{[i/2]} C_j^{i-j}(-\xi^2)^{-j}(j + x/\xi)_{i-2j}, \qquad (2)$$

where $x = (\varepsilon - \varepsilon_0)/t$, $\xi = E/t$, C_m^n is the binomial coefficient, $[u]$ is the entire part of u, and $(u)_n = u(u + 1)\ldots(u + n - 1)$ is the Pochhammer symbol. Next this finite chain (called the gate, g) is attached to semi-infinite chains (source, s, and drain, d), with respective on-site energies ε_s, ε_d and hopping parameters (see Fig. 1, supposing that the electrical voltage drop between the sites in s, d elements is negligible), to generate a collective electronic state with energy ε. This defines the 1D transmission coefficient (spin-dependent through the Stoner shifts in ε_s, ε_d) for given electrical field as $T(\varepsilon) = -2i(t_{sg}t_d|\gamma_s|\sin q_s)/(t_s t_{gd} D)$ where the characteristic denominator:

$$D = \varphi\left[p_n(x_g) - p_{n-1}(x_g + \xi)\gamma_s\right] - p_{n-1}(x_g)\gamma_d + p_{n-2}(x_g + \xi)\gamma_s\gamma_d, \qquad (3)$$

with $q_i = \arccos[(\varepsilon - \varepsilon_i)/2t_i]$, $\varphi = 1 + (n+1)\xi e^{iq_d}$, $\gamma_i = e^{iq_i} t_{gi}^2/(t_g t_i)$ for $i = s$, d and $x_g = (\varepsilon - \varepsilon_g)/t_g$, allows for up to n resonance spikes in the Landauer conductance formula. Its 3D generalized and temperature dependent form reads as

$$G = (e^2/h) \sum_{\boldsymbol{k}} f_s(\boldsymbol{k})[1 - f_d(\boldsymbol{k})]|T(\boldsymbol{k})|^2,$$

with the Fermi function $f_i(\boldsymbol{k}) = \{\exp[\beta(\varepsilon_i(\boldsymbol{k}) - \mu_i)] + 1\}^{-1}$ for a dispersion law $\varepsilon_i(\boldsymbol{k})$, chemical potential μ_i ($i = s,d$) and inverse temperature β. The calculated behaviour for a characteristic choice of model parameters (Fig. 2) shows an intriguing possibility of further enhancement of TMR efficiency by a proper choice of applied voltage on the quantum coherent device, as an alternative/addition to the previously suggested adjustment of its elemental composition [5]. Moreover, this voltage effect proves to be temperature stable, permitting to compensate the common temperature degradation of TMR.

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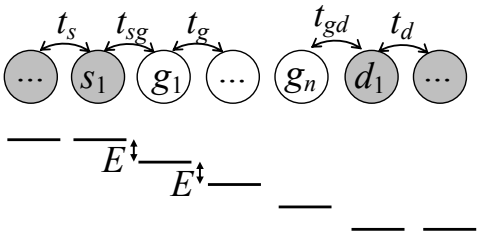

Fig.1 – On-site amplitudes, hopping parameters, and spatial distribution of electrical voltage in the composite chain system.

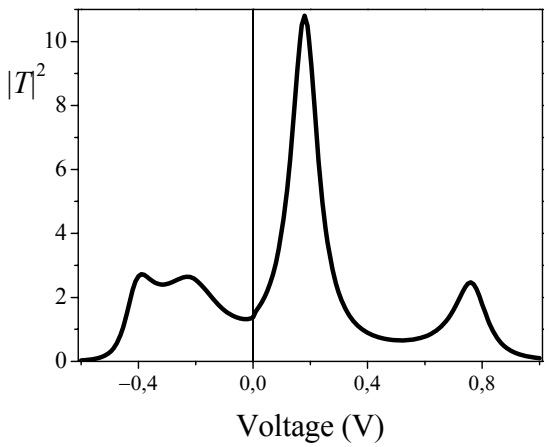

Fig.2 – 1D transmission coefficient $|T|^2$ (at zero temperature) of the composite chain system with parameters $\varepsilon_s = -0.5$eV, $\varepsilon_d = -1.0$ eV, $\varepsilon_g = 0.2$ eV (ε_F=0), $t_s = t_d = 0.5$ eV, $t_g = t_{sg} = t_{gd} = 0.25$ eV and $N_g = 4$ (number of planes) in function of the bias voltage.

TEMPERATURE DEPENDENT TRANSPORT PROPERTIES OF MgO-BASED ULTRA-THIN MAGNETIC TUNNEL JUNCTIONS: EXPERIMENT AND MODELING.

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Magnetic tunnel junctions (MTJs), constituted by two ferromagnetic (FM) layers separated by an insulating barrier, are currently used as magnetic sensors in high density recording media. The characteristics of the tunnel junctions implemented in read heads include a low resistance-area product ($R \times A$), to achieve a high readout speed, and a high enough sensitivity to read the ever smaller magnetic bit. To achieve the desired $R \times A$-values, the thickness of the insulating barrier is decreased to less than one nanometer, towards a few atomic planes thick. This leads to the possible existence of metallic paths across the insulating barrier (pinholes), with consequences in device reproducibility, performance and reliability. Furthermore, the presence of pinholes can have important impact on the MTJ-spin transfer driven magnetization dynamics, or on the MTJ-magnetoresistance sign.

Recently, tunnel junctions with crystalline MgO(001) barriers displaying very large tunnel magnetoresistive (TMR) ratios were successfully fabricated, opening new opportunities to develop read heads for ultrahigh density hard drives. The large TMR ratio of crystalline MgO tunnel junctions arises from the different symmetry-related decay rates of the Bloch waves for majority and minority spin channels. For sensor applications, MTJs with tunnel magnetoresistance above 50% and $R \times A$ as low as 0.4 $\Omega\mu m^2$ were recently obtained using thin MgO barriers.[1] However, a significative TMR-decrease is usually observed with decreasing MgO thickness,[2] showing the importance of studying the impact of pinholes on the magneto-transport properties of ultra-thin magnetic tunnel junctions.

To probe the absence of pinholes in MTJs one usually uses the three applicable Rowell criteria. However, both the exponential dependence of resistance with insulator thickness and the non-linear current-voltage characteristics were found to be non-reliable even in high resistance tunnel junctions ($R \times A \geq 1$ kΩm^2).[3] On the other hand, the third criteria [the weak insulating-like temperature dependence of the electrical resistance ($dR/dT<0$)], although insensitive to the presence of few or small pinholes in low resistance MTJs (≤ 10 $\Omega\mu m^2$),[4] can be used to probe if sizeable pinholes are present in the barrier.[5]

Here we study the temperature dependence (300-20 K) of the transport properties of low resistance magnetic tunnel junctions with an ultra-thin MgO barrier (7.5 Å). Our samples display $R \times A \geq 40$ $\Omega\mu m^2$ and TMR ~ 60-75% at room temperature. Temperature dependent electrical resistance measurements [R(T)] allowed us to observe different behaviors depending on the MTJ-magnetic state. The studied samples showed positive dR/dT for the parallel (P) state (Fig. 1), indicating a metallic-like behavior, so that pinholes are already present in the barrier. However, in the antiparallel (AP) state, the R(T) curves exhibit a mixed character, with dR/dT negative at sufficiently high temperatures but changing to positive at low temperatures (Figs. 1 and 2b). These results show an interesting competition between tunnel and metallic transport in the studied samples.

In order to understand this transport behavior, we propose a simple model of two conducting channels, metallic and tunnel, acting in parallel. We assume a linear temperature variation of the electrical resistance for both conducting channels, as observed experimentally over a broad temperature range. The model also takes into account the experimentally observed dependence of the linear coefficients on the MTJ-magnetic state (parallel and antiparallel). According to the model, the sign of the *dR/dT* derivative does not illustrate the dominant conductance mechanism and the crossover temperature (T^*) at which *dR/dT* changes sign in the

AP state depends strongly on the linear temperature coefficients. Fittings performed to the experimental *R*(*T*) data, using the developed model, reproduce the data quite well, illustrating the validity of the model.

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Figures:

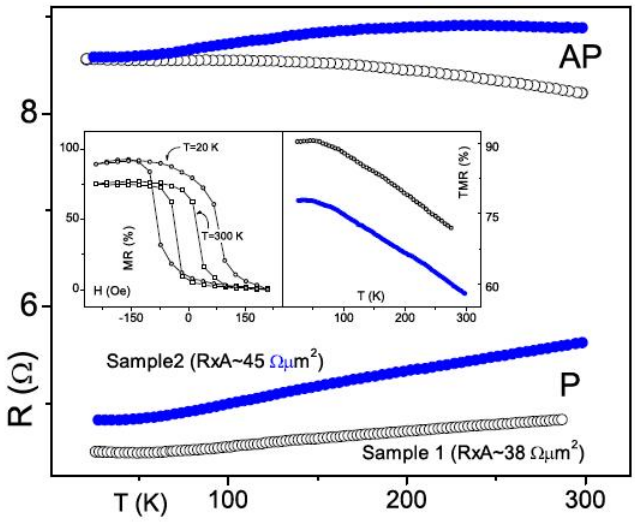

Fig. 1: Temperature dependence of the electrical resistance of samples 1 and 2 in the parallel and antiparallel states. Insets: Room and low temperature magnetoresistance cycles (sample 1) and MR-temperature dependence.

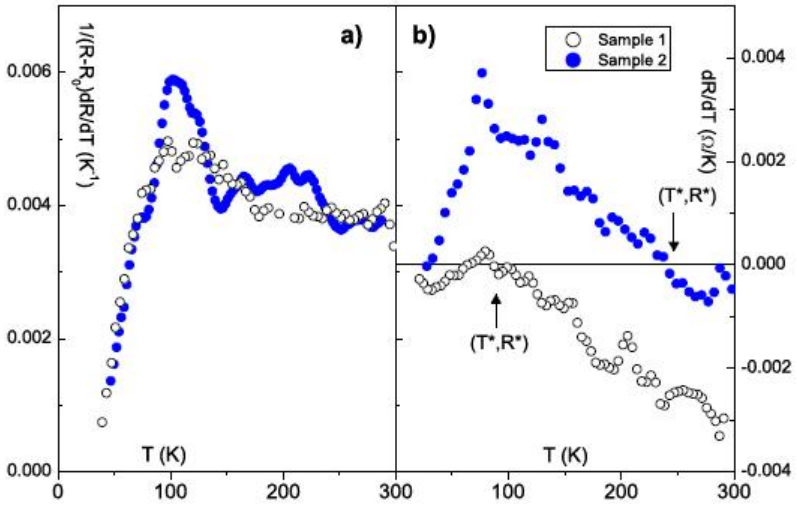

Fig. 2: Temperature derivative of (a) the normalized electrical resistance in the parallel state and (b) the electrical resistance in the antiparallel state.

ORAL CONTRIBUTIONS

"NanoScience in Asturias" Parallel Session

AN OLD MATERIAL IN THE NANOWORLD: ORGANIC-INORGANIC HYBRID NANOTUBES BASED ON γ- TITANIUM PHOSPHATE LAYERED STRUCTURE

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Since the great success of carbon nanotubes in 1991, interest in low-dimensional nanomaterials has fuelled a spectacular and unusual activity [1]. Nowadays the nanotubes are not only made of carbon but also of inorganic materials [2], many of which are related with previously well-known layered structures. On the other hand, although only two crystalline structure of layered Ti-phosphate are found, α-$Ti(HPO_4)_2 \cdot H_2O$ and γ-$Ti(PO_4)(H_2PO_4) \cdot 2H_2O$, many derivatives as partially and completely substituted ion-exchanged forms and intercalated compounds have been reported [3]. The layered γ-titanium phosphate is an acid solid amenable to intercalation processes of basic species (see Fig. 1). In fact, more than a decade ago, we described a mechanism of intercalation of *n*-alkylamines in γ-titanium phosphate, showing that most of the P-OH groups have an important tendency to interact with amine groups of the guest molecules [4]. In this way, compounds with formula γ-$Ti(PO_4)(H_2PO_4) \cdot 1.3C_nH_{2n+1}NH_2 \cdot H_2O$ (with n ranking from 1 to 6) can be synthesized.

In this contribution we report on the synthesis of organic-inorganic hybrid nanotubes based on the γ-titanium phosphate structure spaced with trialkylamines. These materials have been prepared by using microemulsion-mediated solvothermal and microwave-assisted methods. The interlayer distance in the inorganic sheets of the nanotube can be controlled by both the alkyl chain length and the amount of the amine template. All nanotubes obtained are open-ended. Cross-sectional TEM images (see Fig. 2) of these nanotubular phases show that the tubes are made up of concentric cylinders, i.e., layers that fold and close within themselves. The possible reason for having this morphology seems to be related to the combination of two factors: *i)* the interaction between the nitrogen of trialkylamine molecules and the hydrogen belonging to inorganic skeleton that seeks to be maximum, and *ii)* the pseudo-conical geometry of the trialkylamine molecules that limits the number of accessible acid centers (see Fig. 3). In this way, the number of H-N links will depend on the length of the alkyl chain.

Further studies using synchrotron powder x-ray diffraction in tandem with high-resolution NMR spectroscopy will provide information on the local environment in the inorganic-organic link for the formation of these new γ-titanium phosphate based nanotubes.

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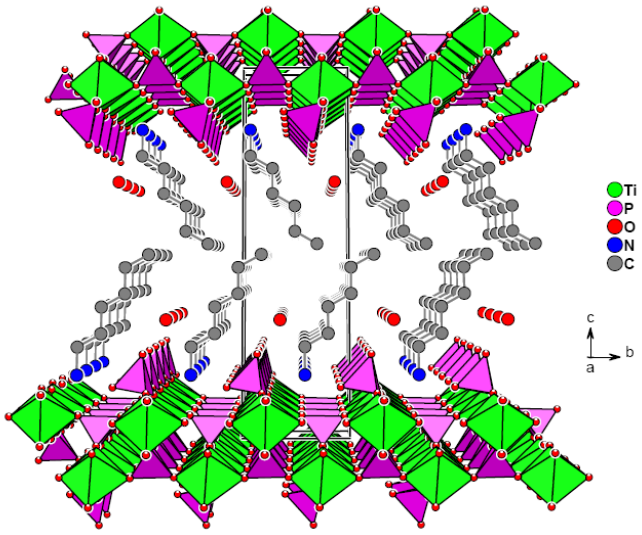

Fig. 1.- Schematic view of the γ-$Ti(PO_4)(H_2PO_4)\cdot C_6H_{13}NH_2\cdot H_2O$ structure.

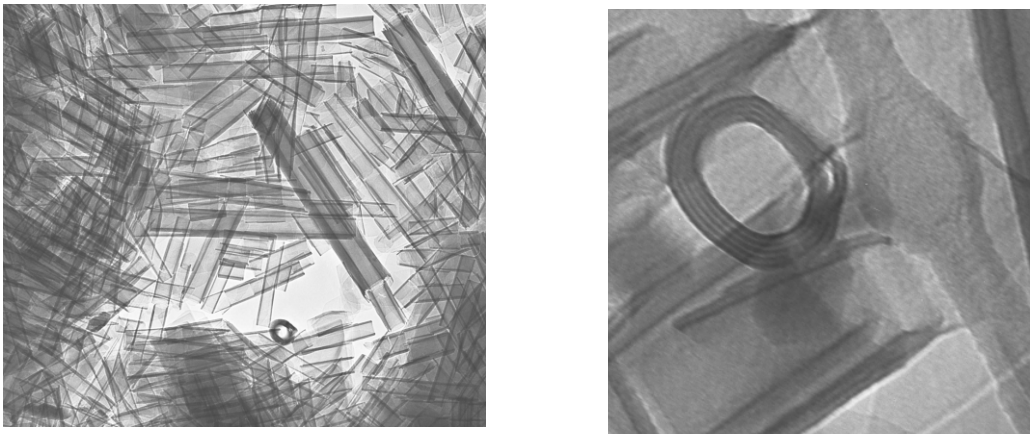

Fig.2.- TEM images of the trialkylamine/γ-titaniumphosphate hybrid nanotubes showing concentric cylinder-like scrolls.

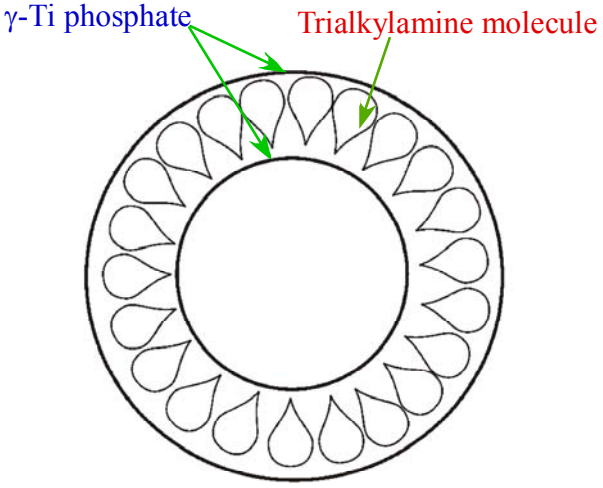

Fig. 3.- Model of curved lattice for trialkylamine/γ-titaniumphosphate hybrid nanotubes.

CHEMICAL ANALYSIS AND CHARACTERIZATION OF NANOLAYERS ON CONDUCTING AND INSULATING SUBSTRATES BY PULSED RADIOFREQUENCY GLOW DISCHARGE TIME OF FLIGHT MASS SPECTROMETRY

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Direct surface and depth profiling chemical analysis of multilayer materials demands a "multi-dimensional" knowledge, including simultaneous elemental and molecular information to characterize the new materials. Pulsed radiofrequency glow discharges (pulsed rf-GDs) with detection by time of flight mass spectrometry (TOFMS) allow to obtain direct chemical information from a great variety of materials in a fast and easy way. A glow discharge is a low pressure plasma produced in an inert atmosphere due to a voltage applied between two electrodes, being the cathode the sample to analyze. Ions and fast atoms impinge on the cathode producing its erosion. The atoms and clusters sputtered from the surface of the sample are diffused into the plasma where they are excited and ionized. If radiofrequency power (instead of direct current) is applied to the electrodes, the discharge can be ignited even when the cathode is a non conductor. Therefore, the application field of rf-GDs covers a wide variety of materials (metals, oxides, glasses, polymers…). On the other hand, the temporal distribution of the applied power in pulsed rf-GDs produces three main regimes in the discharge (prepeak, plateau and afterpeak) with different mechanisms of ionization. As a result it is obtained a real possibility of measuring elemental and molecular ions at the different regimes when coupling the GD ion source to a fast mass spectrometer such as the time-of-flight mass spectrometer (TOFMS) [1].

Therefore, development of new instrumentation based on pulsed (rf)-GD-TOFMS is being investigated in the frame of an European Project [2]. In this work, it is evaluated the capability of a pulsed rf-GD-TOFMS prototype to provide depth profiling analysis of thin and ultra-thin layers deposited on different types of substrates. This study covers different types of layers and substrates: a Cr delta layer of 2 nm in an alumina layer on Al, thin B layer on Si or several ultra-thin layers deposited on glass substrates. Also, different polymers like Polymethyl methacrilate (PMMA), polystyrene PS, polyethylene terephthalate-co-isophtalate (PETí) deposited on silicon wafers are studied using the pulsed rf-GD-TOFMS and the molecular information that can be extracted from the qualitative profiles is investigated.

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DUAL SENSOR BASED ON GOLD NANOSTRUCTURED SCREEN-PRINTED CARBON ELECTRODES FOR THE DETECTION OF PROSTATE SPECIFIC ANTIGEN (PSA)

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In this work an electrochemical immunosensor for the simultaneous detection of free and total Prostatic Specific Antigen (PSA) is developed, using gold nanostructured screen-printed carbon electrodes (SPCEs) as transducers (Figure 1).

Nanostructuration of the electrodic surface is carried out following an electrochemical method which consists in the *in situ* electrodeposition of gold at a constant current for an adequate time. The surface of the gold nanostructured SPCEs obtained is the one shown in Figure 2.

The presence of gold nanoparticles improves the adsorption of proteins on the electrode surface. Thus, this advantage is used to design the immunosensor for detection of PSA following a sandwich format assay that is carried out on the electrode surface.

First of all, an anti-PSA antibody is adsorbed on the gold nanostructured SPCEs, followed by a blocking step with casein; the sensing phase obtained in this way is very stable and reproducible. After that, the sandwich format assay is carried out using the PSA or sample, a biotinylated anti-PSA antibody and streptavidin labeled with alkaline phosphatase. The detection is performed using an electrochemical substrate that consists in a mixture of 3-indoxyl phosphate and silver ions. After the enzymatic reaction, the enzymatically reduced silver is detected by anodic stripping voltammetry [1].

The use of gold nanostructured electrodic surfaces as transducers gives rise to very sensitive immunosensor devices for the simultaneous detection of both free PSA and total PSA at low levels of concentration (0.5 ng/mL - 10 ng/mL), within the clinical significant range for diagnosing prostatic cancer.

This work has been supported by project PC06-004 from the Consejería de Educación y Ciencia del Principado de Asturias.

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Figures:

Figure 1

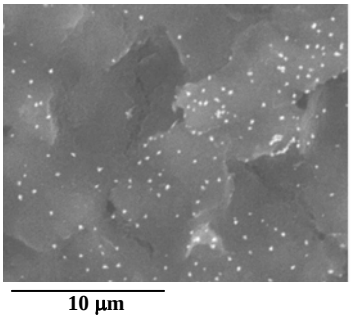

Figure 2

INTERACTION OF FUNCTIONALIZED GOLD NANOPARTICLES WITH METAL IONS AND AMINE COMPOUNDS: DEVELOPMENT OF SELECTIVE ANALYTICAL METHODS.

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Gold nanoparticles have attracted a great deal of attention due to their size dependent physical and chemical characteristics. As a result, a variety of optical methods for different analytes using gold nanoparticles have been developed for sensitive determinations, such as colorimetric detection [1], surface plasmon resonance analysis [2], fluoresence [3-5] and scattering-based sensing [6]. This presentation deals with the interaction of functionalized gold nanoparticles with metal ions in order to tailor their optical properties for selective recognition of amine compounds. The model metal ions selected in this study were Eu^{3+} and Cu^{2+} and two model amine compounds were also considered: lysine (amino acid) and histamine (biogenic amine).

Recent experiments on the resonance light scattering properties of Eu^{3+} in gold colloid were made by A.Jian et al [7]. These authors reported the effects of gold nanoparticles on the fluorescence and resonance light scattering properties of europium ions and suggested an efficient energy transfer from the nanoparticles surface plasmon resonance to the metal ions. In this presentation, we report on the fundamental aspects of the role of europium ions on the resonance light scattering (RLS) properties of gold nanoparticles in solution phase. Our proposal is conceptually different from the above mentioned study as ours relies on gold nanoparticles functionalized with 11-mercaptoundecanoic acid (MUA) and the cooperative binding of europium ions and lysine to enhance the RLS properties of MUA-functionalized gold nanoparticles (Figure 1). Results demonstrated that upon addition of lysine to the MUA-GNPs-Eu(III) system, a hyper-Rayleigh scattering emission was observed, thus providing an inherently sensitive method for lysine determination. Finally, the analytical potential of the system and the mechanism for RLS enhancement is outlined.

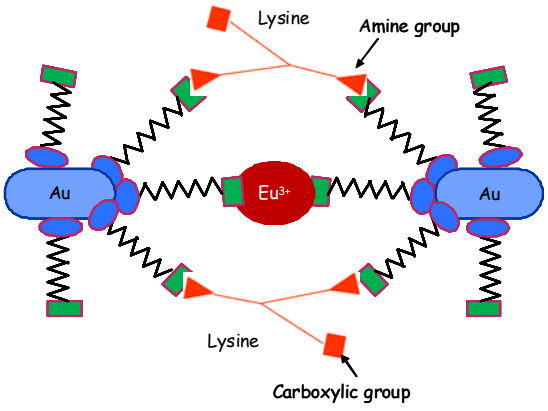

Figure 1. Schematic for MUA-GNPs resonance light scattering plasmon enhancement model through cooperative binding with europium and lysine [8]

On the other hand, addition of Cu^{2+} ions to the Au-MUA resulted in a red-shift in the absorption spectrum of gold-nanoparticles. The spectral changes observed may be explained on the basis of interplasmon coupling phenomena [9], suggesting that upon addition of the metal ions nanoparticles were brought into proximity. On the other hand, experimental data demonstrated that addition of histamine to the MUA-GNPs-Cu^{2+} system resulted in an enhanced absorbance at 600 nm of the histamine-Cu^{2+} complex. Other structurally related amines (cadaverine, putrescine, tyramine) commonly found in foods were assayed for selectivity and the system was applied to real sample food analysis (the content of biogenic amines may be indicator for freshness of fish raw material and thereby serve as a quality criterion for fish meal).

In conclusion: although differentiation between similar analytes is hard to achieve, small differences in chemical structure may make important differences in chemical action. In the systems described here metal ions and amine-compounds binding interactions, working in cooperation and coupled to gold nanoparticles, allowed for the amine-compounds discrimination from other structurally related through the enhanced RLS of gold nanoparticles and/or enhanced absorption.

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NICKEL NANOPARTICLES DEPOSITED INTO AN ACTIVATED POROUS CARBON: SYNTHESIS, MICROSTRUCTURE AND MAGNETIC PROPERTIES

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Activated carbons (AC) are being extensively used for adsorption and catalytic purposes, mainly due to their outstanding efficiency together with a wide availability and low cost [1]. Frequently, they are exploited in liquid phase for a number of applications, such as, catalyst or catalytic supports, to remove contaminants or for recovering specific products. On the other hand, if the selective manipulation of valuable substances associated with AC is pursued, magnetic separation could be the most effective strategy for achieving this task. However, the commonly used magnetic adsorbents have poor porous characteristics, and the conventional synthesis procedures are too complex and expensive for large production compared with those of AC porous materials [2].

In this contribution, we present a new and easy-to-follow synthesis procedure to prepare magnetically separable porous carbons [3,4]. The starting material is a commercial and low-cost AC with a high pore volume (1.47 cm^3g^{-1}), which after being impregnated with an aqueous solution containing sucrose and nickel nitrate, and a subsequent heat-treatment, results in the formation of Nickel nanoparticles dispersed along the porous AC. The addition of sucrose favours protection against acid corrosion. The final amount of Ni in the sample is around 12 wt. %. We will also present and discuss the correlation between microstructure, morphology and magnetic response of these Ni-AC nanoparticles.

The room temperature x-ray powder diffraction pattern can be indexed using the Bragg reflections of a face centred cubic crystal structure with a lattice parameter close to that of bulk Nickel. Transmission electronic microscopy (TEM) shows that the Nickel nanoparticles are quasi-spherical in shape and uniformly dispersed throughout the carbon matrix, with a rather broad crystalline size distribution (diameter values in the range 7 to 25 nm, see fig. 1) and a mean diameter of 16(1) nm.

The magnetic properties of the Ni-AC sample have been investigated using a Vibrating Sample Magnetometer, through the measure of both the temperature (from 2 K to 300 K) and applied magnetic field (up to 1.5 T) dependence of magnetization. The saturation magnetization at room temperature is around 4 Am^2kg^{-1}, high enough to manipulate the sample using conventional magnets. Magnetization vs. applied magnetic field cycles, M(H), show hysteresis for temperatures below 150 K, with a coercive field $H_c \approx 40$ mT at T = 2 K, while the reversible M(H) behaviour at 300 K suggests that the nanoparticles are in superparamagnetic (SPM) regime (see fig. 2). From the measured M(H) cycles at different temperatures, we have obtained the temperature evolution of H_c (see fig. 3). The inset of figure 3 shows the almost linear H_c vs $T^{1/2}$ behaviour, which allows us to estimate a value of the blocking temperature, $T_B \approx 62$ K, which can be associated with the nanoparticles of 16 nm in diameter.

On the other hand, zero-field-cooling magnetization vs. temperature, $M_{ZFC}(T)$, curve, measured under a low applied magnetic field ($\mu_0 H = 1$ mT), shows a broad maximum around 100 K, with a rapid increase of the magnetization from nearly vanishing values at 10 K. Besides that, the $M_{FC}(T)$ (field cooling) and $M_{ZFC}(T)$ curves does not overlap up to temperatures above 200 K.

These experimental findings suggest that the blocking temperature is not unique for the whole system, as it can be expected due to the broad crystalline particle-size distribution. In other words, the smaller particles (7 nm) become superparamagnetic at temperatures slightly above 10 K, while the largest ones (25 nm) have T_B values close to room temperature. The fit of the $M_{ZFC}(T)$ curves using the Stoner-Wohlfarth model allows us to estimate a value for the effective magnetic anisotropy constant, which is double to that of the Ni bulk, in good agreement with previously reported data in other Ni-nanoparticle systems [5]. Finally, this easy-synthesis route for preparing Ni-AC nanoparticles with the possibility of controlling the nanoparticle size seems to be the most challenging issue for tailoring intrinsic properties such as the effective magnetic anisotropy.

The financial support for this research work provided by the Spanish MEC (MAT2005-00262 and MAT2005-06806-C04-01) is acknowledged.

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Figures:

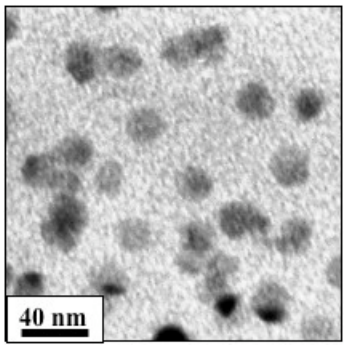

Figure 1. TEM image of the Ni-AC sample

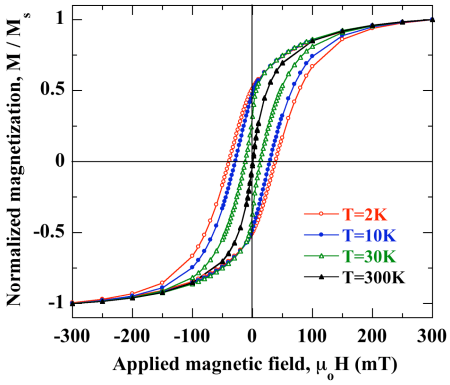

Figure 2. M(H) cycles measured at four selected temperatures

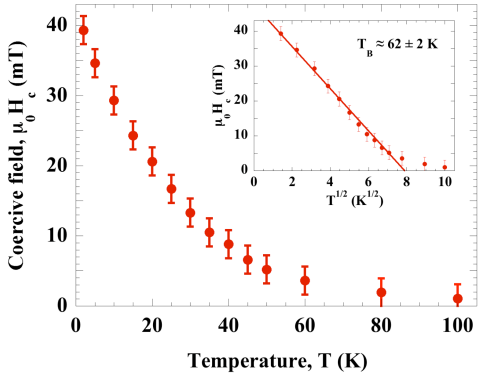

Figure 3. Hc vs. T and $T^{1/2}$ (inset) behaviours of the Ni-AC sample.

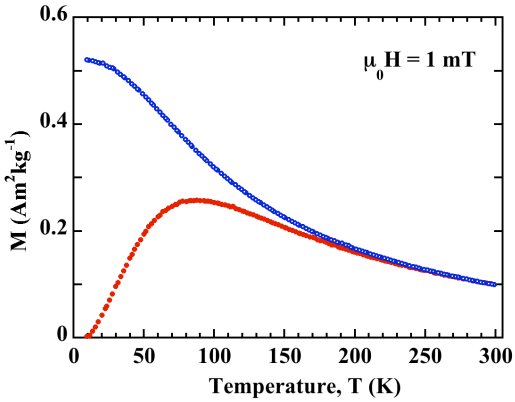

Figure 4. ZFC and FC magnetization vs. temperature curves.

ONSET OF POSITIVE EXCHANGE BIAS IN NANOSTRUCTURED THIN FILMS

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Exchange bias (EB) phenomenon appears in ferromagnetic/antiferromagnetic (FM/AF) materials in intimate contact and below the Néel temperature of the AF (T_N) [1,2]. The exchange interaction between FM and AF spins at the interface leads to a shift of the hysteresis loop along the magnetic field axis known as exchange bias field (H_{EB}).

The sign of H_{EB} depends on the magnetic history of the cooling process across T_N. Most of the EB systems exhibit only negative H_{EB} at positive cooling fields (H_{FC}), independently of the magnitude of H_{FC}. However, there are few magnetic systems, like FeF_2/FM bilayers, that show positive H_{EB} at high H_{FC}. These systems also show negative H_{EB} at low H_{FC}, as regular EB films. The transition between negative and positive EB regimes depends on the crystalline quality of the AF. In epitaxial FeF_2 it has been observed that it occurs through a *bidomain* state [3], where AF domains with opposite pinned uncompensated moments coexist below T_N. This lateral structure yields double hysteresis loops (DHL), i.e. two subloops with the same absolute value of H_{EB} and opposite sign [4]. The ratio between both positive and negative subloops depends on the magnitude of H_{FC} [3].

In this work we report about the minimum H_{FC} necessary for fully positive EB in both patterned and unpatterned FeF_2/Ni bilayers. The onset of DHL and positive EB was investigated in FM dotted magnetic nanostructures as function of the dot size and compared to the value of continuous films. Fig. 1 shows a cross section sketch of patterned AF/FM bilayers (a) and an atomic force microscopy (AFM) image of the array (b). Magneto-optical measurements of hysteresis loops demonstrate that the smaller the dot size the lower the magnitude of H_{FC} necessary for positive H_{EB}. This effect has been related to the correlation of FM and AF domain sizes, which can qualitatively explains the results.

Work supported by US-DOE and European Marie-Curie-OIF.

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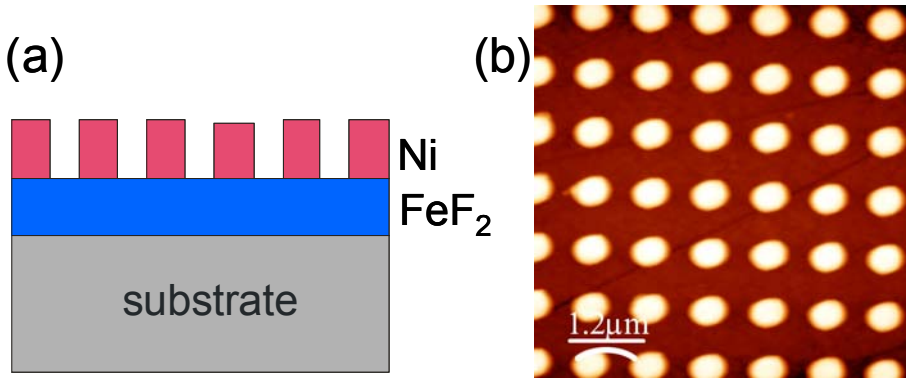

Fig. 1. (a) Cross section sketch of FM dotted FeF_2/Ni bilayers. (b) AFM image of FeF_2/Ni nanostructures.

HARDENING EFFECT OF METAL NANOPARTICLES IN CERAMIC-MATRIX COMPOSITES

J.S. Moya, T. Rodriguez-Suarez, S. Lopez-Esteban, C. Pecharroman , L.A. Diaz, R. Torrecillas

The design of new materials with hardness comparable to diamond is an ongoing challenge for scientists and engineers. In the present investigation, enhanced values of hardness have been found in different ceramic-matrix composites reinforced with metal nanoparticles. The hardness increase has been justified by a novel model which takes into account the *Hall–Petch* effect and the mean particle size according to the Percolation theory. It has been found that this model can be successfully applied to different superhard composites. As the obtained densified composites show improved mechanical properties, they can be proposed as alternative materials for cutting and shaping tools, as well as for bearings and other typical applications of high performance materials. The results obtained clearly point out that ceramic-matrix composites reinforced with metal nanoparticles can favourably compete with covalent diamond-like materials in both cost and wear performance.

NANOSTRUCTURED MATERIALS: SYNTHESIS, STRUCTURAL AND MAGNETIC PROPERTIES

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The synthesis of artificially structured solid-state materials with nanometer-sized geometries and different entities inside them are actually strongly investigated because of the exciting novel quantum size physical effects displayed by these systems and, at the same time, due to its increasing interest in the miniaturization of computational, electro-optical, magnetoelectronic and sensing devices [1]. These novelty nanostructured composites become in promising candidates for many applications in a broad range of scientific and technological areas, such as functionalized arrays for magnetic sensors, ultrahigh density data storage media or spin-based electronic devices, among other applications as for biotechnology, etc.

In this work we pay special emphasis on the control of synthesis parameters leading to different ordering degree for the array symmetry arrangement of the anodic alumina [2], or titania [3], self-assembled nanoporous templates, allowing to fix the nanowires dimensions and inter-wires distances, which also determine the magnetic behavior of highly-ordered metallic nanowires arrays embedded into the nanoporous templates via electrochemical deposition.

Magnetic nanostructured materials in form of nanoparticles or nanowires, with controlled magnetic and magnetocaloric properties can also serve as good candidates for lowering the temperature of nanosized systems [4]. Using simulation techniques we study the entropy change and refrigerant capacity of an assembly of fine magnetic nano-entities as a function of their anisotropy and magnetization, key-parameters of the magnetic behavior of the system. We focus our attention on the anisotropy energy/dipolar energy ratio and we discuss how the magnetocaloric response of an assembly of magnetic nanoparticles may be tuned by an appropriate choice of the magnetic material composition.

Finally, an overview about the more recently applications based on these novel nanostructured materials will be given.

Spanish funding under research projects MAT2006-13925-C02-01, MAT2007-65420-C02-01, NAN2004-09203-C04-01, NAN2004-09203-C04-03, and NAN2004-09203-C04-04 are acknowledged.

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Topics: Nanostructured and nanoparticle based materials, Low dimensional materials (nanowires, clusters, quantum dots, etc.), Nanomagnetism and Spintronics

ANTIFERROMAGNETIC COUPLING IN AMORPHOUS CoSi/Si MULTILAYERS: CHARACTERIZATION AND MODIFICATION BY ION BEAM NANOPATTERNING

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This work is a summary of the main results obtained during the last years by our research group, in collaboration with groups from the European Synchrotron Radiation Facility (ESRF, Grenoble, France) and Institute Néel (CNRS, Grenoble, France), concerning the characterization and modification of antiferromagnetic coupling in amorphous multilayers through semiconducting spacers.

Antiferromagnetic coupling in magnetic multilayers with few nanometer thick metallic spacers has been intensively studied in the last years so that, nowadays, the fundamental aspects of the physics of the process are well established [1]. In addition, the application of the peculiar electronic transport properties of some of these systems to the design of spin-valve type read heads of hard disks has lead to a big increase in their sensitivity and, consequently, to a marked increase of the areal density of information recorded in commercial hard disk drives [1]. However, the case of the magnetic coupling in multilayers with semiconducting spacers has been much less studied. As a consequence, in spite of the strong technological interest of semiconductor materials like Si, the role of this type of spacers in the magnetic coupling is not fully understood.

Our group has been intensively working in this field during the last years. In particular, we have found that amorphous alloys of Co-Si separated by Si spacer prepared by dc-magnetron co-sputtering align spontaneously in an antiferromagnetic configuration when the Si layer thickness is lower than 8 nm [2]. The magnetic field needed to break this alignment is very low, around 1-2 Oe, as deduced from magneto-optical transverse Kerr effect (MOTKE) loops. The coupling strength has been shown to decrease with temperature, what has been used to discuss the compatibility of different possible mechanisms responsible of the coupling with this temperature dependence [3].

Soft x-ray resonant magnetic scattering (SXRMS) measurements have been carried out to further investigate the details of the reversal process. The low field character of the coupling has been unequivocally shown by the disappearance of half order Bragg peaks when around 1-2 Oe are applied to the multilayers. In addition, a new scattering effect, consisting of the shift of antiferromagnetic reflectivity peaks depending on the photons helicity, has been experimentally observed and theoretically explained [4]. This new result means a contribution to the development of a synchrotron radiation based technique, like SXRMS, which is in continuous evolution.

Finally, a simple method has been developed to tune the strength of the antiferromagnetic coupling. It is based on the use of 1 keV Ar^+ ions to pattern Si(100) substrates with structures

having several tens of nm wide and few nm height, and, subsequently, growing the magnetic multilayers on top of them. The results show that, using this technique, the coupling can be enhanced by about one order of magnitude (see Fig. 1). In particular, a correlation between ion induced surface roughness and antiferromagnetic coupling strength has been found. The results suggest that magnetostatic effects related to non-magnetic inhomogeneities and to the presence of oblique structures in the films may be affecting the coupling mechanisms [5].

In summary, antiferromagnetic coupling has been observed in amorphous multilayers of Co-Si alloys when the thickness of the Si spacers is lower than 8 nm. The coupling strength has been shown to monotonically decrease with temperature. The low switching field of the coupling has been confirmed by using synchrotron radiation to perform SXRMS measurements. Finally, a simple method, based on ion beam nanopatterning of Si substrates, has been developed to tune the coupling, and a correlation between ion induced substrate roughness and antiferromagnetic coupling strength has been observed.

Acknowledgments: Work supported by Spanish CICYT (grants FIS2005-07392 and NAN2004-09087). Technical staff from the ID08 and BM05 beamlines of ESRF is also acknowledged. C. Q. acknowledges support from Spanish Government and European Social fund under "Ramón y Cajal" program.

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Figures:

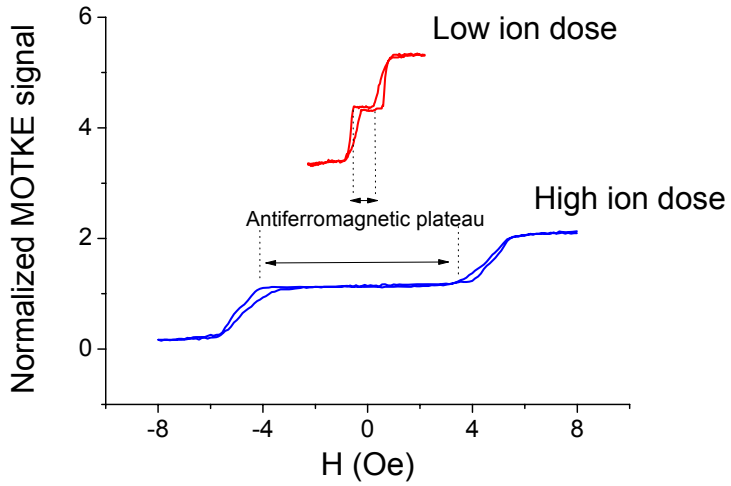

Figure 1. MOTKE signal of two magnetic multilayers grown on Si(100) substrates prepatterned with Ar^+ ion beams leading to rms roughness values of 0.23 nm for the low ion dose case, and to 0.88 nm for the high ion dose case.

CLOSURE STRUCTURES AROUND NON MAGNETIC INCLUSIONS IN UNIAXIAL MAGNETIC THIN FILM: MFM CHARACTERIZATION AND THEORETICAL ANALYSIS

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The study of magnetic nanostructures either in the shape of thin film magnetic nanoelements or of continuous patterned magnetic films has deserved increased attention in recent years, due to their possible applications in the field of high density magnetic recording [1]. One common feature in many of these magnetic nanostructures, such as magnetic nanorings or thin films patterned with arrays of antidots [2], is the existence of non magnetic holes within the magnetic material. Most of the attention has been devoted to the analysis of the different magnetic configurations corresponding to each different kind of structure, such as the transitions between in-plane, axial and vortex states in nanorings, the different kinds of periodic closure domain structures in magnetic films with antidots, or the domain wall pinning characteristics of the patterned holes [2,3]. However, up to now, the simplest problem of a continuous magnetic film with a single non magnetic hole has received little attention, even though it is qualitatively very different from the typical blade domains that appear around non-magnetic inclusions in bulk magnetic material.

In this work we have performed a detailed study by Magnetic Force Microscopy (MFM) of the magnetic configuration around non magnetic holes patterned in Co-based magnetic amorphous thin films by electron beam lithography and etching [4]. The results have been compared with micromagnetic simulations using the OOMMF code [5] as a function of material parameters (saturation magnetization M_S, uniaxial anisotropy K and exchange constant A). Also an analytical model based in the competition of magnetostatic and anisotropy energies has been developed in order to understand the characteristic confinement distance of the magnetic perturbations induced by the hole.

Work supported by Spanish Ministerio de Educación y Ciencia under grants NAN2004-09087 and FIS2005-07392. G. R. R acknowledges financial support from MERG-2004-513625.

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Figures:

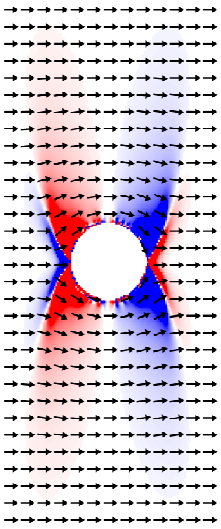

Fig.1 Micromagnetic simulation of the closure structure around a hole in an uniaxial magnetic film composed of two pairs of charged Neel walls emanating from two -1/2 half vortices situated at opposite sides of the hole.

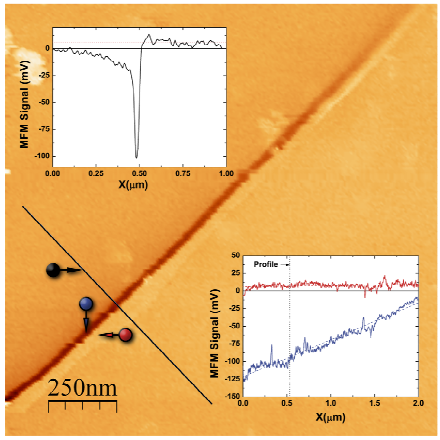

Fig.2 MFM image of a domain wall emanating from a hole in a Co-Zr magnetic film. Top inset is a profile of the MFM contrast across the wall, typical of a charged Neel wall. Bottom inset shows the contrast evolution as a function of distance to the hole, that fades away in agreement with micromagnetic simulations.

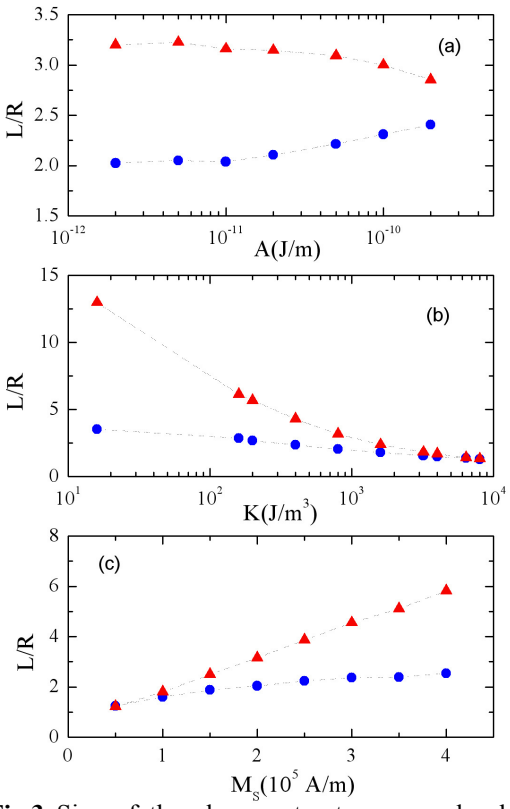

Fig.3 Size of the closure structure around a hole of radius R as a function of (a) exchange, (b) anisotropy, (c) saturation magnetization obtained from micromagnetic simulations. Triangles; along hard axis, circles: along easy axis,

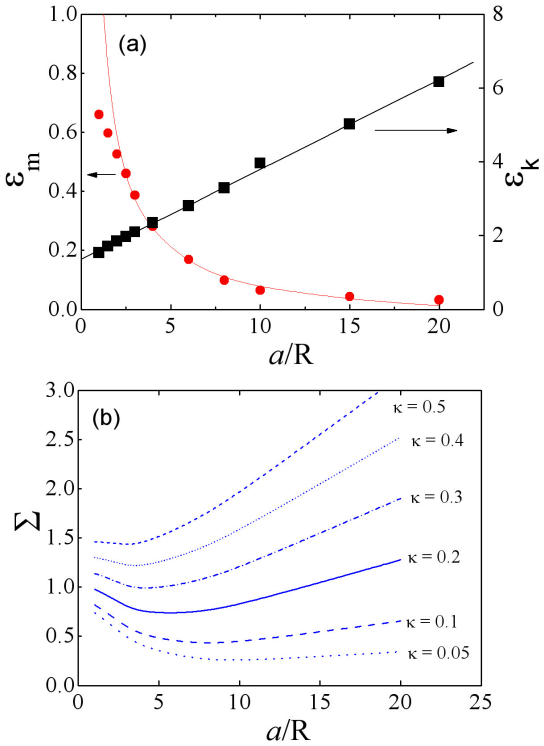

Fig.4 (a) Anisotropy ε_k and magnetostatic ε_m energy of the closure structure around a hole of radius R calculated with an analytical model as a function of wall position (determined by parameter *a*/R). (b) Total system energy $\varepsilon_k + \varepsilon_m$ showing the change in optimum wall position (minima in the curve) as a function of $\kappa = 2K/\mu_0 M_S^2$.

TNT2008
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INDEX

POSTERS

SESSION PA / SESSION PB

Session A (PA) is dedicated to students and **Session B (PB)** to seniors (Doctors)

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Presenting Author		Country	Topic	Poster Title
Alphabetical Order (Session PA / Session PB)				
Adámek	Martin	Czech Republic	Nanostructured and nanoparticle based materials	*Fabrication of impedimetric gas sensor with Au/TiO2 ordered structure on microhot-plate system*
Alahgholipour Omrani	Arash	Iran	Nanostructured and nanoparticle based materials	*Growth Of Silver Nano Particles On Cellulose Fibers using UV Irradiation*
Alarcón Pardo	Alfonso	Spain	Theory and modelling at the nanoscale	*Time-dependent Electron Driven Tunneling Phenomena for multipurpose Terahertz applications: self-consistent computation of conduction and displacement current in mesoscopic systems*
Alija	Alejandro	Spain	Nanomagnetism and Spintronics	*Ratchet effects on domain wall motion in Co-Si amorphous films with arrays of asymmetric holes: experiments and theoretical simulations*
Alonso	Amanda	Spain	NanoChemistry	*Intermatrix synthesis of metal nanoparticles with core-shell or core-sandwich structure for antibacterial aplications*
Alvarez	Pablo	Universidad de Oviedo	Nanostructured and nanoparticle based materials	*Magneto-volume anomalies and Magnetocaloric effect on ball-milling nanostructured Pr2Fe17 compounds*
Alvarez	Jesus	Spain	NanoOptics & NanoPhotonics	*A theoretical comparison of strip and vertical slot-waveguide resonators in silicon nitride for sensing purposes*
Alvarez	Lucia	Spain	Nanostructured and nanoparticle based materials	*Metalorganic nanostructures: 2d- extended structures*
Arroyo-Hernández	María	Spain	Nanobiotechnologies	*Characterization of DNA immobilization and hybridization combining nanomechanical and electrochemical biosensors*
Ashrafi	Ali Reza	Iran	NanoChemistry	*PI Index of Single and Multi-walled Carbon Nanotubes*
Aubéry Torres	Carolina	Spain	Nanostructured and nanoparticle based materials	*Synthesis and Characterization of Mn-Zn Ferrite Magnetic Nanoparticles by the Microemulsion Reaction Method*
Barrett	Claire	Ireland	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Formation and Electrical Interfacing of Nanocrystal-Molecule Nanostructures*
Bedwani	Stéphane	Canada	Theory and modelling at the nanoscale	*Electronic Properties of Strongly Reshaped Organic-Metal Interfaces*
Berry	Vikas	United States	Other	*'Spring-Like' Molecular Junctions: An Avenue to Store Energy in Molecules to Power Molecular-Machines*
Bittmann	Birgit	Germany	Nanostructured and nanoparticle based materials	*A Model for the Ultrasonic Dispersion of Nanoparticles in Epoxy Resin*
Blasiak	Barbara	Canada	Nanobiotechnologies	*A magnetic resonance study of iron and cobalt based nanoparticles as potential contrast agents for molecular imaging of cancer*
Bonastre	Jordi	Spain	Nanostructured and nanoparticle based materials	*Development of nanostructured materials by mechanical alloying and/or rapid solidification*
Brunet	Ernesto	Spain	NanoChemistry	*Porous Materials Based in Laminar and Pillared Zirconium Phosphates for the Efficient Storage of Hydrogen*
Carballeira	Pablo	Germany	Nanostructured and nanoparticle based materials	*Upgrading thermosets with carbon nanofibers*
Cardona	Claudia	United States	Other	*Endohedral metallofullerenes as high efficiency acceptor materials for organic solar cells*

Castro	Laura	Spain	NanoChemistry	*Characterization of metallic nanoparticles obtained by biomass reduction*
Castro-Garcia	Socorro	Spain	NanoChemistry	*MFe2O4 (M= Mn, Co and Ni) nanoferrites: A simple solvothermal synthesis*
Chian Shiun	Kuek	Malaysia	Theory and modelling at the nanoscale	*Temperature dependence of electrical conduction through1, 4-dithiolbenzene molecular assembly (part II)*
Chonco	Louis	Spain	Nanobiotechnologies	*Prevention of HIV-mucosal barrier interaction by new synthesised carbosilane polyanionic dendrimers*
Chutia	Sucismita	France	Theory and modelling at the nanoscale	*III-V semiconductor quantum dots with a magnetic impurity*
Coto	Borja	Spain	Theory and modelling at the nanoscale	*Sorptive behaviour of nanoporous material as molecular sieve for compressor applications: a computational study*
Cuadrado	Ramón	Spain	Theory and modelling at the nanoscale	*A first principles study of Thiol-Capped Au Nanoparticles*
Cunningham	Vincent	Spain	Nanostructured and nanoparticle based materials	*Optoacoustic Spectroscopy of Spherical Gold Nanoparticle Contrast Agents in a Scattering Media*
Dadvand	Afshin	Canada	Other	*Heterocirculenes as a new class of organic semiconductors*
Daneshgar	Parandis	Iran	NanoChemistry	*Dysprosium hydroxide nanowire modified carbon paste electrodes for voltammetric investigation and determination of rifampicin in biological samples*
de Carvalho Miranda	Maria Adelaide	Portugal	NanoChemistry	*Gold Nanocubes: novel photo-synthetic method and morphological characterization*
de la Cruz	Rosa María	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*General solution for interface optical phonon modes in a double nanoshell system*
de la Cruz	Rosa María	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*The effects of embedding medium and size on optical properties of II-VI core/shell nanocrystals*
de la Escosura-Muñiz	Alfredo	Spain	Nanobiotechnologies	*Direct electrochemical detection of gold nanoparticles: application in magnetobiosensors*
Dembélé	Kadiatou Thérèse	Canada	Other	*Simulation of an absorption chiller dual effect operating with the couple H2O/LiBr*
Demers-Carpentier	Vincent	Canada	NanoChemistry	*Isolated Nanoscale Prochiral Reaction Assemblies on Pt(111)*
Di Corato	Riccardo	Italy	Nanobiotechnologies	*Development of a novel magnetic-fluorescent colloidal nano-cluster*
Díaz	Marisel	Venezuela	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*The effect of electrochemical potential on conductance of Au nanocontacts*
Díaz	Javier	Spain	Nanomagnetism and Spintronics	*Study of compositional inhomogeneities in magnetic Fe-Si and Co-Si amorphous films by Grazing Incidente Small Angle Scattering (GISAXS)*
Drbohlavova	Jana	Czech Republic	Nanomagnetism and Spintronics	*Various magnetic nanoparticles preparation and comparison regarding biomedical application*
Dubey	Girjesh	Canada	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Use of Conductivity on Silicon-on-Insulator as a Probe of Molecule-Surface Interactions*
Dunn	Kerry	Canada	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*The effect of single nanocrystal blinking on the luminescence decay of ensembles*
Enculescu	Monica	Romania	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Nanorods growth from solution by a template approach*

Fernandez	Ivan	Spain	SPM	*Magnetostrictive drive of AFM cantilevers for liquid operation*
Fernández Argüelles	María Teresa	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Quantum Dots-Based Fluorescent Inmunoassay for the Determination of Aflatoxins*
Fernández García	Mª Paz	Spain	Nanostructured and nanoparticle based materials	*Competing Superparamagnetism and exchange bias in Fe nanoparticles embedded in an amorphous carbon matrix*
Fernández Seivane	Lucas	Spain	Theory and modelling at the nanoscale	*On-site approximation for spin-orbit coupling in LCAO density functional methods: Application to clusters and chains*
Fernandez Torrado	Jorge	Spain	Nanobiotechnologies	*Hybrid noble metal-ferromagnet nanoparticles for biosensing applications: a preliminary study*
Fiore	Angela	Italy	Nanostructured and nanoparticle based materials	*Seeded growth approach for synthesis of semiconductor nanotetrapods*
Fostner	Shawn	Canada	Nanofabrication tools & nanoscale integration	*Contacts at the nanoscale: Using silicon nanostencils to make wires and contacts on ultra high vacuum cleaved insulators*
Franchini	Isabella Raffaella	Italy	Nanostructured and nanoparticle based materials	*End-to-End Assembly of Shape-Controlled Nanocrystals via a Nano-welding Approach.*
Frolov	Vadim	Russia	Nanostructured and nanoparticle based materials	*Nanocones on (a-C:H):Si films: basic conditions for processing and optical properties*
Garcia	Jorge	Spain	NanoChemistry	*Organometallic silver compoundsas precursors for nanomaterials. Use of thiols and polymers as nanoparticle stabilizers.*
García-Mochales	Pedro	Spain	Theory and modelling at the nanoscale	*Characterization of Icosahedral Metallic Nanowires Formed under Stretching*
Gicquel	Maud	France	NanoOptics & NanoPhotonics	*Highlighting excitonic optical properties of bundled carbon nanotubes to tailor novel nanomaterials-based devices*
Gomez-Casado	Alberto	Netherlands	SPM	*Probing multivalent host-guest complexes using AFM*
Goyer	Francois	Canada	Theory and modelling at the nanoscale	*Using complex potentials to describe electron transmission through molecules*
Gupta	Varun	United States	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Effect of Growth Parameters and Silicon-doping on Boron Carbide Nanostructures*
Hagedorn	Till	Canada	SPM	*Characterizing contact formation at the atomic scale: A combined Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM) study*
Hajizadeh	Solmaz	Iran	Carbon nanotubes based nanoelectronics and field emission	*Catalysts effects on the production of carbon nanotubes by an automatic arc discharge set up*
Hajizadeh	Solmaz	Iran	Nanobiotechnologies	*Evaluation of hydrodynamic parameters of fluidized bed adsorption on purification of nanobioproducts*
Hawshemianzadeh	Majid	Iran	Theory and modelling at the nanoscale	*First-Principle Study of Hydrogen Storage on Boron-Based Organometallic Nanostructures*
Herranz Zamorano	Jesús	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Growth of site-controlled InAs quantum dots on prepatterned GaAs (001) substrates by AFM local oxidation*
Hierro Rodríguez	Aurelio	Spain	Nanofabrication tools & nanoscale integration	*Growing up of magnetic nanostructures by EBL using double layer resist system and characterization by AFM and magneto optical SNOM.*
Hojati Talemi	Pejman	Australia	Other	*Effect of Different Microwave-Based Treatments on multiwalled carbon nanotubes*
Hosseini	Ali A	Iran	Nanostructured and nanoparticle based materials	*Fabrication and charactrization of Al-CNT nano composiy using powder metallurgy methode*

Hrdý	Radim	Czech Republic	Nanobiotechnologies	*Detection of Ureasa Enzyme Analysis Using Electrode Modified with Vertically Aligned Ni Nanopillars*
Hsieh	Chien-Wen	United Kingdom	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*ZnO nanowires for nanocomposite organic thin film transistors*
Hubalek	Jaromir	Czech Republic	Nanomagnetism and Spintronics	*Magnetic Particles for Fully Automated Nucleic Acids Isolation and Their Application in Nanomedicine*
Hwang	Sung-Ho	Korea	Nanostructured and nanoparticle based materials	*Novel Polymer-Metal Precursor Route for Simple and Mass Production of ITO Nanoparticles*
Im	Jongmo	Korea	Nanostructured and nanoparticle based materials	*Comparison of electro and air-blast spray deposition for preparing lanthanum strontium manganite films*
Jahr	Norbert	Germany	NanoOptics & NanoPhotonics	*Single nanoholes with gold nanoparticles a novel tool in nanooptics*
Jang	Sungeun	Korea	Nanostructured and nanoparticle based materials	*Fabrication of Ni-YSZ anode for SOFC by ESD*
Jimenez	Vicente	Spain	Other	*Chemical activation of fish-bone type carbon nanofibers*
Jiménez	David	Spain	Theory and modelling at the nanoscale	*Ferroelectric materials to the aid of low-power switching*
Junquera	Alejandro	Spain	Other	*Ozone analyzer for Air quality monitoring based in nanotechnology: A real industrial application*
Kandaswamy	Prem Kumar	France	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Polarization effects in GaN/AlN Short-Period Superlattices for Intersubband Optoelectronics*
Kokado	Satoshi	Japan	Nanomagnetism and Spintronics	*A Localized Quantum Spin Reversal by Spin Injection in A Spin Quantum Dot: Effect of Spin Relaxation*
Kondratenko	Mykola	Canada	NanoChemistry	*Design and rectification study of different Aviram-Ratner model molecules*
Labuda	Aleksander	Canada	SPM	*Atomic-Scale Friction of Gold and Copper in Perchloric Acid*
Lange	Holger	Germany	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Experimental observation of the radial breathing mode in nanorods*
Le Goff	Alan	France	Nanostructured and nanoparticle based materials	*Modified electrodes based on ferrocene attached to multi-walled carbon nanotubes: Application to glucose biosensing*
Lee	Soo-Keun	Korea	Other	*Nitridation of Pt-TiO2 nanoparticle and their characteristics as a visible light photocatsyst*
Lim	Sang Kyoo	Korea	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*ZnO nanorods fabricated by a wet chemical method*
Lockwood	Tobias	Canada	Nanostructured and nanoparticle based materials	*Electrochemically grown PEDOT on nanotube films for transparent electrodes*
Lopez	Rosa	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Transport through hybrid double kondo dots*
Lovera	Pierre	Ireland	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Determination of Molecular Orientations in Single Polyfluorene Nanowires Using Polarisation Dependent Nonlinear Microscopy*
Luque	Aitor	Spain	Theory and modelling at the nanoscale	*Mode II loading behaviour of intergranular nanocracks lying on a S17(530) symmetrical tilt boundary in copper*
Maillard	Arnaud	Canada	Theory and modelling at the nanoscale	*Band-Alignment Engineering of Organic Photovoltaic Materials*

Martín Rodríguez	Emma	Spain	NanoOptics & NanoPhotonics	*Second Harmonic Generation by ferroelectric nanoparticles of Strontium Barium Niobate*
Martinez	Eduardo	Germany	Other	*Response of Mn overlayers on Fe substrate to external magnetic fields*
Massuyeau	Florian	France	NanoOptics & NanoPhotonics	*Conjugated polymer nanofibers: effects of nanostructuration on photoemission properties*
Mehdizadeh	Alireza	Iran	Nanobiotechnologies	*Synthesis and Characterization of Folate-Conjugated Gold NanoparticlesDesigned for Selective Targeting of Cancerous Cells*
Méndez Ramos	Jorge	Spain	Nanostructured and nanoparticle based materials	*Sol-gel derived nano-glass-ceramics containing Eu3+-doped NaYF4 nanocrystals*
Méndez Ramos	Jorge	Spain	Nanostructured and nanoparticle based materials	*Tuneable up-conversion phosphor based in sol-gel derived nano-glass-ceramics containing Yb3+-Er3+ co-doped NaYF4 nanocrystals*
Mohr	Marcel	Germany	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Ab-initio calculations of core-shell CdSe/ZnS nanowires*
Morozan	Adina	Romania	Other	*Plasma processing of polypyrrole-heparin thin films on titanium substrates for biomedical applications*
Naghshineh	Negin	Iran	Theory and modelling at the nanoscale	*First-Principle Study of Alkali Metal Atoms Adsorbed on Silicon Carbide Nanotubes and the corresponding Adsorption of Hydrogen molecules to the Alkali Metal Atoms*
Nastase	Claudia	Romania	Other	*Plasma processing of PMMA films for biomedical applications*
Norman	Lana	Canada	NanoChemistry	*Towards the Controlled Nanomechanical Actuation of Microcantilevers Using Redox Reactions in Electroactive Self-Assembled Monolayers*
Park	Inyu	Korea	Nanostructured and nanoparticle based materials	*Fabrication of Sm0.5Sr0.5CoO3 cathode thin films for IT-SOFCs by Electrostatic Spray Deposition*
Partridge	Jim	Australia	Nanostructured and nanoparticle based materials	*Films consisting of graphite-like sheets suitable for interconnects with high electrical and thermal conductivity*
Pastor-Abia	Luis	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Stress-strain curves of aluminum nanowires: fluctuations in the plastic regime and absence of hardening*
Peláez Machado	Samuel	Spain	Theory and modelling at the nanoscale	*Mechanical properties at the nanoscale: the dependence of Young\'s modulus of nanowires on the shape and axial orientation*
Perez de Lara	David	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Nanorectifiers Based on Superconducting/magnetic Hybrids*
Pérez García	Beatriz	Spain	SPM	*P3OT surface characteritation as a function of temperature by Variable Temperature Scanning Force Microscopy.*
Pinto	Henry	Finland	SPM	*Composition and structure of Si(001)/CaF2 interfaces*
Podrazky	Ondrej	Czech Republic	Nanostructured and nanoparticle based materials	*Use of Nanoparticles for Preparation of Rare-Earth Doped Silica Fibers*
Pons	Miquel	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Spin contamination in quantum dot RHF states: a phase diagram*
Prášek	Jan	Czech Republic	Nanobiotechnologies	*Using of Carbon Nanotubes for Fabrication of Printed Electrodes and Their Employing in DNA Analysis*
Primiceri	Elisabetta	Italy	Nanobiotechnologies	*On-Line Monitoring of Cytotoxic Effects Using EIS based Cell-Chips*

Provencher	Marie-Ève	Canada	Nanobiotechnologies	*Design of peptides nanostructures having antimicrobial activity*
Prudnikava	Alena	Belarus	Carbon nanotubes based nanoelectronics and field emission	*Microwaves Electromagnetic Interference Shielding Properties of Magnetically Functionalized Multiwalled Carbon Nanotubes*
Puente	Antonio	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Spin projection energies in RHF: application to quantum dots*
Rashad	Mohamed	Egypt	Nanostructured and nanoparticle based materials	*Effect of synthesis conditions on the preparation of barium titanate nanopowders via hydrothermal route*
Rashad	Mohamed	Egypt	NanoChemistry	*Effect of supersaturation and ammonium fluoride on the gelation rate of silica nanoparticles synthesized by sol gel technique*
Reguer	Alan	France	Nanofabrication tools & nanoscale integration	*Growth study of silicon nanowires using gold and gallium as catalyst by In Situ scanning electron microscopy*
Reynolds	Ken	Ireland	Nanofabrication tools & nanoscale integration	*Manipulation, Assembly and Characterization of Optically Functional 1-D Organic Nanostructures*
Ricart	Susagna	Spain	Nanostructured and nanoparticle based materials	*Nanoparticles in YBa2Cu3O7 superconducting thin films*
Ricote	Jesús	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Ferroelectric behavior of polycrystalline ultrathin lead titanate films*
Robert	Gaël	France	Carbon nanotubes based nanoelectronics and field emission	*Carbon Nanotubes as Electrodes for Molecular Electronics: from SAMs to Single-Molecule Connection*
Rocheleau	Philippe	Canada	Theory and modelling at the nanoscale	*Molecular conductance in terms of orbital densities and polarizabilities*
Rodríguez-Rodríguez	Gabriel	Spain	SPM	*Micromagnetic simulation of MFM tip hysteresis and stray field*
Rodríguez-Vázquez	María J.	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Synthesis of metallic atom clusters by soft methods. Characterization and properties.*
Románszki	Loránd	Sweden	Other	*Hydrogen Storage in Thin Metallic Films*
Ruiz	Patricia	Spain	NanoChemistry	*Intermatrix synthesis of polymer-copper nanocomposites with predetermined parameters by using coproportionation reaction.*
Rumpf	Klemens	Austria	Nanomagnetism and Spintronics	*Temperature dependence of a twofold magnetic behaviour of a nanoscopic metal/silicon hybrid system – a comparison between Ni/Si and Co/Si*
Rycerz	Adam	Germany	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Graphene nanoconstriction as a single-level quantum dot*
Salgado-Remacha	Francisco Javier	Spain	Other	*Diffraction gratings embedded in bulk fused silica by laser ablation*
Samuely	Tomas	Switzerland	NanoChemistry	*Phthtalocyanine derivatives on (111) noble metal surfaces – multiphase behavior and capability of hosting other molecules*
Sanchez	Humberto	Netherlands	Nanobiotechnologies	*Nanometer localization and identification of DNA repair proteins by combined AFM-fluorescence analysis*
Sánchez	David	Spain	Nanomagnetism and Spintronics	*Strong current modulation in quantum wires with localized Rashba interaction*
Sanfabián	Emilio	Spain	NanoChemistry	*Magnetic molecules derived from hydrogenation of polycyclic aromatic hydrocarbons*
Santalla	Silvia	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Substrate orientation effects on the lattice parameter profiles in the stranski-krastanov growth mode*

Santos Expósito	Hernán	Spain	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Friedel Oscillations in Carbon Nanotube Quantum Dots*
Sattayasamitsathit	Sirilak	Thailand	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Electrochemical Synthesis and Characterizations of Versatile Nanowires*
Schäffel	Franziska	Germany	Carbon nanotubes based nanoelectronics and field emission	*CVD routes to carbon nanotube systems with highly anisotropic nanomagnets*
Serena	Pedro A.	Spain	Theory and modelling at the nanoscale	*MC simulation of water meniscus in nanocontainers: explaining the collapse of viral particles due to capillar forces*
Silva	Hugo	Portugal	Theory and modelling at the nanoscale	*Temperature and Voltage TMR Dependencies for High Performance Magnetic Junctions*
Sonoda	Tsutomu	Japan	Other	*Coating of Pure Titanium with TiN/Ti Multi-Layered FIlms by Sputter-Deposition for Improving Blood Compatibility*
Stancu	Rodica	Romania	Nanostructured and nanoparticle based materials	*Zn-Al2O3 electrodeposited nanocomposites*
Steinbrueck	Andrea	Germany	Nanostructured and nanoparticle based materials	*Nanoparticle constructs of metallic and core-shell nanoparticles based on DNA-hybridization*
Steplecaru	Cristiana Sonia	Spain	Other	*Transport and optical measurements in epitaxial ZnO thin films and ZnO/Co3O4 multilayers*
Suarez	Nery	Venezuela	Nanostructured and nanoparticle based materials	*Dynamics in Polymer-Clay Nanocomposites As Studied by FTIR, XRD, TEM, TSDC and DSC Techniques*
Sukyte	Judita	Lithuania	NanoChemistry	*The different species of telluropentathionates as precursors for formation of copper chalcogenides layers on the surface of polyamide*
Tal Or	Lev	Israel	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Controlled Charge Transport Measurements Through short dsDNA using Conductive AFM*
Tang	Nathalie Y-Wa	Canada	Nanostructured and nanoparticle based materials	*Enzyme-Assisted Attachment of Gold Nanoparticles onto Patterned Organic Surfaces*
Teixeira	José	Portugal	Nanomagnetism and Spintronics	*Temperature dependent transport properties of MgO-based ultra-thin magnetic tunnel junctions: experiment and modeling.*
Temprano	Israel	Canada	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Molecular contacts through inducing surface initiated polymerization of nanowires on molybdenum carbide*
Trandafilovic	Lidija	Yugoslavia	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Properties of CdS and CdSe nanopoarticles in poly(2-(dimethylamino)ethyl methacrylate-co-acrylic acid) co-polymer matrix*
Vale	Filipa	Portugal	Nanobiotechnologies	*A DNA Chip for Simultaneous Detection of Microorganims in Water Samples: Coliform Bacteria, non-mandatory bacteria, hepatitis A virus and noroviruses*
Valtsifer	Igor	Russia	Nanostructured and nanoparticle based materials	*The influence of surface modification of nanoparticles on their structuring in a liquid medium*
Vantsyan	Mikhail	Russia	Low dimensional materials (nanowires, clusters, quantum dots, etc.)	*Low-dimensional Metallized Biodegradable Polymers Preparation, Study and Application*
Vega	Andrés	Spain	Nanomagnetism and Spintronics	*Magnetization reversal process in spin spring magnets. Electronic structure calculations*
Vega	Victor	Spain	Nanomagnetism and Spintronics	*Synthesis and magnetic properties of FePd hexagonally ordered nanohole arrays*

Velázquez García	José Joaquín	Spain	Nanostructured and nanoparticle based materials	*Structure and up-conversion luminescence in transparent Er3+-Yb3+ co-doped SiO2-PbF2 sol-gel derived nano-glass-ceramics*
Velázquez García	José Joaquín	Spain	Nanostructured and nanoparticle based materials	*Color tuneability and white light generation in Yb3+-Ho3+-Tm3+ doped SiO2-LaF3 nano-glass-ceramics prepared by sol-gel method*
Veronese	Giulio Paolo	Italy	Carbon nanotubes based nanoelectronics and field emission	*Field emission properties of carbon nanotube arrays grown in porous anodic alumina*
Wang	JinJin	United Kingdom	Theory and modelling at the nanoscale	*Atomistic Simulations of Catalytic Carbon Nanotubes Growth*
Watanabe	Masato	Japan	Nanostructured and nanoparticle based materials	*Fabrication of Fe-Pt and Au Monodispersed Nanoparticle Colloids by KrF Excimer Laser Irradiation*
Wu	Chien-Ching	Netherlands	Nanobiotechnologies	*Fabrication of Metal-Ion Patterns by uCP and DPN for Protein Immobilization*
Yáñez Vilar	Susana	Spain	Nanostructured and nanoparticle based materials	*Magnetocapacitance in Fe3O4@SiO2 nanocomposite*
Yousefi-Azari	Hassan	Iran	NanoChemistry	*Computer Calculations of the Wiener Index of Fullerenes*

SESSION PA (98) (*) poster not eligible for competition			
Presenting Author		**Country**	**Poster Title**
TOPIC: Carbon Nanotubes Based Nanoelectronics and Field Emission			
Hajizadeh	Solmaz	Iran	Catalysts effects on the production of carbon nanotubes by an automatic arc discharge set up
Prudnikava	Alena	Belarus	Microwaves Electromagnetic Interference Shielding Properties of Magnetically Functionalized Multiwalled Carbon Nanotubes
Robert	Gaël	France	Carbon Nanotubes as Electrodes for Molecular Electronics: from SAMs to Single-Molecule Connection
Schäffel	Franziska	Germany	CVD routes to carbon nanotube systems with highly anisotropic nanomagnets
TOPIC: Low-Dimensional Materials			
Barrett	Claire	Ireland	Formation and Electrical Interfacing of Nanocrystal-Molecule Nanostructures
Dubey	Girjesh	Canada	Use of Conductivity on Silicon-on-Insulator as a Probe of Molecule-Surface Interactions
Dunn	Kerry	Canada	The effect of single nanocrystal blinking on the luminescence decay of ensembles
Fernández Argüelles	María Teresa	Spain	Quantum Dots-Based Fluorescent Inmunoassay for the Determination of Aflatoxins
Gupta	Varun	United States	Effect of Growth Parameters and Silicon-doping on Boron Carbide Nanostructures
Herranz Zamorano	Jesús	Spain	Growth of site-controlled InAs quantum dots on prepatterned GaAs (001) substrates by AFM local oxidation
Hsieh	Chien-Wen	United Kingdom	ZnO nanowires for nanocomposite organic thin film transistors
Kandaswamy	Prem Kumar	France	Polarization effects in GaN/AlN Short-Period Superlattices for Intersubband Optoelectronics
Lovera	Pierre	Ireland	Determination of Molecular Orientations in Single Polyfluorene Nanowires Using Polarisation Dependent Nonlinear Microscopy
Mohr	Marcel	Germany	Ab-initio calculations of core-shell CdSe/ZnS nanowires
Pons	Miquel	Spain	Spin contamination in quantum dot RHF states: a phase diagram
Rodríguez-Vázquez	María J.	Spain	Synthesis of metallic atom clusters by soft methods. Characterization and properties.
Santos Expósito	Hernán	Spain	Friedel Oscillations in Carbon Nanotube Quantum Dots
Sattayasamitsathit	Sirilak	Thailand	Electrochemical Synthesis and Characterizations of Versatile Nanowires
Temprano	Israel	Canada	Molecular contacts through inducing surface initiated polymerization of nanowires on molybdenum carbide
Trandafilovic	Lidija	Yugoslavia	Properties of CdS and CdSe nanopoarticles in poly(2-(dimethylamino)ethyl methacrylate-co-acrylic acid) co-polymer matrix

TOPIC: Nanobiotechnologies			
Blasiak	Barbara	Canada	A magnetic resonance study of iron and cobalt based nanoparticles as potential contrast agents for molecular imaging of cancer
Chonco	Louis	Spain	Prevention of HIV-mucosal barrier interaction by new synthesised carbosilane polyanionic dendrimers
Di Corato	Riccardo	Italy	Development of a novel magnetic-fluorescent colloidal nano-cluster
Fernandez Torrado	Jorge	Spain	Hybrid noble metal-ferromagnet nanoparticles for biosensing applications: a preliminary study
Hajizadeh (*)	Solmaz	Iran	Evaluation of hydrodynamic parameters of fluidized bed adsorption on purification of nanobioproducts
Hrdý	Radim	Czech Republic	Detection of Ureasa Enzyme Analysis Using Electrode Modified with Vertically Aligned Ni Nanopillars
Mehdizadeh	Alireza	Iran	Synthesis and Characterization of Folate-Conjugated Gold NanoparticlesDesigned for Selective Targeting of Cancerous Cells
Primiceri	Elisabetta	Italy	On-Line Monitoring of Cytotoxic Effects Using EIS based Cell-Chips
Provencher	Marie-Ève	Canada	Design of peptides nanostructures having antimicrobial activity
Wu	Chien-Ching	Netherlands	Fabrication of Metal-Ion Patterns by uCP and DPN for Protein Immobilization
TOPIC: Nanochemistry			
Alonso	Amanda	Spain	Intermatrix synthesis of metal nanoparticles with core-shell or core-sandwich structure for antibacterial aplications
Castro	Laura	Spain	Characterization of metallic nanoparticles obtained by biomass reduction
Daneshgar	Parandis	Iran	Dysprosium hydroxide nanowire modified carbon paste electrodes for voltammetric investigation and determination of rifampicin in biological samples
de Carvalho Miranda	Maria Adelaide	Portugal	Gold Nanocubes: novel photo-synthetic method and morphological characterization
Demers-Carpentier	Vincent	Canada	Isolated Nanoscale Prochiral Reaction Assemblies on Pt(111)
Garcia	Jorge	Spain	Organometallic silver compoundsas precursors for nanomaterials. Use of thiols and polymers as nanoparticle stabilizers.
Kondratenko	Mykola	Canada	Design and rectification study of different Aviram-Ratner model molecules
Norman	Lana	Canada	Towards the Controlled Nanomechanical Actuation of Microcantilevers Using Redox Reactions in Electroactive Self-Assembled Monolayers
Ruiz	Patricia	Spain	Intermatrix synthesis of polymer-copper nanocomposites with predetermined parameters by using coproportionation reaction.
Samuely	Tomas	Switzerland	Phthtalocyanine derivatives on (111) noble metal surfaces – multiphase behavior and capability of hosting other molecules
TOPIC: Nanofabrication Tools and Nanoscale Integration			
Fostner	Shawn	Canada	Contacts at the nanoscale: Using silicon nanostencils to make wires and contacts on ultra high vacuum cleaved insulators
Hierro Rodríguez	Aurelio	Spain	Growing up of magnetic nanostructures by EBL using double layer resist system and characterization by AFM and magneto optical SNOM.
Reguer	Alan	France	Growth study of silicon nanowires using gold and gallium as catalyst by In Situ scanning electron microscopy

Reynolds	Ken	Ireland	Manipulation, Assembly and Characterization of Optically Functional 1-D Organic Nanostructures
TOPIC: Nanomagnetism and Spintronics			
Alija	Alejandro	Spain	Ratchet effects on domain wall motion in Co-Si amorphous films with arrays of asymmetric holes: experiments and theoretical simulations
Teixeira	José	Portugal	Temperature dependent transport properties of MgO-based ultra-thin magnetic tunnel junctions: experiment and modeling.
Vega	Victor	Spain	Synthesis and magnetic properties of FePd hexagonally ordered nanohole arrays
TOPIC: NanoOptics & NanoPhotonics			
Alvarez	Jesus	Spain	A theoretical comparison of strip and vertical slot-waveguide resonators in silicon nitride for sensing purposes
Jahr	Norbert	Germany	Single nanoholes with gold nanoparticles a novel tool in nanooptics
Martín Rodríguez	Emma	Spain	Second Harmonic Generation by ferroelectric nanoparticles of Strontium Barium Niobate
Massuyeau	Florian	France	Conjugated polymer nanofibers: effects of nanostructuration on photoemission properties
TOPIC: Nanostructured and Nanoparticle Based Materials			
Alvarez	Lucia	Spain	Metalorganic nanostructures: 2d- extended structures
Alvarez	Pablo	Universidad de Oviedo	Magneto-volume anomalies and Magnetocaloric effect on ball-milling nanostructured Pr2Fe17 compounds
Aubéry Torres	Carolina	Spain	Synthesis and Characterization of Mn-Zn Ferrite Magnetic Nanoparticles by the Microemulsion Reaction Method
Bittmann	Birgit	Germany	A Model for the Ultrasonic Dispersion of Nanoparticles in Epoxy Resin
Bonastre	Jordi	Spain	Development of nanostructured materials by mechanical alloying and/or rapid solidification
Carballeira	Pablo	Germany	Upgrading thermosets with carbon nanofibers
Cunningham	Vincent	Spain	Optoacoustic Spectroscopy of Spherical Gold Nanoparticle Contrast Agents in a Scattering Media
Fernández García	Mª Paz	Spain	Competing Superparamagnetism and exchange bias in Fe nanoparticles embedded in an amorphous carbon matrix
Fiore	Angela	Italy	Seeded growth approach for synthesis of semiconductor nanotetrapods
Franchini	Isabella Raffaella	Italy	End-to-End Assembly of Shape-Controlled Nanocrystals via a Nano-welding Approach.
Hosseini	Ali A	Iran	Fabrication and charactrization of Al-CNT nano composiy using powder metallurgy methode
Im	Jongmo	Korea	Comparison of electro and air-blast spray deposition for preparing lanthanum strontium manganite films
Jang	Sungeun	Korea	Fabrication of Ni-YSZ anode for SOFC by ESD
Lockwood	Tobias	Canada	Electrochemically grown PEDOT on nanotube films for transparent electrodes

Park	Inyu	Korea	Fabrication of Sm0.5Sr0.5CoO3 cathode thin films for IT-SOFCs by Electrostatic Spray Deposition
Steinbrueck	Andrea	Germany	Nanoparticle constructs of metallic and core-shell nanoparticles based on DNA-hybridization
Tang	Nathalie Y-Wa	Canada	Enzyme-Assisted Attachment of Gold Nanoparticles onto Patterned Organic Surfaces
Valtsifer	Igor	Russia	The influence of surface modification of nanoparticles on their structuring in a liquid medium
Velázquez García (*)	José Joaquín	Spain	Structure and up-conversion luminescence in transparent Er3+-Yb3+ co-doped SiO2-PbF2 sol-gel derived nano-glass-ceramics
Velázquez García	José Joaquín	Spain	Color tuneability and white light generation in Yb3+-Ho3+-Tm3+ doped SiO2-LaF3 nano-glass-ceramics prepared by sol-gel method
Watanabe (*)	Masato	Japan	Fabrication of Fe-Pt and Au Monodispersed Nanoparticle Colloids by KrF Excimer Laser Irradiation
Yáñez Vilar	Susana	Spain	Magnetocapacitance in Fe3O4@SiO2 nanocomposite
TOPIC: Other			
Dadvand	Afshin	Canada	Heterocirculenes as a new class of organic semiconductors
Dembélé	Kadiatou Thérèse	Canada	Simulation of an absorption chiller dual effect operating with the couple H2O/LiBr
Hojati Talemi	Pejman	Australia	Effect of Different Microwave-Based Treatments on multiwalled carbon nanotubes
Jimenez	Vicente	Spain	Chemical activation of fish-bone type carbon nanofibers
Románszki	Loránd	Sweden	Hydrogen Storage in Thin Metallic Films
Salgado-Remacha	Francisco Javier	Spain	Diffraction gratings embedded in bulk fused silica by laser ablation
Steplecaru	Cristiana Sonia	Spain	Transport and optical measurements in epitaxial ZnO thin films and ZnO/Co3O4 multilayers
TOPIC: Scanning Probes Methods			
Fernandez	Ivan	Spain	Magnetostrictive drive of AFM cantilevers for liquid operation
Gomez-Casado	Alberto	Netherlands	Probing multivalent host-guest complexes using AFM
Hagedorn	Till	Canada	Characterizing contact formation at the atomic scale: A combined Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM) study
Labuda	Aleksander	Canada	Atomic-Scale Friction of Gold and Copper in Perchloric Acid
Pérez García	Beatriz	Spain	P3OT surface characteritation as a function of temperature by Variable Temperature Scanning Force Microscopy.
Rodríguez-Rodríguez	Gabriel	Spain	Micromagnetic simulation of MFM tip hysteresis and stray field

TOPIC: Theory and Modelling at the Nanoscale			
Alarcón Pardo	Alfonso	Spain	Time-dependent Electron Driven Tunneling Phenomena for multipurpose Terahertz applications: self-consistent computation of conduction and displacement current in mesoscopic systems
Bedwani	Stéphane	Canada	Electronic Properties of Strongly Reshaped Organic-Metal Interfaces
Chian Shiun	Kuek	Malaysia	Temperature dependence of electrical conduction through1, 4-dithiolbenzene molecular assembly (part II)
Cuadrado	Ramón	Spain	A first principles study of Thiol-Capped Au Nanoparticles
Fernández Seivane	Lucas	Spain	On-site approximation for spin-orbit coupling in LCAO density functional methods: Application to clusters and chains
Goyer	Francois	Canada	Using complex potentials to describe electron transmission through molecules
Maillard	Arnaud	Canada	Band-Alignment Engineering of Organic Photovoltaic Materials
Naghshineh	Negin	Iran	First-Principle Study of Alkali Metal Atoms Adsorbed on Silicon Carbide Nanotubes and the corresponding Adsorption of Hydrogen molecules to the Alkali Metal Atoms
Peláez Machado	Samuel	Spain	Mechanical properties at the nanoscale: the dependence of Young\'s modulus of nanowires on the shape and axial orientation
Rocheleau	Philippe	Canada	Molecular conductance in terms of orbital densities and polarizabilities
Silva	Hugo	Portugal	Temperature and Voltage TMR Dependencies for High Performance Magnetic Junctions
Wang	JinJin	United Kingdom	Atomistic Simulations of Catalytic Carbon Nanotubes Growth

SESSION PB (66)			
Presenting Author		**Country**	**Poster Title**
TOPIC: Carbon nanotubes based nanoelectronics and field emission			
Veronese	Giulio Paolo	Italy	Field emission properties of carbon nanotube arrays grown in porous anodic alumina
TOPIC: Low dimensional materials (nanowires, clusters, quantum dots, etc.)			
de la Cruz	Rosa María	Spain	The effects of embedding medium and size on optical properties of II-VI core/shell nanocrystals
de la Cruz	Rosa María	Spain	General solution for interface optical phonon modes in a double nanoshell system
Díaz	Marisel	Venezuela	The effect of electrochemical potential on conductance of Au nanocontacts
Enculescu	Monica	Romania	Nanorods growth from solution by a template approach
Lange	Holger	Germany	Experimental observation of the radial breathing mode in nanorods
Lim	Sang Kyoo	Korea	ZnO nanorods fabricated by a wet chemical method
Lopez	Rosa	Spain	Transport through hybrid double kondo dots
Pastor-Abia	Luis	Spain	Stress-strain curves of aluminum nanowires: fluctuations in the plastic regime and absence of hardening
Perez de Lara	David	Spain	Nanorectifiers Based on Superconducting/magnetic Hybrids
Puente	Antonio	Spain	Spin projection energies in RHF: application to quantum dots
Ricote	Jesús	Spain	Ferroelectric behavior of polycrystalline ultrathin lead titanate films
Rycerz	Adam	Germany	Graphene nanoconstriction as a single-level quantum dot
Santalla	Silvia	Spain	Substrate orientation effects on the lattice parameter profiles in the stranski-krastanov growth mode
Tal Or	Lev	Israel	Controlled Charge Transport Measurements Through short dsDNA using Conductive AFM
Vantsyan	Mikhail	Russia	Low-dimensional Metallized Biodegradable Polymers Preparation, Study and Application
TOPIC: Nanobiotechnologies			
Arroyo-Hernández	María	Spain	Characterization of DNA immobilization and hybridization combining nanomechanical and electrochemical biosensors
de la Escosura-Muñiz	Alfredo	Spain	Direct electrochemical detection of gold nanoparticles: application in magnetobiosensors
Prášek	Jan	Czech Republic	Using of Carbon Nanotubes for Fabrication of Printed Electrodes and Their Employing in DNA Analysis
Sanchez	Humberto	Netherlands	Nanometer localization and identification of DNA repair proteins by combined AFM-fluorescence analysis

Vale	Filipa	Portugal	A DNA Chip for Simultaneous Detection of Microorganims in Water Samples: Coliform Bacteria, non-mandatory bacteria, hepatitis A virus and noroviruses
TOPIC: Nanochemistry			
Ashrafi	Ali Reza	Iran	PI Index of Single and Multi-walled Carbon Nanotubes
Brunet	Ernesto	Spain	Porous Materials Based in Laminar and Pillared Zirconium Phosphates for the Efficient Storage of Hydrogen
Castro-Garcia	Socorro	Spain	MFe2O4 (M= Mn, Co and Ni) nanoferrites: A simple solvothermal synthesis
Rashad	Mohamed	Egypt	Effect of supersaturation and ammonium fluoride on the gelation rate of silica nanoparticles synthesized by sol gel technique
Sanfabián	Emilio	Spain	Magnetic molecules derived from hydrogenation of polycyclic aromatic hydrocarbons
Sukyte	Judita	Lithuania	The different species of telluropentathionates as precursors for formation of copper chalcogenides layers on the surface of polyamide
Yousefi-Azari	Hassan	Iran	Computer Calculations of the Wiener Index of Fullerenes
TOPIC: Nanomagnetism and Spintronics			
Díaz	Javier	Spain	Study of compositional inhomogeneities in magnetic Fe-Si and Co-Si amorphous films by Grazing Incidente Small Angle Scattering (GISAXS)
Drbohlavova	Jana	Czech Republic	Various magnetic nanoparticles preparation and comparison regarding biomedical application
Hubalek	Jaromir	Czech Republic	Magnetic Particles for Fully Automated Nucleic Acids Isolation and Their Application in Nanomedicine
Kokado	Satoshi	Japan	A Localized Quantum Spin Reversal by Spin Injection in A Spin Quantum Dot: Effect of Spin Relaxation
Rumpf	Klemens	Austria	Temperature dependence of a twofold magnetic behaviour of a nanoscopic metal/silicon hybrid system – a comparison between Ni/Si and Co/Si
Sánchez	David	Spain	Strong current modulation in quantum wires with localized Rashba interaction
Vega	Andrés	Spain	Magnetization reversal process in spin spring magnets. Electronic structure calculations
TOPIC: NanoOptics & NanoPhotonics			
Gicquel	Maud	France	Highlighting excitonic optical properties of bundled carbon nanotubes to tailor novel nanomaterials-based devices
TOPIC: Nanostructured and Nanoparticle Based Materials			
Adámek	Martin	Czech Republic	Fabrication of impedimetric gas sensor with Au/TiO2 ordered structure on microhot-plate system
Alahgholipour Omrani	Arash	Iran	Growth Of Silver Nano Particles On Cellulose Fibers using UV Irradiation
Frolov	Vadim	Russia	Nanocones on (a-C:H):Si films: basic conditions for processing and optical properties
Hwang	Sung-Ho	Korea	Novel Polymer-Metal Precursor Route for Simple and Mass Production of ITO Nanoparticles
Le Goff	Alan	France	Modified electrodes based on ferrocene attached to multi-walled carbon nanotubes: Application to glucose biosensing

Méndez Ramos	Jorge	Spain	Sol-gel derived nano-glass-ceramics containing Eu3+- doped NaYF4 nanocrystals
Méndez Ramos	Jorge	Spain	Tuneable up-conversion phosphor based in sol-gel derived nano-glass-ceramics containing Yb3+-Er3+ co-doped NaYF4 nanocrystals
Partridge	Jim	Australia	Films consisting of graphite-like sheets suitable for interconnects with high electrical and thermal conductivity
Podrazky	Ondrej	Czech Republic	Use of Nanoparticles for Preparation of Rare-Earth Doped Silica Fibers
Rashad	Mohamed	Egypt	Effect of synthesis conditions on the preparation of barium titanate nanopowders via hydrothermal route
Ricart	Susagna	Spain	Nanoparticles in YBa2Cu3O7 superconducting thin films
Stancu	Rodica	Romania	Zn-Al2O3 electrodeposited nanocomposites
Suarez	Nery	Venezuela	Dynamics in Polymer-Clay Nanocomposites As Studied by FTIR, XRD, TEM, TSDC and DSC Techniques
TOPIC: Other			
Berry	Vikas	United States	'Spring-Like' Molecular Junctions: An Avenue to Store Energy in Molecules to Power Molecular-Machines
Cardona	Claudia	United States	Endohedral metallofullerenes as high efficiency acceptor materials for organic solar cells
Junquera	Alejandro	Spain	Ozone analyzer for Air quality monitoring based in nanotechnology: A real industrial application
Lee	Soo-Keun	Korea	Nitridation of Pt-TiO2 nanoparticle and their characteristics as a visible light photocatsyst
Martinez	Eduardo	Germany	Response of Mn overlayers on Fe substrate to external magnetic fields
Morozan	Adina	Romania	Plasma processing of polypyrrole-heparin thin films on titanium substrates for biomedical applications
Nastase	Claudia	Romania	Plasma processing of PMMA films for biomedical applications
Sonoda	Tsutomu	Japan	Coating of Pure Titanium with TiN/Ti Multi-Layered FIlms by Sputter-Deposition for Improving Blood Compatibility
TOPIC: Scanning Probes Methods			
Pinto	Henry	Finland	Composition and structure of Si(001)/CaF2 interfaces
TOPIC: Theory and Modelling at the Nanoscale			
Chutia	Sucismita	France	III-V semiconductor quantum dots with a magnetic impurity
Coto	Borja	Spain	Sorptive behaviour of nanoporous material as molecular sieve for compressor applications: a computational study
García-Mochales	Pedro	Spain	Characterization of Icosahedral Metallic Nanowires Formed under Stretching
Hawshemianzadeh	Majid	Iran	First-Principle Study of Hydrogen Storage on Boron-Based Organometallic Nanostructures

Jiménez	David	Spain	Ferroelectric materials to the aid of low-power switching
Luque	Aitor	Spain	Mode II loading behaviour of intergranular nanocracks lying on a S17(530) symmetrical tilt boundary in copper
Serena	Pedro A.	Spain	MC simulation of water meniscus in nanocontainers: explaining the collapse of viral particles due to capillar forces

LIST OF PARTICIPANTS

TNT2008

ALPHABETICAL ORDER

TNT2008 Participants (271)

Only fully registered participants (payment processed) are listed below.
Last update (25/08/2008)

TNT2008 – Participants

Registered Participants: 271 - last update: August 25, 2008

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TNT2008

Trends in NanoTechnology

Oviedo (Spain)

September 01-05, 2008

www.tntconf.org

Edited by

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Cover pictures - Courtesy:

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