2013-2014
Activity Report

CIC nanoGUNE
nanoscience cooperative research center

Design: www.bitymina.com

nanoGUNE in numbers

143 ISI publications

2645 citations

5.6 average impact factor

59 researchers

87 seminars

103 invited talks

9 research groups

84 guest researchers

9 PhD theses accomplished

47 collaboration agreements in place

5 patents

830 visitors from high schools and universities

10 conferences and workshops organized

29 PhD theses ongoing

340 times in the media

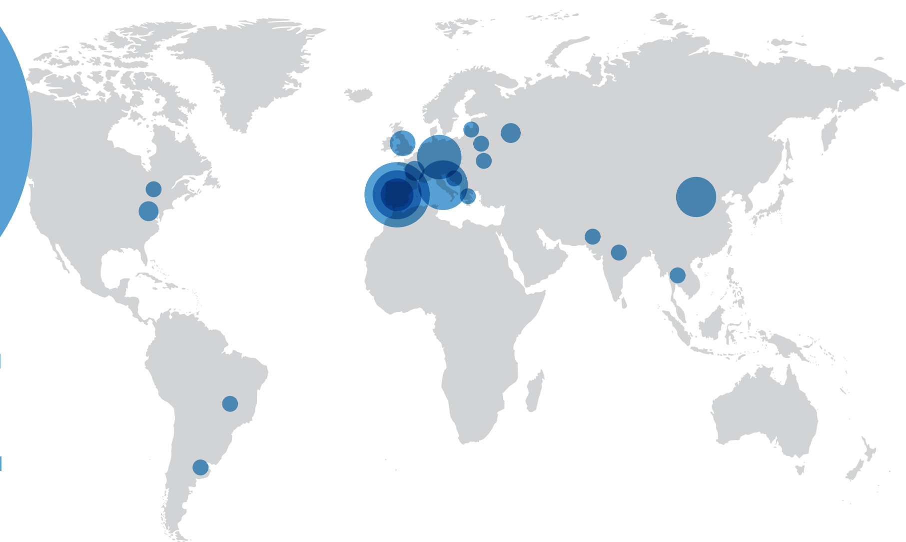
3 new spin-offs

8 contracts with companies

66 grants in place

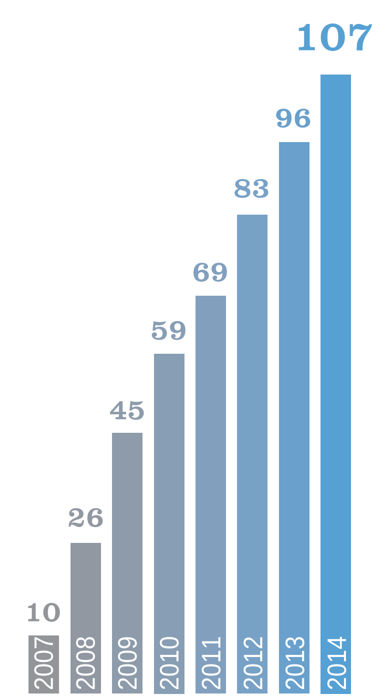
Our mission is to perform world-class nanoscience research for the competitive growth of the Basque Country

Researchers from **24** countries



Argentina 1	Greece 1	Portugal 1
Belarus 1	Hungary 1	Russia 2
Brazil 1	India 1	Slovakia 1
Canada 1	Iran 1	Spain 55
China 7	Italy 9	Thailand 1
Croatia 1	Japan 1	Ukraine 1
France 2	Latvia 1	UK 6
Germany 8	Pakistan 1	USA 2

nanoPeople
(including students and guests)



- **11** Senior Scientists
- **5** Research Fellows
- **18** Post-docs
- **25** Pre-docs
- **6** Master students
- **1** Undergraduates
- **19** Guest Researchers
- **12** Technical Team
- **10** Management & Services

nanoGUNE personnel on 31 December 2014

“We will take advantage of the great potential that the nanoworld is offering us”

Nanoscience and nanotechnology have been developing for more than two decades. During this period of time, much work has been done in this emerging field; but the potential is so large that we could very well say nanotechnology is still in its infancy. Since the discovery of the scanning tunneling microscope in the early 1980's and the development of supramolecular chemistry, we have been able to control matter atom by atom and to create new materials with unexpected properties, electronic devices that might soon become *spintronic*, and functionalized nanoparticles that could act as "trojan horses" in our body.

Nanoscience is a cross-cutting discipline that is enabling much progress in a large variety of industries, from manufacturing to energy and health, and is expected to lead to a new economic and social revolution. At nanoGUNE, it is our commitment to place the Basque Country at the forefront of this revolution, by carrying out world-class nanoscience research and by creating an effective framework of cooperation that should drive our companies through a wide range of nanotechnologies, thus allowing them to rise their global competitiveness.

Thanks to the support of a good number of individuals, public institutions, especially the Basque Government, and our International Advisory Committee, we have reached cruising speed. We have been able to put together a team formed by nine world-class research groups working in a state-of-the-art infrastructure in close collaboration with industry and other research laboratories worldwide. This research effort together with a clear commitment to our society, expressed through technology transfer and the promotion of high-level training and outreach activities, defines our mission.

During the last two years, we have been making outstanding contributions in the fields of nanomagnetism, nanooptics, self-assembly, nanobiomechanics, nanodevices, electron microscopy, theory, nanomaterials, and nanoimaging. In particular, we have opened a new research group, nanobiomechanics, led by Ikerbasque Research Professor Raúl Pérez-Jiménez, and we have launched an external-services department with the aim of offering nanoscale fabrication and characterization services to both academic and industrial users. Our team is now composed of more than 70 researchers (including graduate students and post-docs) and technicians, all coming from 24 different countries worldwide, in addition to a good number of guest researchers that are spending some time with us.

We are also succeeding in our commitment to transfer our knowledge to industry and the whole society. Several technology-transfer activities have been initiated within our industrial environment, and we have created new high-tech companies. Our first start-up company Graphenea, founded four years ago, is now commercializing high-quality graphene wafers worldwide; during the last year, three new companies have been founded in the areas of atomistic simulations (Simune), coating technologies (Ctech-nano), and evolution and genomics technologies (Evolgene).

These pages represent a look into the past and they represent, at the same time, the seed to face the future with optimism and responsibility. Being a small center in a small country, we will keep doing our best to take advantage of the great potential that the nanoworld is offering us, with the expectation that we will always find a niche for us to offer something different. This is *the big challenge of the small.*

José M. Pitarke
Director

Donostia – San Sebastian, December 2014

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Researchers in Action

9 Research Groups

59 Researchers

Nanomagnetism

The Nanomagnetism group conducts world-class fundamental and applied research in nanomagnetism and magnetic characterization techniques. The group is hereby playing a worldwide leading role in the development of advanced experimental magneto-optical tooling including scattering/diffraction magneto-optics, magneto-optical spectrometry, and ellipsometry. The group also has a long-standing expertise in leading-edge scientific research in the fields of thin-film and multilayer growth and magnetic properties design, as well as in the development of theoretical and computational models for quantitative descriptions of magnetic and optical properties at the nanoscale.

The main scientific topics currently pursued by the Nanomagnetism group encompass several key scientific themes that are at the very forefront of research worldwide. We are working on understanding magnetism and magnetic phenomena on very small length and very fast time scales in systems with competing interactions by means of experiments, theory, and modeling, with the long term goal of aiding and enabling novel nanomagnetic device concepts. We are also developing advanced methodologies and tooling for magnetic-materials characterization at the nanometer length scale and the picosecond time scale to assist materials development. Moreover, we are focused on the design, fabrication, and characterization of novel nanometer-scale magnetic structures, meta-magnetic materials, thin films, and multilayers to achieve improved or novel materials properties. Finally, we study novel concepts for designing magnetic nanoscale materials to achieve utilization in novel devices.

Over the last two years, key achievements were accomplished, also in collaboration with other Basque and international research groups, among which we would like to highlight the following: We have realized flexible magnetic nano-devices for magnetic remote manipulation of fluid-borne nanoparticles with potential applications in biology and medicine, such as lab-on-a-chip diagnostic devices. Also, our group has demonstrated magneto-plasmonics for nano-optical devices (flat optics) and ultrasensitive detection applications with potential utility in environmental and biosensing. Furthermore, we have fabricated and characterized novel magnetic materials including magnetic oxides and metallic alloys that have potential applications as magnetic recording media in hard disk drive storage. Lastly, we have experimentally verified the existence of dynamic phase transitions and the overlapping stability ranges of dynamic phases in magnetic systems, which represents a key step forward towards universal classification and description of dynamic pattern out-of-equilibrium.

Andreas Berger
Research Director
Group Leader

PhD in Physics in 1993, RWTH Aachen University (Germany)

Paolo Vavassori
Ikerbasque Research Professor
Group Coleader

PhD in Physics in 1994, Politecnico di Milano (Italy)

Post-doctoral researchers

Juan González, nanoGUNE Fellow (until 14/10/13)
Anandakumar Sarella, nanoGUNE Fellow (until 30/04/14)
Anna Suszka, nanoGUNE Fellow (until 31/03/13)

Pre-doctoral researchers

Jon Ander Arregi, FPI Fellow, Study of ultrafast magnetization dynamics in thin-films and nanostructures for technical applications
Lorenzo Fallarino, PFPI Fellow, Fabrication and magnetic characterization of Co-based magnetic alloy films, multilayers, and nanostructures
Olatz Idigoras, PFPI Fellow, Magnetization reversal behavior of ferromagnetic thin films and nano-structures (until 30/09/13)
Nicolò Maccaferri, PFPI Fellow, Magneto-optical studies of magnetic micro- and nanostructures
Matteo Pancaldi, FPI Fellow, Magnetization reversal in magnetic films, multilayers, and nanostructures
José María Porro, PFPI Fellow, Fast magnetization dynamics near magnetic ordering temperatures (until 15/05/14)

Master Students

Alba Pascual, UPV/EHU
Patricia Riego, UPV/EHU

Undergraduate students

Xabier Inchausti, UPV/EHU (until 31/08/14)
Iñaki Madinabeitia, UPV/EHU (until 16/08/13)
Iñigo Martínez, UPV/EHU (until 31/08/14)

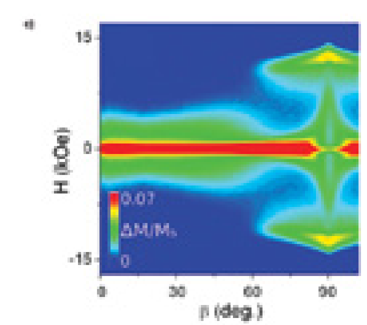
Technician

César Rufo

Guest Researchers*

Christian Binek, University of Nebraska (USA), Ikerbasque Visiting Professor
Veli Mikko Kataja, Aalto University (Finland)
Pedro Landeros, Federico Santa María Technical University (Chile)
Leonardo Martini, University of Perugia (Italy)
Ana Vieira, University of Porto (Portugal)

FPI, predoctoral grant of the Spanish Government
PFPI, predoctoral grant of the Basque Government
* One-month stay minimum



Magnetic hysteresis of a 200 nm thick epitaxial Cobalt film with (0001) surface orientation as a function of the applied field strength H and orientation β. The quantity displayed in this map is the normalized magnetization difference $\Delta M/M_s$ between the hysteresis loop branch with decreasing and increasing field strength. One can clearly see that the low field hysteresis occurring for $\beta < 60º$ changes towards a high field structure for $\beta > 60º$, which indicates an abrupt fundamental change of the magnetization reversal behavior.
(A. K. Suszka et al., Appl. Phys. Lett. *105*, 222402, 2014)

Nanooptics

The Nanooptics Group develops and applies optical nanoscopy (scattering-type scanning near-field optical microscopy, s-SNOM) and infrared nanospectroscopy (Fourier-transform infrared nanospectroscopy, nano-FTIR). Both techniques offer a wavelength-independent spatial resolution of about 10 to 20 nm at visible, infrared, and terahertz frequencies, thus beating the conventional resolution (diffraction) limit by a factor of up to 1 000.

During the last two years, we have continued working on novel instrumental developments. We aim on pushing the spatial resolution towards the single-molecule level and to enable three-dimensional infrared-spectroscopic nanotomography.

We apply s-SNOM and nano-FTIR to study plasmons in metal and graphene nanostructures for the development of ultracompact nanophotonic devices and their application, for example, in opto-electronics and sensing.

We further use our microscopy tools for nanoscale infrared bioimaging and biospectroscopy, particularly to study protein conformation on the nanometer scale for better understanding of protein (mis) folding processes.

Applications in materials sciences and solid-state physics aim at nanoscale mapping of chemical, structural, and optoelectronic properties. For example, we study nanoscale polymer structures, as well as carrier distribution and generation in semiconductors.

Our activities involve manifold and widely interdisciplinary collaborations, internationally and within the Basque Country.

Rainer Hillenbrand
Ikerbasque Research Professor
Group Leader

PhD in Physics in 2001, Technical University of Munich (Germany)

Research Fellow
Alexey Nikitin, Ikerbasque Research Fellow

Post-doctoral researchers
Pablo Alonso-González, FP7 Fellow
Jianing Chen, FP7 Fellow (until 15/06/13)
Thales De Oliveira, ERC Fellow
Alexander Govyadinov, ERC Fellow
Martin Schnell, ERC Fellow
Edward Yoxall, ERC Fellow

Pre-doctoral researchers
Iban Amenabar, FPI Fellow, Infrared near-field imaging and near-field spectroscopy of biological nanostructures
Florian Huth, ERC Fellow, nano-FTIR - Broadband infrared near-field spectroscopy
Roman Krutohvostovs, nanoGUNE Fellow, Characterization and application of infrared resonant scanning probe tips in near-field microscopy
Stefan Mastel, ERC Fellow, Near-field spectral contrast and enhanced sensitivity in s-SNOM
Paulo Sarriugarte, PFPI Fellow, Development of novel infrared near-field probes based on antenna and waveguide structures
Johannes Stiegler, nanoGUNE Fellow, Infrared spectroscopic near-field microscopy of nanoparticles and semiconductor nanowires (until 31/03/13)

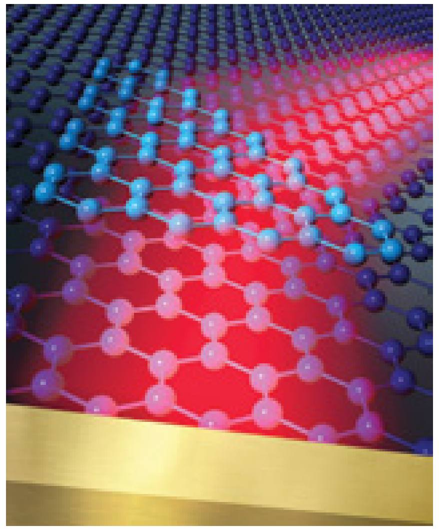
Master students
Francisco Javier Alfaro, UPV/EHU
Jana Damková, Brno University of Technology (until 12/08/14)

Undergraduate students
Iñigo Arrazola, UPV/EHU (until 17/08/13)
Nora Etxezarreta, University of Navarre (until 13/02/14)
Irati Soto, University of Navarre (until 16/07/14)

Technician
Carlos Crespo

Guest Researchers*
Francisco J. Bezares, ICFO (Spain)
Paul Scott Carney, University of Illinois (USA)
Dimitry Melnikau, Materials Physics Center (Spain)
Achim Woessner, ICFO (Spain)

FPI, predoctoral grant of the Spanish Government
PFPI, predoctoral grant of the Basque Government
* One-month stay minimum



Graphic representation of the refraction of graphene plasmons - launched by a tiny gold antenna - when passing through a one-atom-thick prism.

Alexander M. Bittner
Ikerbasque Research Professor
Group Leader

Self-Assembly

The Self-Assembly of molecules is a method to create complex nanoscale structures. Our research group is interested in one-dimensional structures, such as fibers and tubes, built from proteins. We use filamentous plant viruses as models because they feature the rare combination of well-defined chemical properties with a well-defined shape.

Our structures are useful as scaffolds to assemble and to confine liquids, with the long-term objective of handling extremely small amounts of liquids. Specifically for water, little is known about the wetting of protein surfaces, though it is essential for life. Moreover, the physical properties of water in and at nanostructures can be quite different from bulk water.

In our electrospinning projects we combine natural self-assembly with electrostatic forces, to arrange proteins and peptides into fibers. For basic research, we have achieved diameters as small as a single protein. For applications, we are developing instrumentation, and we are establishing the method for a large range of substances, from polymers to food.

We combine experimental approaches from biochemistry, chemistry, and physics. Hence, our partners are essential: With the nanodevices group, we focus on two-dimensional assembly of conductive polymers. Such sheets can be contacted by magnetic leads and open new avenues for spintronics. Our protein fibers are becoming standard substrates for the nanooptics group. We are starting to explore the theoretical approaches to water confinement together with the theory group. Moreover, much of our analysis is done together with the electron microscopy group.

Alexander M. Bittner
Ikerbasque Research Professor
Group Leader

PhD in Chemistry in 1996, Free University of Berlin (Germany)

Research Fellow
Mitsuhiro Okuda, Ikerbasque Research Fellow

Post-doctoral researchers
Marcin Gorzny, nanoGUNE Fellow (until 04/09/13)
Wiwat Nuansing, nanoGUNE Fellow
Amaia Rebollo, nanoGUNE Fellow (until 18/08/14)

Pre-doctoral researchers
María Cascajo, PI Fellow, Nanofluidics at single-molecule scale
Thales De Oliveira, ERC Fellow, Polythiophene-based nanoscale lateral devices (until 31/05/14)

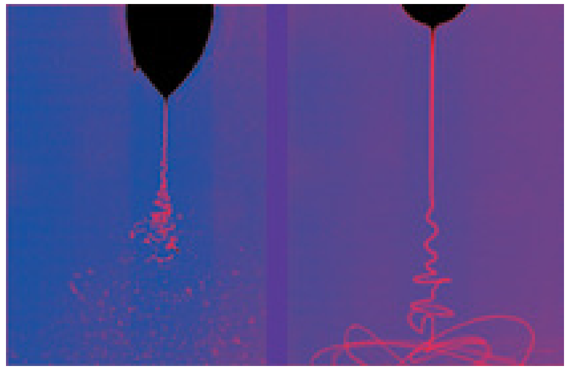
Master students
Nasim Tavakoli, UPV/EHU

Undergraduate students
Jon Arin, Bidasoa Technical College (until 02/06/14)
Aizeti Burgoa, UPV/EHU (until 26/08/14)
Aida Villarroel, UPV/EHU (until 16/08/13)

Technicians
Aitziber Eleta
Monika Goikoetxea, Innpacto Fellow

Guest Researcher*
Marie Suzanne Sylvie Morin, York University (Canada), Visiting Professor

PI, Basque grant
* One-month stay minimum



Electrospraying (left) and electrospinning (right). False color images, solution droplet black, charged jet red. Highly concentrated peptide solutions usually form jets, which break up into droplets, while polymer solutions form stable jets of micrometer diameter. The lower right part shows an irregular, unstable trajectory, which is typical for the electrospinning of nanofibers.

Raúl Pérez-Jiménez
Ikerbasque Research Professor
Group Leader

Nanobiomechanics

All living organisms feel and react to mechanical forces. Our skin, our muscles, and our bones are all designed to resist and function under force. We are able to walk because our muscles are capable of generating mechanical forces; our heart pumps blood creating a shear stress in vessels and arteries. Almost any biological process is related somehow with the existence of mechanical interactions. Unfortunately, this also includes diseases and disorders such as inflammation, tumor spread, heart failure, injuries, arthritis, etc. In addition, bacterial and viral infections occur with the interplay of mechanical forces at the molecular level, at the nanoscale.

The nanobiomechanics group, launched in February 2013, employs state-of-the-art techniques to investigate how mechanical forces impact the molecules that form living cells. From a multidisciplinary point of view, we are focused on proteins that are captured individually and studied in detail. From bacteria to animals and viruses, our group investigates biological process that occur under force and that are crucial for life, using single-molecule spectroscopy. This allows us to observe how the conformation of proteins changes under force and how forces can also trigger biochemical reactions.

We believe that studying the mechanics of proteins is essential to understand the development of many diseases. In particular, we investigate proteins involved in viral and bacterial infections. We also use imaging techniques such as confocal microscopy to investigate the dynamic interaction of viruses and bacteria with their target under mechanical stress. Our research provides new information that no other technique can reveal. We are discovering new aspects of microbial infections that could lead to new methodologies for treatment and prevention of microbial diseases.

Over the last two years, the group has investigated the implication of mechanical forces on HIV-1 infection. A recent work published in ACS Nano reveals, for the first time, how forces can affect the molecules involved in the interaction between the HIV virus and human cells. Using single-molecule AFM, the new data has shown unprecedented information that no other technique can reveal. Furthermore, we have developed new techniques based on molecular evolution to improve the efficiency of enzymes that could be used for biotechnological applications.

new group

Raúl Pérez-Jiménez
Ikerbasque Research Professor
Group Leader

PhD in Physical Chemistry in 2005, University of Granada (Spain)
Coming from Columbia University, New York (USA)
Joining date: 1 February 2013

Post-doctoral researchers
Simon Poly, nanoGUNE Fellow

Pre-doctoral researchers
Álvaro Alonso, nanoGUNE Fellow, Nanomechanics of cell-surface proteins
Nerea Barruetabeña, Evolgene Fellow, Ancestral cellulases for bioenergy
Aitor Manteca, nanoGUNE Fellow, Molecular evolution: Nanomechanic and biotechnological aspects

Undergraduate students
Faria Bruna, Federal University of São João del-Rei (until 07/06/13)
Maite Del Corte, Francisco de Vitoria University (until 17/01/14)
Mikel Novella, UPV/EHU (until 28/02/14)
Laura Ramos, UPV/EHU (until 16/08/13)
Bárbara Rodríguez, UPV/EHU
Ane Sáez, Don Bosco Technical College (until 07/06/14)
Laura Tato, Don Bosco Technical College (until 03/06/13)

Technician
Marie Fertin

Guest Researcher*
Jörg Schönfelder, Autonomous University of Madrid (Spain)

* One-month stay minimum

AFM tip where proteins adhere and can be mechanically stretched.

Nanodevices

A major challenge faced nowadays by the electronics industry is to find suitable materials to continue with the progressive size reduction of transistors. In this context, our group is focused on the study of the electrons behavior in a wide range of materials with nanometer dimensions. Some of these materials are potential candidates for future transistors, but they are also interesting for electronic memories, light-emitting or photovoltaic devices, and many other gadgets.

We are currently working in three main lines of research connected with possible applications in several industry fields. In the first place, we use very diverse methods to fabricate nanometric structures. In particular, we are focused on the use of electron-beam lithography, among other techniques, to produce electronic and photonic structures, and we are now able to reach down to 10 nm. Moreover, our expertise proves to be useful whenever we need to massively reduce the dimensions of any device.

In the second place, we are working on spintronics. This field is based on the use of the electron spin, a purely quantum mechanical entity, to transmit information: just as the electron charge is used in standard electronics. We implement different approaches for exploring how spintronics could become a niche field in the future electronics. One of our approaches is to merge spin transport in metals with interfacial spin studies using diverse molecules. An important collaboration within this field is our participation in the EU-funded project SPINOGRAPH, which aims to push graphene as a material for second-generation spintronic devices.

In third place, we are interested in electronic memories as a potential replacement of flash-memory devices. On the one hand, we are investigating resistive memory in oxides in order to understand the basic processes behind such effect. On the other hand, we are trying to replicate complex neuronal processes, such as learning and forgetting information, in a solid-state device. Within a collaborative project led by Argentinian colleagues, our memory devices are currently being tested in a satellite orbiting around the earth.

Luis E. Hueso
Ikerbasque Research Professor
Group Leader

PhD in Physics in 2002, University of Santiago de Compostela (Spain)

Fèlix Casanova
Ikerbasque Research Professor

PhD in Physics in 2003, University of Barcelona (Spain)

Research Fellows
Santiago Blanco, Ikerbasque Research Fellow
Pablo Stoliar, Ramón y Cajal Fellow

Post-doctoral researchers
Amilcar Bedoya, FP7 Fellow
David Ciudad, Marie Curie Fellow (until 31/07/14)
Marco Gobbi, ERC Fellow (until 31/08/13)
Federico Golmar, FP7 Fellow (until 30/04/13)
Subir Parui, ERC Fellow
Xiangnan Sun, ERC Fellow
Mariana Ungureanu, Juan de la Cierva Fellow (until 31/01/14)
Saül Vélez, ERC Fellow
Wenjing Yan, Marie Curie Fellow

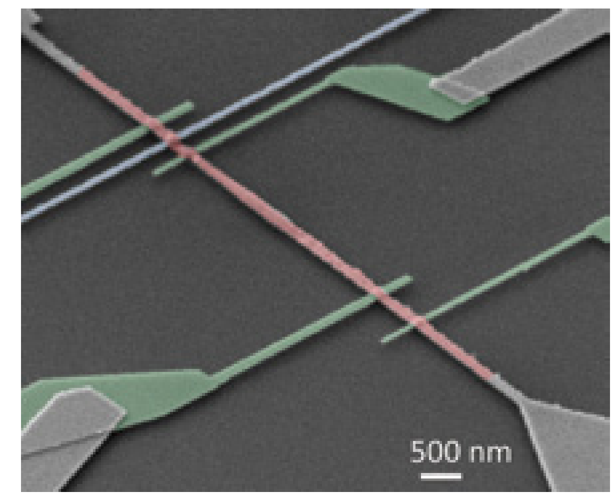
Pre-doctoral researchers
Libe Arzubiaga, PFPI Fellow, Electronic transport in molecular nanocontacts
Ainhoa Atxabal, nanoGUNE Fellow, Hot-electron devices
Miren Isasa, PFPI Fellow, Generation and detection of pure spin currents in metallic nanostructures
Emmanouil Masourakis, Marie Curie Fellow, Electronic transport in single molecular devices
Mário O. Ribeiro, Marie Curie Fellow, Control of spin injection and spin transport in graphene and other 2D crystals by molecular decoration
Luca Pietrobon, Marie Curie Fellow, Spintronics in graphene
Oihana Txoperena, FPI Fellow, Spin transport in 2D materials
Estitxu Villamor, PFPI Fellow, Spin injection, manipulation, and detection using lateral spin valves
Raúl Zazpe, nanoGUNE Fellow, Resistive switching in oxides (until 31/03/14)

Master students
Edurne Sagasta, UPV/EHU

Technician
Roger Llopis

Guest Researchers*
David Etayo, Das-Nano (Spain)
Sara Gómez, University of Valencia (Spain)
Miriam Sanz, University of Konstanz (Germany)
Néstor Fabián Ghenzi, National University of San Martín (Argentina)

FPI, predoctoral grant of the Spanish Government
PFPI, predoctoral grant of the Basque Government
* One-month stay minimum



Lateral spin valves (LSVs) are devices that enable the creation, transport, manipulation, and detection of pure spin currents, which are all essential ingredients for spintronics. These devices are fabricated using advanced nanofabrication techniques and they consist of two ferromagnetic electrodes, used to create/detect pure spin currents, and a nonmagnetic channel, where the spin current propagates. LSVs are interesting not only from the point of view of future applications, but also because they allow the understanding of different physical phenomena.

Electron Microscopy

Information about the structure and composition of materials is of key importance for the basic understanding of their properties and of the functioning of nanodevices. Moreover, our ability to characterize and understand these structures is critical for revealing the quality issues of existing products, providing answers for problems currently faced by industry. The Electron-Microscopy Laboratory provides a top-level electron-microscopy characterization and focused-ion-beam nanofabrication support for nanoGUNE's research groups and for the Basque R&D community, in order to face these challenges.

Our laboratory is specialized in high-resolution TEM imaging and structure analysis, local analysis of the composition of materials, prototyping of metal plasmonic structures, and the study of plasmonic resonances by electron energy-loss spectroscopy (EELS), visualization of magnetic fields by electron holography and Lorentz microscopy, nanofabrication using focused-ion and electron beams, as well as electron microscopy of wet and liquid materials.

During the last two years, we have developed a methodology for characterizing the dynamics of individual defects in graphene, giving access to a kinetic data on a single atom level. We have systematically studied a novel and technologically valuable method for the fabrication of functional nanostructures - electron-beam induced deposition of cobalt - and we have proposed a number of new approaches for the fabrication of magnetic nanodevices.

We maintain collaborations with many institutions in the Basque Country and abroad, the most valuable of those being UPV/EHU, biomaGUNE, Mondragon University, and FEI company. We are also involved in several ongoing international collaboration projects together with research institutions in Russia, Italy, Sweden, Finland, and France.

Electron Microscopy

Andrey Chuvilin
Ikerbasque Research Professor

PhD in Physics and Mathematics in 1998, Siberian Branch of the Russian Academy of Sciences, Novosibirsk (Russia)

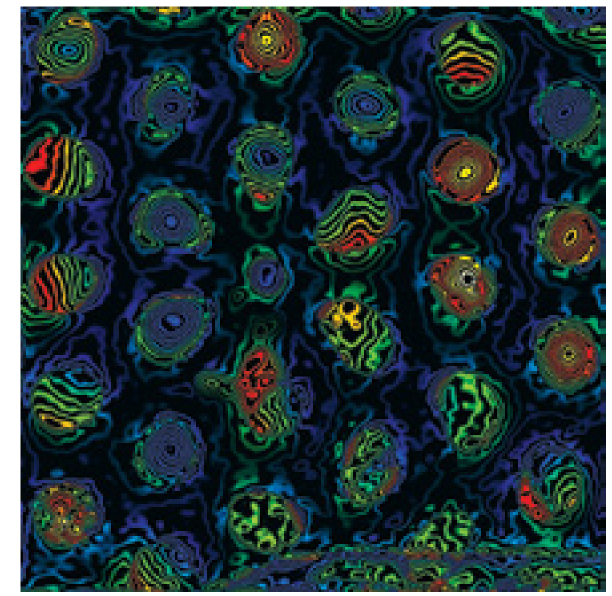
Post-doctoral researchers
Elizaveta Nikulina, FEI Fellow (until 13/05/13)
María Jesús Pérez, FEI Fellow

Undergraduate students
Javier Iturriria, Bidasoa Technical College (until 02/06/14)

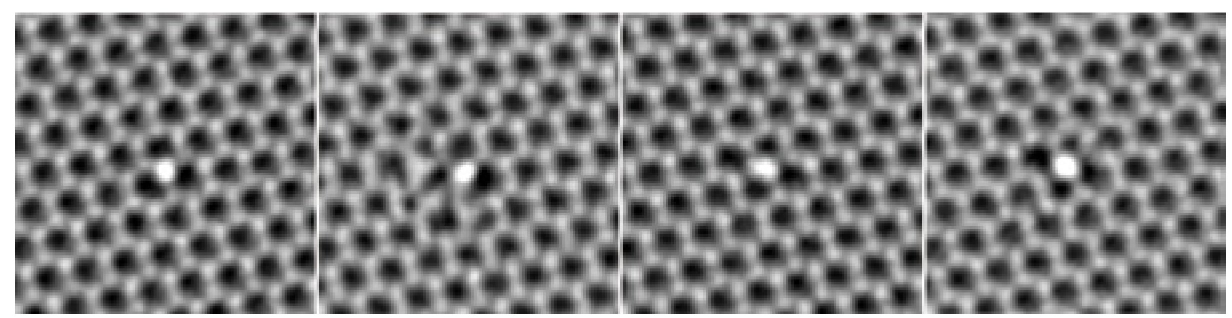
Technician
Christopher Tollan

Guest Researchers*
Olga Antonova, NIIC (Russia)
Lyubov Bulusheva, NIIC (Russia)
Victor Koroteev, NIIC (Russia)
Alexei V. Nashchekin, Ioffe Institute (Russia)
Yuliya A. Nashchekina, Ioffe Institute (Russia)
Ekaterina Obraztsova, Russian Academy of Sciences (Russia)
Eugenii Pustovalov, Far Eastern State University (Russia)
Valeria Zagaynova, Ioffe Institute (Russia)
Victoria Zhigalina, Shubnikov Institute (Russia)

NIIC, Nikolaev Institute of Inorganic Chemistry
* One-month stay minimum



The image displays the magnetic field lines inside the array of monocrystalline Co nanowires in a cross section imaged by electron holography. The nanowires are 20μm long and have a diameter of about 70nm. Concentric rings indicate that there are magnetic vortices inside the nanowires. The color depicts the chirality.



Evolution of a defect state around an impurity atom in graphene. The image sequence is obtained by an aberration-corrected high-resolution TEM at 60kV acceleration voltage.

Theory

Emilio Artacho
Ikerbasque Research Professor
Group Leader

In the Theory group we do theoretical simulations of matter at the nanoscale. Starting from the fundamental equations of quantum physics, which are the ones describing the behaviour of electrons and nuclei, we do "virtual reality" simulations of materials, nanoparticles, liquids, and their interfaces at the atomic scale, thereby gaining a very detailed view of their structure and dynamics, as well as predicting properties of interest for such systems.

Part of our work is in the development and improvement of simulation methods allowing the more effective simulation of systems of increasing complexity. Such developments are based on progress in the theoretical physics of solids and liquids, in a project called SIESTA that involves scientists in Spain (Madrid, Barcelona, San Sebastian, Santander), the USA (Stanford), and Australia (Perth). The Siesta method is used by thousands of scientists world-wide.

But we also use those methods in lines of research of interest to us, to nanoGUNE, and to the scientific and technological community in general. A prominent line of research in our group explores the behaviour of water and wet systems at the atomic scale, including nanoscale wetting and nano-confined water (in collaboration with the Self-Assembly group), and biomolecules in water (in collaboration with the Nanobiomechanics group). We also collaborate in this with scientists at the University of Stony Brook (USA) and the Autonomous University of Madrid (Spain). Understanding water confined at the nanoscale is extremely important for understanding the inner workings of cells. There is emerging evidence that water in such conditions is very different from bulk water, and it seems to play a much more active role than traditionally assumed in many biological processes.

Another important line of research is the study of radiation damage in materials, relevant to the treatment of cancer by ion therapy, for instance. When a charged particle shoots through a material or biological tissue, electronic excitation processes take place, which we try to understand with time-dependent (non-equilibrium) theories. This we do in collaboration with top players in the field: DIPC and CFM, both in the same campus as nanoGUNE, Helsinki, and several USA National Laboratories (Argonne, Los Alamos, and Livermore).

In other lines of research, we study low-dimensional structures as oxide thin-films for electronic devices, or graphene. The latter in collaboration with the Electron Microscopy group and with Graphenea. We are also in very close contact with Simune, the spin-off company that offers simulation services to industry.

Emilio Artacho
Ikerbasque Research Professor
Group Leader

PhD in Physics in 1990, Autonomous University of Madrid (Spain)

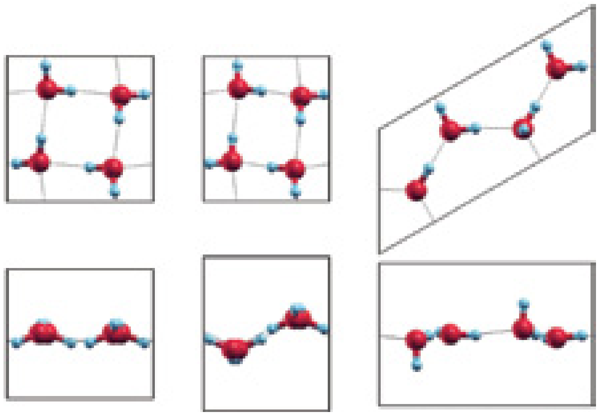
Post-doctoral researchers
Pablo Aguado, GFA Fellow
Fabiano Corsetti, nanoGUNE Fellow
Ester Sola, nanoGUNE Fellow (until 30/06/14)

Pre-doctoral researchers
Rafi Ullah, FPI Fellow, Non-adiabatic processes in the radiation damage of materials from first principles
Jon Zubeltzu, FPI Fellow, Theoretical simulation of nanoconfined water from first principles

Master students
Julen Arruti, University of Deusto (until 13/12/13)

Guest Researchers*
José Francisco García-Vidal, Autonomous University of Madrid (Spain)
Mario Gravina, University of Calabria (Italy)
Eleanor C. R. Green, University of Mainz (Germany)
Michele Pisarra, University of Calabria (Italy)
Andrea Maria Enrico Schiaffino, University of Milano (Italy)
Paul Matthews, University of Cambridge (UK)
Oliver Strickson, University of Cambridge (UK)
Binglun Yin, Zheijang University (China)

FPI, predoctoral grant of the Spanish Government
GFA, Regional Council of Gipuzkoa
* One-month stay minimum



Nano-confined monolayer ice. The different mono-layer phases of nano-confined ice have been obtained and characterized from first principles. In the upper panel the views from above (upper row) and the lateral views (lower row) are shown for the obtained phases: two tetracoordinated phases, one flat and square (left) and one rectangular and puckered (center), and one of the tricoordinated ones, of triangular symmetry and a honeycomb structure for the oxygen atoms (right). The ice rules have had to be revised for these structures: there is a hydrogen disordered phase for the triangular case, but not for the square/rectangular one. In the lower panel different configurations for hydrogen atoms are shown for the square phase, by depicting the dipoles of the molecules and the dipolar textures they generate. The most stable configuration is the one showing an array of topological defects of topological charge +1 and -1.

Nanomaterials

The Nanomaterials group is dedicated to the development of functional materials that will be the building blocks of new or improved technologies. Working with materials on the nanoscale allows for enhancing functionalities or even introducing completely new properties that are not present in the macroscopic shape of the materials.

With the aim of improving the application potential of different materials in catalysis, electronics, energy storage, and nanomedicine, we are developing functional materials in form of thin films, nanoparticles, nanotubes, or nanowires. In the last two years, our group has done a great effort towards the combination of inorganic materials with (bio-) organic materials as a new and promising approach, as the final compositions shall benefit from the properties of both constituting materials. For example, bio-inorganic nanocomposites were found to act as mimic for a number of enzymatic reactions while at the same time provide the ability to deliver drugs to cells in a controlled way.

Many industrial sectors, from the technology-based to the most traditional ones, are demanding new material compositions and structures, making our research highly compatible with their current need. With this respect, we are working together with industrial partners in order to exploit the technological opportunities our research field offers. Our collaborative partners include companies such as OSRAM (Germany) and Sefar (Switzerland) in the framework of a FP7 project, and Pirelli (Italy) in the framework of an international training network (ITN), but also research institutions including the Max-Planck Institute of Colloids (Germany), diverse institutes of the Fraunhofer society (Germany), EMPA (Switzerland), and many more. Locally, we collaborate with the University of the Basque Country, research institutions such as Tecnalia, microGUNE, Cidetec, and with several industrial partners including IKOR, AVS, Cadinox, and Leartiker.

Nanomaterials

Mato Knez
Ikerbasque Research Professor
Group Leader

PhD in Physical Chemistry in 2003, Max Planck Institute of Solid State Research, Stuttgart (Germany)

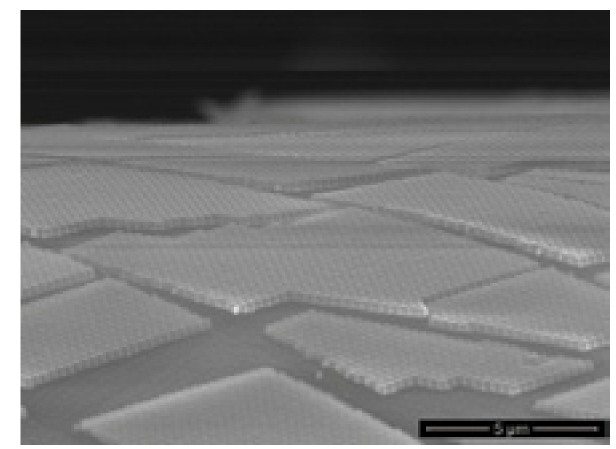
Post-doctoral researchers
Chaoqiu Chen, nanoGUNE Fellow
Keith Gregorczyk, FP7 Fellow (until 31/10/14)
Le Li, nanoGUNE Fellow
Lianbing Zhang, FP7 Fellow
Ana Zuzuarregi, FP7 Fellow

Pre-doctoral researchers
Unai Carmona, FP7 Fellow, Bio-inorganic nanoparticles for catalysis
Mabel Andrea Moreno, nanoGUNE Fellow, Hybrid materials with potential application in nanodevices by means of atomic layer deposition (ALD) (until 31/12/13)
Weike Wang, Marie Curie Fellow, Vapor phase doping and infiltration of conducting polymers
Fan Yang, nanoGUNE Fellow, Functionalization of materials through coating and infiltration by atomic layer deposition (ALD)

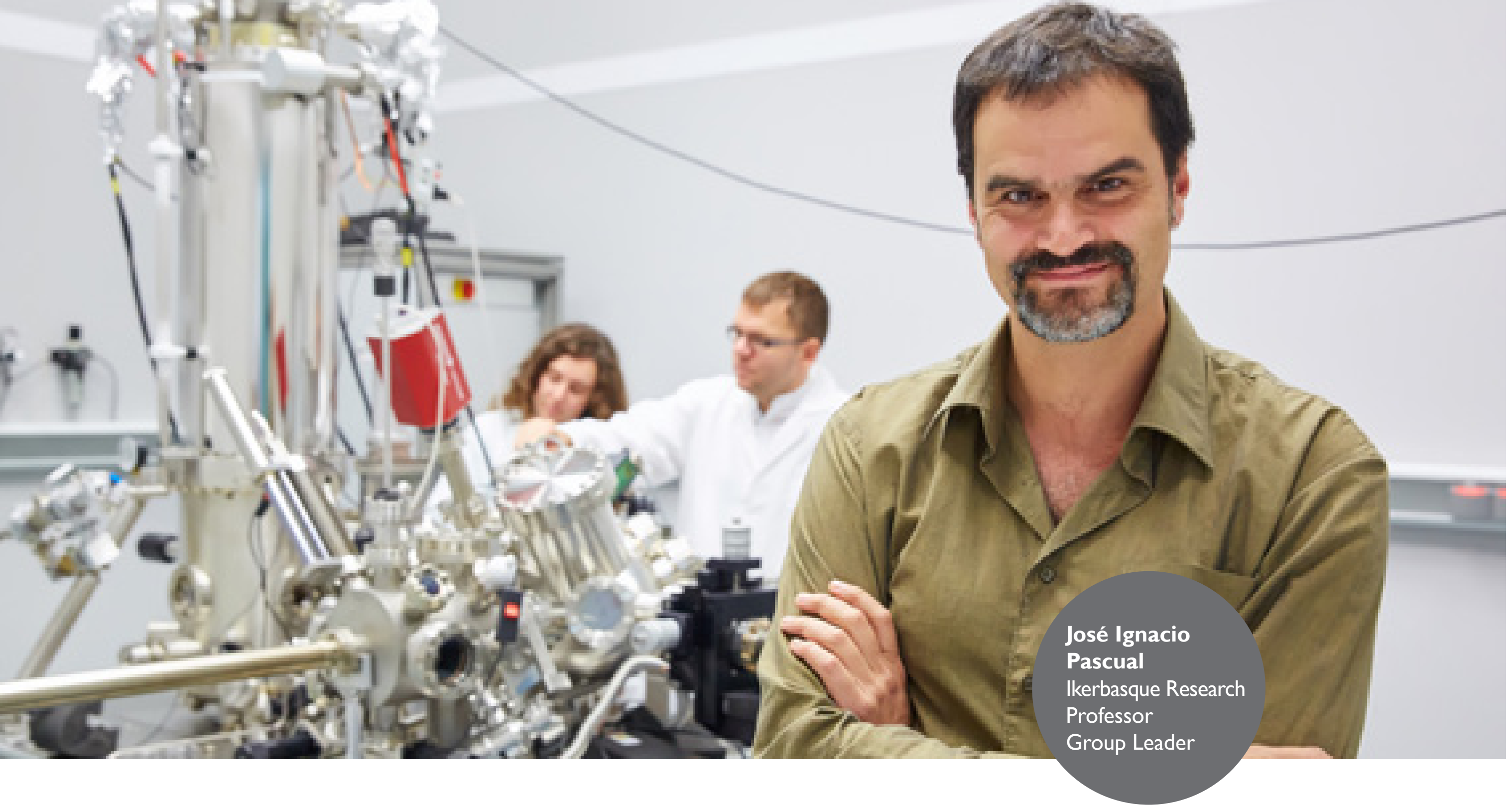
Master students
Itxasne Azpitarte, UPV/EHU
Alejandro Martín, UPV/EHU (until 15/08/14)
Miren García, UPV/EHU (until 31/07/14)

Undergraduate students
Edurne Peña, UPV/EHU (until 15/08/14)

Technicians
Mikel Beltrán



Nanostructured ceramic platelets deposited on a polymeric template by atomic layer deposition (ALD).



Nanoimaging

Nature behaves differently at the scale of atoms. Our group studies the quantum phenomenology of small objects, just formed by a small number of atoms or molecules, using scanning probe microscopies. The goal is to obtain models of their function that could make them relevant for the basis of novel materials.

A major field of research is single-molecule physics. Here, we study how well a molecule can transport electricity, emit light, or behave as a nanomagnet. We are particularly interested in creating hybrid molecular nanostructures with tailored properties by inducing reactions between molecules and atoms of different kind on the two-dimensional playground imposed by a surface. In these hybrid systems, fundamental properties such as electron mobility, magnetic ordering, and light absorption can be improved.

A current research line also studies how electrons injected into a nanostructure can produce light and, inversely, how the nanostructure can capture light, the basic processes in optoelectronic devices. The structures are much smaller than the wavelength of light, reaching sizes where quantum effects may play a role in the scattering of light.

Superconductivity is a quantum phenomenon in macroscopic scales. Little is known about their local properties and, in particular, how it is affected by magnetic impurities. We investigate different methods in which magnetic effects can modify the superconducting state of a metal.

These research fields are established in collaboration with various groups within nanoGUNE, and with university groups in Berlin, Zaragoza, Santiago de Compostela, and the Basque Country, as well as with research institutes such as ICN2 in Barcelona.

José Ignacio Pascual
Ikerbasque Research Professor
Group Leader

PhD in Physics in 1998, Autonomous University of Madrid (Spain)

Research Fellow
Richard Balog, Ikerbasque Research Fellow

Post-doctoral researchers
M. Reyes Calvo, Marie Curie Fellow
Jiangchen Li, DFG Fellow (until 31/01/14)
Zsolt Majzik, nanoGUNE Fellow

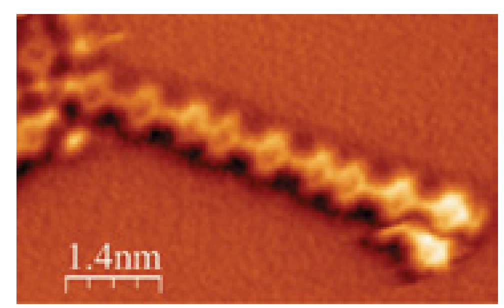
Pre-doctoral researchers
Eduard Carbonell, nanoGUNE Fellow, Light emission from quantum systems induced by tunneling electrons
Nieves Morquillas, FP7 Fellow, Quantum effects in the interaction of light with metallic nanostructures
Carmen Rubio, nanoGUNE Fellow, Ultra-low temperature study of the atomic limits of magnetism

Undergraduate students
Laura Arregui, UPV/EHU (until 31/08/14)
Miguel Borinaga, UPV/EHU (until 31/08/13)
Laura Viñolas, University of Navarre (until 31/05/13)

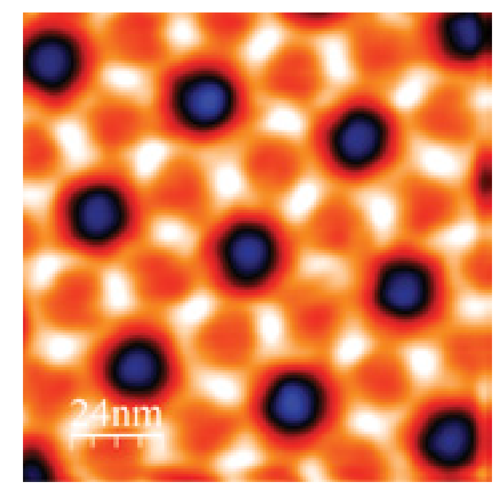
Technician
David Arias

Guest Researchers*
Martina Corso, Materials Physics Center (Spain)
Claudia Giallombargo, University of Calabria (Italy)
Mikel López, UPV/EHU (Spain)
Sascha Sadewasser, Iberian Nanotechnology Laboratory (Portugal)
Oscar Val, UPV/EHU (Spain)

DFG, Deutsche Forschungsgemeinschaft
* One-month stay minimum



Noncontact AFM image at 5 K of an oligophenyl polimer constructed on a Ag(111) surface via a Ulmann coupling reaction of three brominated precursors.



Constant heigth current image (V=1mV) of the vortex structure of an exfoliated $NbSe_2$ crystal in the superconducting state under a 1T magnetic field.

2 Research Outputs

143 ISI Articles

2 645 Citations

103 Invited Talks

Highlighted publications

1. Giant and reversible extrinsic magnetocaloric effects in $La_{0.7}Ca_{0.3}MnO_3$ films due to strain

   Nature Materials **12**, 52-58 (2013)

2. Transient behavior of the dynamically ordered phase in uniaxial cobalt films

   Physical Review Letters **111**, 190602 (2013)

3. Protection of excited spin states by a superconducting energy gap

   Nature Physics **9**, 765-768 (2013)

4. Structural analysis and mapping of individual protein complexes by infrared nanospectroscopy

   Nature Communications **4**, 2890 (2013)

5. Knock-on damage in bilayer graphene: Indications for a catalytic pathway

   Physical Review B **88**, 245407 (2013). Selected as Editor's Suggestion.

Highlighted publications

6. Two-dimensional programmable manipulation of magnetic nanoparticles on-chip

   Advanced Materials **26**, 2384-2390 (2014). Manuscript highlighted in the back cover of Issue 15.

7. Determination of energy level alignment at metal/molecule interfaces by in-device electrical spectroscopy

   Nature Communications **5**, 4161 (2014)

8. Controlling graphene plasmons with resonant metal antennas and spatial conductivity patterns

   Science **344**, 1369-1373 (2014)

9. Impurity-assisted tunneling magnetoresistance under weak magnetic field

   Physical Review Letters **113**, 146601 (2014)

10. Probing the effect of force on HIV-1 receptor CD4

    ACS nano **8**, 10313-10320 (2014)

1

Giant and reversible extrinsic magnetocaloric effects in La0.7Ca0.3MnO3 films due to strain

Nature Materials **12**, 52-58 (2013)

X. Moya, *L. E. Hueso,* F. Maccherozzi, A. I. Tovstolytkin, D. I. Podyalovskii, C. Ducati, L. C. Phillips, M. Ghidini, O. Hovorka, *A. Berger,* M. E. Vickers, E. Defaÿ, S. S. Dhesi, and N. D. Mathur

Magnetic cooling is a powerful environmentally friendly technology currently applied commercially for obtaining ultra-low temperatures. Here we show how such process can be performed without the need of external applied magnetic fields, opening a possible path for its integration in nanoelectronic devices.

The magnetocaloric effect present around the phase transition of ferromagnetic materials allows changing the temperature of an object by cycling the magnetic field. This effect was discovered many decades ago and until recently was only applied for obtaining ultra-low temperatures (in the mK regime) in laboratory experiments. Recently, however, researchers became aware that the magnetocaloric effect could provide an environmentally friendly path for magnetic refrigeration, even at room temperature. In the first place, the adiabatic cycles needed for the temperature change are performed without the need of environmentally dangerous gases such as CFC. In the second place, intense research on the magnetic materials size has increased both the magnitude of the effect (making it suitable for cooling relatively large quantities of materials) and the temperature at which it occurs (putting it closer to room temperature, where it would be needed for home refrigerators for example).

In spite of all these recent advances, the magnetocaloric materials need an external applied magnetic field for performing the cooling cycle. External magnets are usually expensive and bulky, impeding possible application of the magnetocaloric materials even if the effect itself is improved. In this article, we show that the magnetocaloric effect in a ferromagnetic material can be triggered by a structural phase transition in another material. For other study we prepared a layer of the ferromagnetic LCMO on top of a BTO substrate. BTO, a well-known ferroelectric material, has a structural phase transition at around 190 K. When the substrate changes structure, it transmits the stress to the ferromagnetic material grown on top and that stress promotes a magnetic phase transition. The main point here is that we can induce a magnetocaloric effect without the need of an external magnetic field.

> "Magnetic cooling made possible without magnets"

Certainly, our conclusion only applies so far to some materials in which the lattice distortions are coupled with other free variables, such as the magnetic order. Also, the effect is relatively small since we are considering thin films and not massive bulk samples. However, these limitations could be downgraded when thinking of specific niche applications, such as for example using this specific class of strongly correlated materials for cooling electronic devices at the nanoscale. Since electronic heat (specially coming from massive data storage servers) is at the heart of energy expenditure for many internet-base companies, any possible reduction could lead to huge savings.

> "Strongly correlated materials show yet again a striking property"

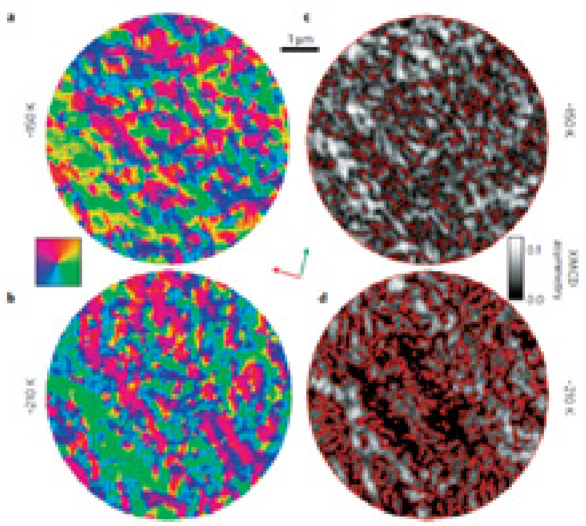


Figure
Local magnetic properties of the magnetic film measured by magnetic circular dichroism above and below the temperature of the structural phase transition of the substrate.

2

Transient behavior of the dynamically ordered phase in uniaxial cobalt films

Physical Review Letters **111**, 190602 (2013)
A. Berger, O. Idigoras, and *P. Vavassori*

This work demonstrates that dynamic responses of magnetic systems, which are very important for technical applications of magnetism such as data storage, follow pattern and laws that are very similar to the laws of thermodynamics. Hereby, it is crucial to properly identify the dynamic quantities that describe the order of the response pattern and the control parameters that define the phase space.

The dynamic response of a ferromagnetic material to external perturbations, especially time-dependent magnetic fields, is a crucial research topic due to its fundamental relevance, and even more so, because applications of magnetic materials most commonly involve time-dependent magnetic field patterns, such as in magnetic data storage, for instance. While the field-induced dynamic behavior can be generally well described on a microscopic level, the predictive power of the corresponding equations for large systems or long time scales is very limited. Our combined experimental and modeling study demonstrates that an alternative approach similar to equilibrium thermodynamics is feasible to describe and understand the long-term behavior of dynamically driven magnetic systems far away from equilibrium.

In our experiments, we apply a sinusoidal magnetic field $H(t)$ to our uniaxial Co film samples and monitor the magnetization response $m(t)$, using a highly sensitive magneto-optical detection method. In particular, we study how the magnetic response pattern changes as we vary the frequency or period P of the exciting magnetic field. Figure 1 (a) – (d) indicates the expected response. For slow field oscillations, i.e. large P, the magnetization can follow the magnetic field very well, because P is significantly larger than the time constant τ that describes the internal dynamics of the magnetic system. In this case, the magnetization simply oscillates back and forth, so that the time averaged magnetization $Q = < m >$ vanishes. However, if P falls below a critical value, the magnetization cannot follow the external excitation anymore and Q starts to deviate from zero. At this point more than one dynamic solution is possible, so that the magnetic system passes a bifurcation point upon reducing P, which can be described as a non-equilibrium phase transition. Our experimental measurements, such as the ones shown in figures 1 (e) – (h) now demonstrate that it is possible to switch between the different dynamic order states by using a static bias field H_b, which acts as the conjugate field to the order parameter Q. Our experiments demonstrate unambiguously that the dynamically ordered states have a stable and a metastable existence range, and they furthermore show that the entirety of the dynamically observed behavior can be understood in the framework of an equation of state, which is equivalent to the thermodynamics of magnetic systems in thermal equilibrium.

> "Our experiments demonstrate that the dynamics of magnetic systems can be described by laws that are very similar to the laws of thermodynamics"

This is a major advance, because it demonstrates the feasibility to create a scientific framework similar to thermodynamics that is able to describe a dynamic pattern far away from equilibrium for length and time scales that are inaccessible to microscopic approaches. The viability of such theoretical approaches to describe the experimental dynamic behavior is visualized in figure 2, which shows a side-by-side comparison of experiment (figures 2 (a) – (d)) and theory (figures 2 (e) – (h)). Figures 2 (a) and (e) show the stable state order parameter Q dependent on the field oscillation period P and the magnetic bias field H_b. All the other figures show the difference in Q, i.e. ΔQ, in between measurements with decreasing and increasing bias field, such as the ones shown in figures 1 (e) – (h). Correspondingly, the plots in figure 2 identify the bistability regime for different choices of the oscillating field strength, illustrating the consistency between experiment and the equation of state based theoretical model.

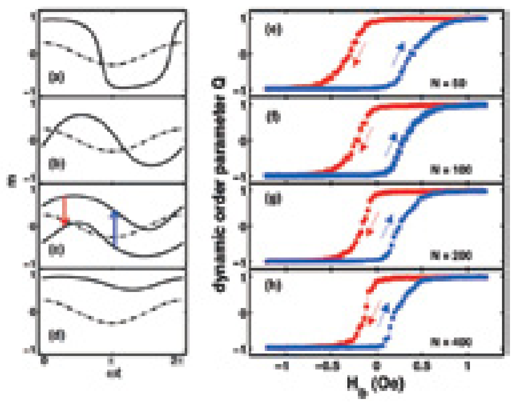


Figure 1

(a) – (d) show the simulated magnetization vs. time behavior (solid lines) that occurs in response to an oscillating magnetic field (dot-dashed lines) for different oscillation periods P. In (a) and (b), P is larger than the critical period P_C, namely P/P_C = 4.232 and P/P_C = 1.185, respectively. In (c) and (d), P is lower than P_C, specifically P/P_C = 0.888, leading to dynamic states that do not oscillate symmetrical around $m = 0$ anymore, but instead lead to a time average magnetization value $< m > = Q$ that is either larger or smaller than zero. In (d), the application of a static bias field H_b leads to the suppression of one of the ordered dynamic states, leaving only one in existence. In (c), the process of changing between different dynamic states is indicated. (e) – (h) show data, in which the switching between different dynamic states is experimentally demonstrated for different numbers N of field oscillations at each H_b value. The transition between the dynamically ordered states is hysteretic, with the extent of hysteresis reducing upon increasing the "measurements time" N.

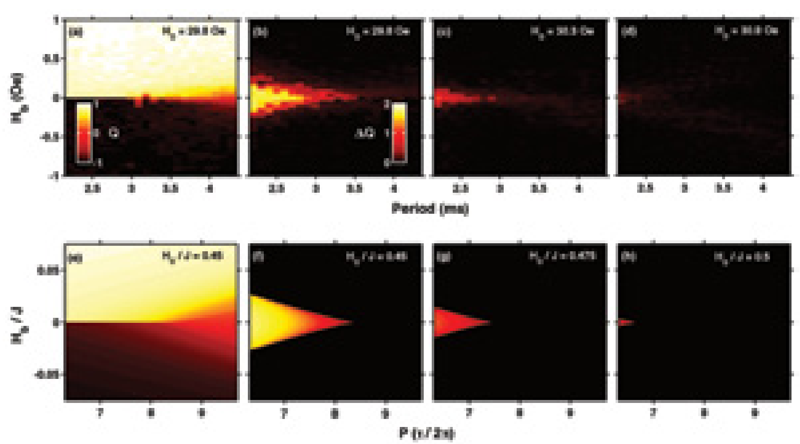


Figure 2

Q and ΔQ data as a function of P and H_b displayed as color-coded maps: (a) – (d) are experimental data, while (e) – (h) display the results of numerical simulations based upon a mean-field approximation. (a) and (e) show the stable dynamic order parameter $Q(H_b,P)$. The color code shown in (a) applies to (a) and (e). (b) – (d) and (f) – (h) show $\Delta Q(H_b,P)$ for measurements and calculations with the corresponding color code for all figures displayed in (b) only. H_0 values are given in each map.

3

Protection of excited spin states by a superconducting energy gap

Nature Physics **9**, 765-768 (2013)
B. W. Heinrich, L. Braun, *J. I. Pascual,* and K. J. Franke

A challenge for computation with spins is controlling their orientation by using electrical impulses, as a method for encoding and reading a piece of data. However, the surrounding media may destroy the information faster than one can access it. We found that a superconductor surface assists in protecting spin states from quenching.

Future computation strategies aim at storing, computing, and reading information using quantum phenomena. Among the many atomic-scale processes devised as promising to be used as quantum bits, the spin orientationof electron or nuclei spins are most promising because they have intrinsically have long coherence lifetimes, and are prone to interact with photons, electrons and among them. Ideally, to compute with spins, one should be able of manipulating the spins to one certain state, keeping them at a certain state for long time scales to be allowed to interact, and reading their state after a certain time. The search of ideal systems, as well as methods to excite and read the quantum states of spins is an active part of research.

Our approach to this field is to investigate atomic spins of individual atoms and ions embedded inside organic cores which ideally protect the quantum state of their spin. "Magnetic molecules" such as the one shown in the figure are deposited on a metal surface and their magnetic behaviour studied using low temperature scanning tunneling microscopy (STM). The spin state of individual metal-organic molecules can primarily point along certain directions and be manipulated by means of inelastic tunneling electrons injected from the STM tip. Contrary to normal (elastic) electrons, inelastic electrons exchange energy and angular momentum with the isolated spin and can, in this way, be excited to states pointing towards another direction. However, when the atom is deposited on a metal surface, the time this new excited state lives is very short, returning very quickly to its preferred, ground state. This hinders the reading of spins excitations.

We demonstrated that using a superconductor surface as a substrate can help to maintain a spin excitation for several nanoseconds, a time scale about 10 000 times larger than typical values on a normal metal surface. As magnetic atom, we used iron embedded in an organic porphyrine molecule. The excitation of the spin into new quantum states was detected as duplication of the superconductor coherence peaks in scanning tunneling spectra, which is a fingerprint of the inelastic spin excitation.

> "A superconductor protects the spin state of a molecule, which can survive for nanoseconds"

> "We can write and read the spin state of an individual atom using electrical currents"

Interestingly, the inelastic spectra changed with increasing tunneling current, revealing additional spin excitations to higher states. This fact was a clear indication that the intermediate states lived for times comparable to the time interval between tunneling electrons induced two sequential excitations to higher states. Fitting the excitation process with rate equations we could quantitatively determine an excitation lifetime of 13 ns, a much larger time than the typical sub-picosecond lifetimes often found for molecules on normal metals.

The origin of the drastic enhancement of spin excitation lifetimes is the complete absence of electronic states within the gap of the superconducting surface. For this molecular system, the excitation energy is smaller than the width of the superconductor gap. Because of this, the excitation energy given by the inelastic electrons could not be deposited back into the surface, and the spin lived for long times. In this way, the superconductivity "protects" the magnetism of the atom and facilitates the processes of writing and reading its spin state. These results will drive forward the exploration of new methods of information storage and quantum computation on an atomic scale.

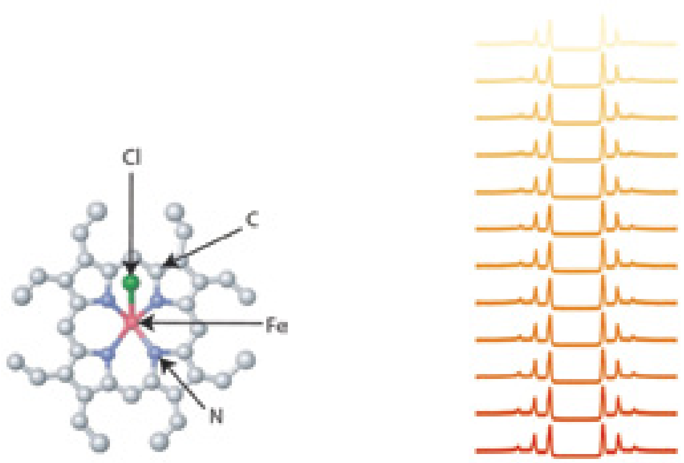


Figure
(left) Atomic structure of the Fe-Octaethylporphyrin-Chloride (FeOEP-Cl) molecule used for this experiment, indicating the chemical nature of each atom. (right) Sequence of differential conductance spectra measured on top of the center of an FeOEP-Cl molecule. From top to bottom, the spectra was acquired consecutively by approaching the STM tip 125 pm towars the molecule.

4 Structural analysis and mapping of individual protein complexes by infrared nanospectroscopy

Nature Communications **4**, 2890 (2013)
I. Amenabar, S. Poly, W. Nuansing, E. H. Hubrich, *A.A. Govyadinov, F. Huth, R. Krutohvostovs, L. Zhang, M. Knez,* J. Heberle, *A. M. Bittner,* and *R. Hillenbrand*

Nanoscale Fourier transform infrared (nano-FTIR) spectroscopy was employed for label-free chemical and structural imaging of proteins with nanoscale spatial resolution, beating the diffraction limit in infrared bio-spectroscopy by orders of magnitude. We demonstrated sensitivity to single protein complexes of less than one attogram (10^{-18} gram) and nanoscale probing of a secondary structure in individual protein complexes and fibrils.

Proteins are basic building blocks of life. The chemistry and structure of proteins are essential for their biological function. Indeed, the structure of proteins determines their mechanical and catalytic properties (e.g. enzymes). Such functions literally shape all living beings. Furthermore, the protein structure also plays a major role in many diseases. For example, the secondary structure of a protein (whether it has alpha-helical or beta-sheet internal substructures) is highly relevant in the pathogenous mechanism leading to Alzheimer, Parkinson, and other neuro-degenerative diseases. Although a variety of methods have been developed to study the protein chemistry and structure, recognizing and mapping the secondary structure on the nanometer scale, or even with single protein sensitivity, is still a major challenge. We recently demonstrated a new method for nanoscale chemical imaging and probing of protein secondary structure based on nano-FTIR spectroscopy.

nano-FTIR is an optical technique that combines scattering-type scanning near-field optical microscopy (s-SNOM) and Fourier transform infrared (FTIR) spectroscopy. The latter is a tool often used for studying secondary structure of proteins that, however, does not allow for nanoscale mapping of proteins by itself. In nano-FTIR, a sharp metalized tip is illuminated with a broadband infrared laser beam, and the backscattered light is analyzed with a specially designed Fourier transform spectrometer. The tip acts as an antenna for infrared light and concentrates it at the very apex, as illustrated in the figure. The nanofocus at the tip apex can be thus considered as an ultra-small infrared light source. It is so small that it only illuminates an area of about 30x30 nm, which is the scale of large protein complexes.

In order to demonstrate the versatility of nano-FTIR for nanoscale-resolved protein spectroscopy, we measured infrared spectra of single viruses, ferritin complexes, purple membranes, and insulin fibrils. The virus we employed, the tobacco mosaic virus, and the ferritin mainly contain alpha-helical structures, while insulin fibrils are constructed from beta-sheet structures. In a mixture of insulin fibrils and a few viruses, standard FTIR spectroscopy did not reveal the presence of the alpha-helical viruses. By probing the protein nanostructures one by one with nano-FTIR, we could clearly identify the virus, i.e. the alpha-helical structures within the beta-sheet ones.

> “nano-FTIR improves the spatial resolution of conventional infrared spectroscopy more than 100 times”

An important aspect of enormous practical relevance is that the nano-FTIR spectra of proteins match extremely well with conventional FTIR spectra, while the spatial resolution is increased by more than 100. We were able to record infrared spectra of even single ferritin particles. These are protein complexes of only 24 proteins. The mass of one ferritin complex is extremely small, only 1 attogram, but we could clearly recognize its alpha-helical structure.

We also studied single insulin fibrils, which are a model system for neurodegenerative diseases. It is known that the core of insulin fibrils is made of beta-sheets; but their complete structure is still not fully clarified. In nano-FTIR spectra of individual fibrils, we recognized not only a beta-sheet structure, but also alpha-helical structures, which might be of relevance for fibril association.

Tips with sharper apex and improved antenna function might enable in the future infrared spectroscopy of single proteins. We foresee manifold applications, such as studies of conformational changes in amyloid structures on the molecular level, the mapping of nanoscale protein modifications in biomedical tissue, or the label-free mapping of membrane proteins. This could lead to a new era in infrared nano-bio-spectroscopy.

> “nano-FTIR sheds light on single protein complexes”

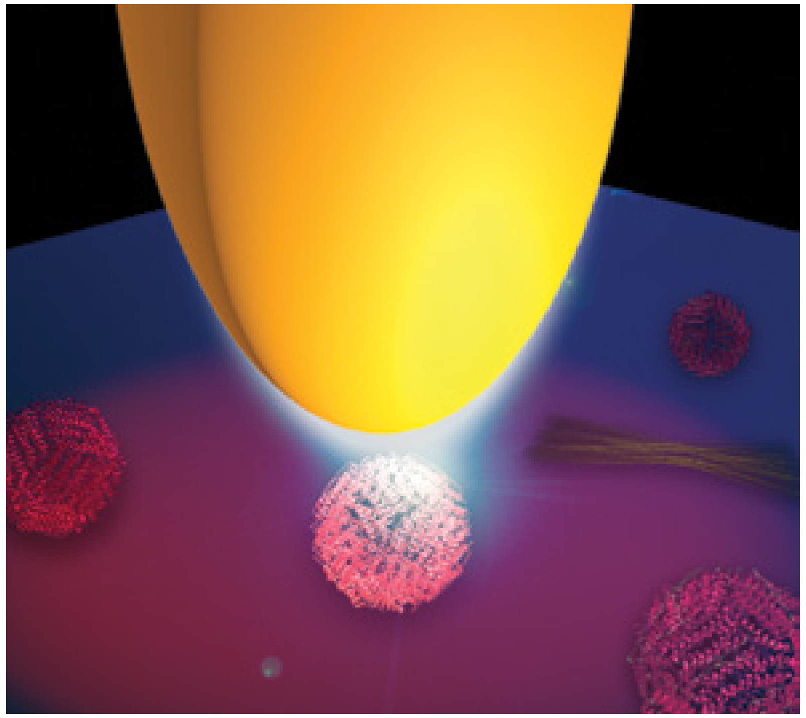


Figure
Illustration of infrared protein nano-spectroscopy. A metal tip (yellow) is illuminated with infrared light. Due to the antenna function of the tip, the light is concentrated at the tip apex and creates a nanofocus, which illuminates the protein.

5

Knock-on damage in bilayer graphene: Indications for a catalytic pathway

Physical Review B **88**, 245407 (2013). Selected as Editor's Suggestion.
J. Zubeltzu, A. Chuvilin, F. Corsetti, A. Zurutuza, and *E. Artacho*

Aberration-corrected high-resolution transmission electron microscopy on high-quality graphene samples shows atomic-scale defects in graphene with great clarity. A certain defect, the "butterfly" defect, was observed in the images and was found to be induced by the electron irradiation of the microscope itself. Interestingly, however, it appears in bilayer graphene at electron energy and flux at which it is not formed in monolayer graphene, even though the defect is of one layer only (the other remains pristine) and the interaction between the layers is weak and unlikely to stabilize the defect. A theoretical study based on density-functional simulations and first-principles molecular dynamics allowed us to understand the phenomenon: one layer acts as catalyzer for the radiation to induce the defect on the other.

Graphene is a two-dimensional material that has revolutionized materials research and nanoscience in the last decade, with prospects of applications in many fields of technology. Defects in materials have always been important, in both the degradation and the improvement of desired properties, and this is also the case for graphene. In this context, we have investigated the formation of a very intriguing defect, called the butterfly defect (see Figure 1) appearing under electron irradiation. It consists of a rearrangement of atoms and bonds that gives the pattern shown in the figure (with pentagons and heptagons, and a rotated hexagon in the center), in which two C atoms are missing from what would have been the normal pattern. The rearrangement is such that all carbon atoms are three-fold coordinated, as in perfect graphene. The intriguing aspect arises from the fact that it appears in bilayer graphene (two atomically-thin layers) under irradiation conditions under which no such defects appear in monolayer graphene. How can this be? The layer-layer interaction in bilayer graphene is too weak to justify this behaviour. But the phenomenon is indisputably observed in experiments done by the Electron Microscopy group at nanoGUNE on graphene samples grown by Graphenea. The butterfly appears in just one of the layers, but always when there is a second layer present.

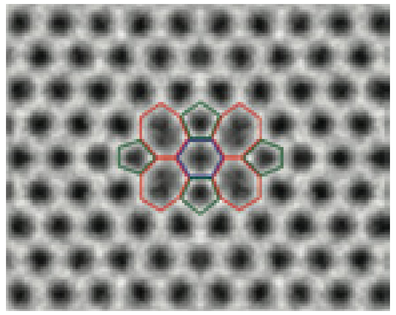


Figure 1
Transmission electron microscopy image of graphene with a butterfly defect. The overlaid colour lines indicate the pentagons, heptagons, and central hexagon associated to the bivacancy defect. The central hexagon is rotated with respect to the others in graphene.

First-principles simulations of the defect in both monolayer and bilayer graphene gives us a quite detailed view on how the second layer modifies both the structure and the formation energy of the defect (see Figure 2). As expected, the alteration is very small and does not explain the observations: if the butterfly does not appear in monolayer graphene it should also be the same in bilayer graphene.

We then looked at the kinetics of the process, with extensive simulations of *ab initio* molecular dynamics: simulating the kick that a carbon atom would receive from a direct hit of an electron, we could follow the motion of that atom and all the atoms around. We found that in order to have an atom ejected from the sample very similar electron energies were needed for monolayer and bilayer graphene. The key difference was found when realizing that in some cases an electron with lower energy than needed for full ejection would displace an atom to a metastable situation between both layers, that is, an intermediate state accessible in bilayer, but not in monolayer graphene. Although in many occasions the atom would have time to fall back to its original position, in some cases the lifetime of the metastable state appeared to be long enough to survive until a second electron would hit it again and unbind it from the vacancy left behind. Essentially, the existence of the second layer opens a reaction path for the vacancy formation that lowers the effective energy barrier of the process providing an intermediate metastable state. This is exactly what a catalyst does; the second layer catalyzes the vacancy formation. Once the monovacancy is formed, the system re-arranges in a way that is quite susceptible for having a second atom ejected, thereby producing the bivacancy and the ensuing butterfly defect. The estimates of rates from energies obtained from the calculations allow estimating concentrations of defects, which fit quite well with observation. Indeed, once we understood the mechanism, other defects could be found in the TEM images that could be identified as the long-lived intermediate state with two interstitial atoms.

> "We have explained the 'Butterfly' defect in bilayer graphene"

A collaboration between experiments and theory has allowed the unraveling of a rather puzzling behavior; but, more importantly, it has unveiled the self-catalytic capabilities of graphene in this kind of processes.

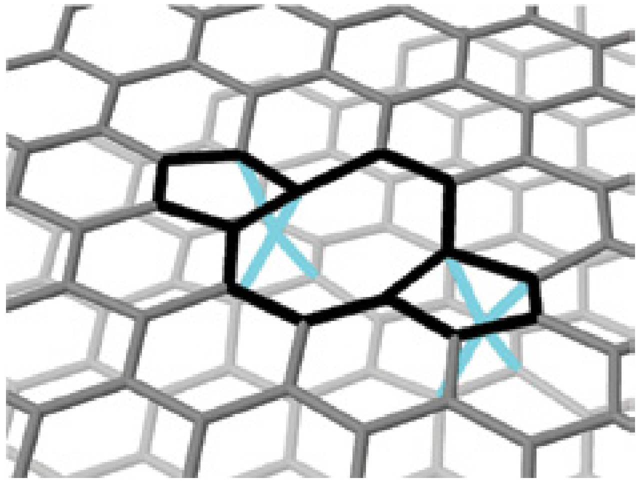


Figure 2
Results of simulations for structure relaxation and energy stabilization of the bi-Frenkel defect made by a bivacancy in the upper layer and two interstitial atoms bridging both graphene layers.

6

Two-dimensional programmable manipulation of magnetic nanoparticles on-chip

Advanced Materials **26**, 2384-2390 (2014). Manuscript highlighted in the back cover of Issue 15.
A. Sarella, A.Torti, *M. Donolato, M. Pancaldi,* and *P. Vavassori*

A novel device for on-chip remote manipulation of fluid-borne magnetic particles is demonstrated. The device is based on the combination of differently shaped ferromagnetic nanorings and field sequences that allows for selective trap and remote manipulation of magnetic particles with high precision along any arbitrary pathway on a chip surface.

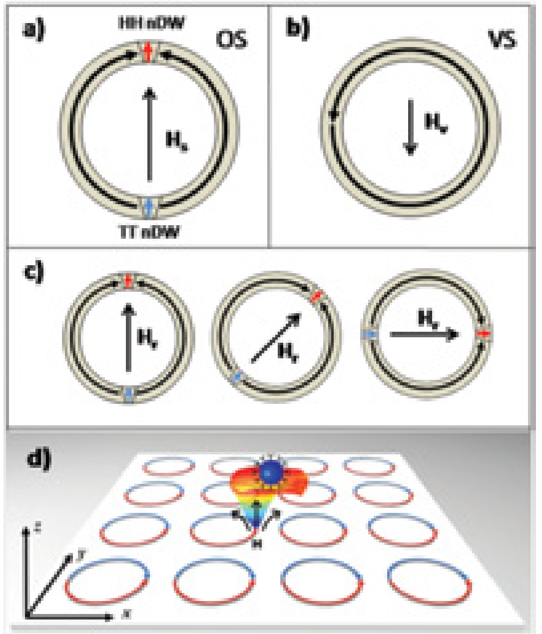
Recent developments of single-molecule manipulation techniques have opened the way to single-molecule biophysics, viz., the study of biomolecular interactions at the level of individual molecules. The advantages of single-molecule biophysics are many: apart from the fascination of looking at individual biomolecules at work, single-molecule techniques could measure intermediates and follow time-dependent pathways of chemical reactions and folding mechanisms that are difficult or impossible to synchronize at the ensemble level, helping to unveil the underlying molecular mechanism of biological processes and to address key issues in protein, nucleic acid, and cellular kinetics and functions. Besides application to biophysical research, remote and precise manipulation of magnetic particles is required to meet the demands for high-throughput and location-specific analysis in lab-on-chip applications. In the last decade many techniques have been developed for the remote manipulation of fluid-borne magnetic particles for accomplishing different tasks in biology, medicine, and chemistry. Magnetic tweezers are commonly employed for the handling of individual magnetic microparticles and nanoparticles with nanoscale accuracy over a limited spatial area. Microfabricated current wires and micromagnets allow simple transport of magnetic particles as well as complex operations such as continuous sorting and enhanced mixing; however, with a loss in the spatial accuracy. Although the individual strategies mentioned above have been developed to separately address one or more of the required tasks, techniques that permit an encompassing approach have yet to be achieved. In addition, the tools developed so far to achieve single-molecule manipulation are highly sophisticated, very specialized, require accurate calibration, and can produce substantial heating.

Here, a novel device concept is presented that enables a vastly improved and encompassing approach to the two-dimensional accurate manipulation of magnetic nanoparticles over large areas with a control at the single unit and at the nanoscale level on a chip surface. The device operation relies on the field-driven displacement of constrained domain walls (CDWs) in ring-shaped nanoscale ferromagnetic conveyors pre-patterned on a chip and their magnetostatic coupling with fluid borne superparamagnetic particles. We realized two test devices that prove the remote manipulation of individual and multiple magnetic nanoparticles on a chip surface.

> "We have demonstrated and developed a novel device concept for a two-dimensional remote manipulation of fluid-borne magnetic beads"

The vastly extended manipulation capabilities offered by the devices concept described here together with the possibility to directly integrate CDWs conveyors into recently established microfluidic devices [Adv. Mater **25**, 623 (2013)] and the utilization of nanoparticles as carriers of biomolecules and cells [Adv. Mater **22**, 2706 (2010)] open up a broad variety of new avenues in biology, medicine, chemistry, and even photonics, since nanoparticles can be assembled on a surface remotely controlling the distance and symmetry of the assembly for the realization of two-dimensional colloidal photonic crystals with adjustable optical band gaps.

In conclusion, we have demonstrated and developed a novel device concept for a two-dimensional remote manipulation of fluid-borne magnetic beads along any arbitrary pathway on a chip surface, with a high potential to open up a broad variety of new avenues.



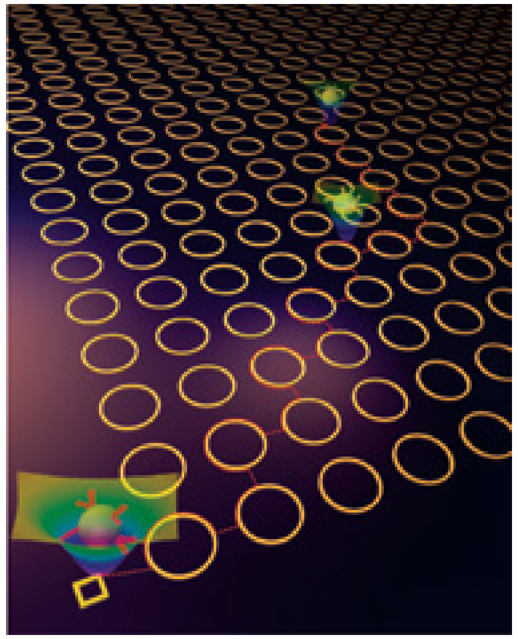


Figure 1
(a) Nucleation of an onion-like-state (OS) with two constrained domain walls head to head (HH CDW) and tail to tail (TT CDW) in a ferromagnetic circular ring, by applying an external magnetic field H_s; (b) Flux closure vortex state (VS) induced from an OS by a reversal field H_v; (c) Synchronous rotation of the HH and TT CDWs in an OS induced by a rotating field H_r; (d) Magnetic potential well generated by the interaction of a magnetic particle and a CDW in an array of rings. Red and blue arrows depict the magnetic domains inside the rings.

Figure 2
Cartoon sketching a fluid-borne magnetic nanoparticle surfing a chip surface patterned with ring-shaped constrained domain walls nano-conveyors.

7

Determination of energy level alignment at metal/molecule interfaces by in-device electrical spectroscopy

Nature Communications **5**, 4161 (2014)

M. Gobbi, L. Pietrobon, A.Atxabal, A. Bedoya-Pinto, X. Sun, F. Golmar, R. Llopis, F. Casanova, and *L. E. Hueso*

The energy level alignment at metal-molecular interfaces determines the performance of many devices present in our everyday lifes (such as organic light emitting diodes or OLEDs). Here we present a technique which allows us to determine such information with a simple device and in realistic conditions.

Organic electronic devices are present in our everyday lifes. For example, currently many mobile phones feature screens with organic light emitting diodes. Other examples are organic photovoltaic devices. A critical factor that determines the performance of such devices is the energy difference between the metal and the organic molecules conductive levels. Unfortunately, it is extremely different to know the information *a priori*. It is possible to determine the energy alignment experimentally by sophisticated techniques such as photoemission and inverse photoemission spectroscopy. However, these techniques need very extreme conditions, such as ultra-high vacuum, which are very different from the real operative conditions of the actual practical devices.

In this article we have presented a technique called hot-electron spectroscopy, which allows us to determine the metal-molecular energy alignment in a simple way and in realistic conditions.

Hot electrons are electrical carriers with an energy that is much higher than the Fermi level of a metal. We have fabricated an electrical device composed by different metal and insulating layers together with the metal-organic interface we want to study. Thanks to the design devised, we can fire electrons with variable energy towards the interface energy barrier. When the voltage provided to the electrons is lower than the energy barrier, they cannot cross it and they are subsequently not recorded as current in a collector electrode. However, when the voltage of the electrons is higher than the energy barrier they can be effectively collected. The threshold can be very easily determined in an electrical measurement. Moreover, the device we use is actually very similar to the ones used in practical commercial applications, thus facilitating the transfer of knowledge from the laboratory to industry.

As a proof of principle, we determined the energy barrier between different metals (such as gold, copper, and iron) and a prototypical molecular semiconductor (C_{60} fullerene). The results obtained agree perfectly with those obtained by photoemission spectroscopy. Moreover, when we use magnetic metals the results can be extended towards spintronics applications.

“We can now obtain key information about organic electronic devices with a simple device”

Currently we are expanding this technique to spin-coated polymers, which will expand the portfolio of materials we can study and will move us closer to commercial devices.

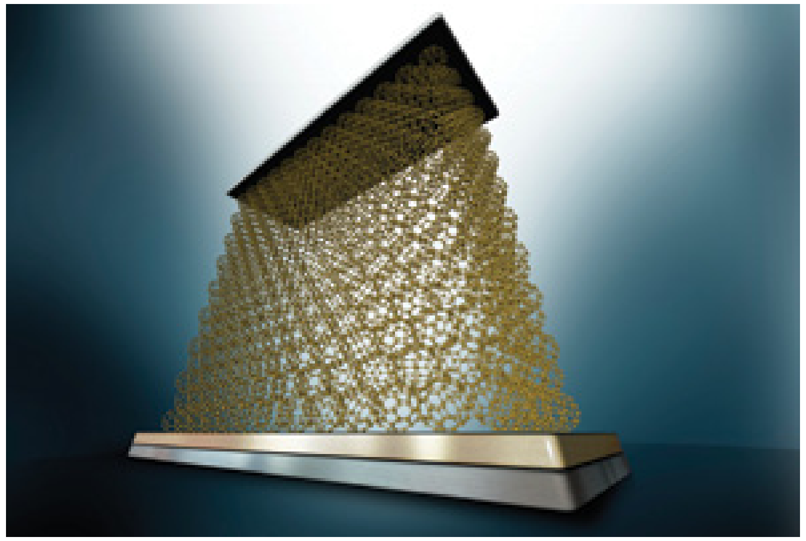


Figure 1
Schematic image of a hot-electron device with fullerene as molecular semiconductor.

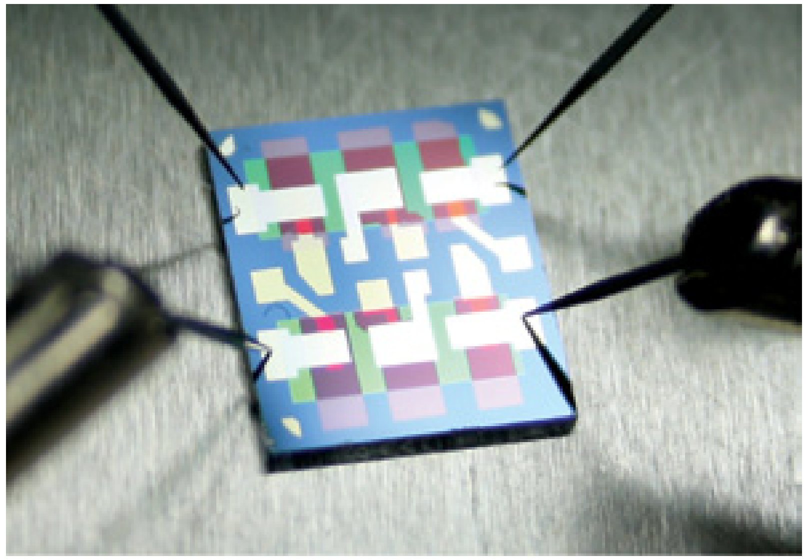


Figure 2
Photograph of a six hot-electron device on a single silicon chip while being measured electrically. Different colors indicate different materials.

8 Controlling graphene plasmons with resonant metal antennas and spatial conductivity patterns

Science **344**, 1369-1373 (2014)

P. Alonso-Gonzalez, A.Y. Nikitin, F. Golmar, A. Centeno, A. Pesquera, *S. Velez,* J. Chen, G. Navickaite, F. Koppens, A. Zurutuza, *F. Casanova, L. E. Hueso,* and *R. Hillenbrand*

We developed an antenna-based platform technology for launching and controlling light propagating along graphene, opening new venues for extremely miniaturized photonic devices and circuits.

Optical circuits and devices could make signal processing and computing much faster. However, although light is very fast, it needs too much space. In fact, propagating light needs at least the space of half its wavelength, which is much larger than state-of-the-art electronic building blocks in our computers. For that reason, a quest for squeezing light to propagate it through nanoscale materials arises.

Graphene, a single layer of carbon atoms with extraordinary properties, has been proposed as one solution. The wavelength of light captured by a graphene layer can be strongly shortened by a factor of 10 to 100 compared to light propagating in free space [Nature **487**, 77 (2012), Nature **82** (2012)]. As a consequence, this light propagating along the graphene layer - called graphene plasmon - requires much less space and promises ultra-compact photonic devices [Science **332**, 1291 (2011), Nat. Photonics **6**, 749 (2012)].

Converting light efficiently into graphene plasmons, however, has been a major challenge. In this work, we demonstrated that the antenna concept of radio-wave technology could be a promising solution. We showed that a nanoscale metal rod on graphene (acting as an antenna for light) can capture infrared light and convert it into graphene plasmons, analogous to a radio antenna converting radio waves into electromagnetic waves in a metal cable. The excitation of graphene plasmons is purely optical, the device is compact and the phase and wavefronts of the graphene plasmons can be directly controlled by geometrically tailoring the antennas. The later is essential for the development of applications that require focusing and guiding of graphene plasmons.

Based on calculations (Figure 1), we fabricated gold nanoantennas on graphene provided by Graphenea. We then used the Neaspec near-field microscope to image how infrared graphene plasmons are launched and propagate along the graphene layer. In the experimental near-field images, we observed that indeed electromagnetic waves on the graphene propagate away from the antenna, with a wavelength that is about 30 times smaller than that of the incident light (Figure 2).

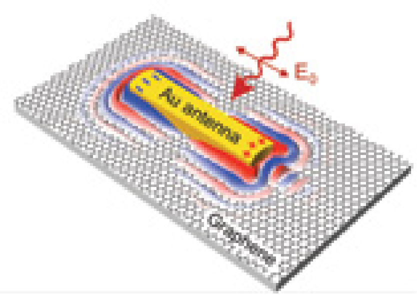


Figure 1
Launching graphene plasmons with a gold antenna. The oscillations of the calculated electromagnetic field around the antenna reveal the graphene plasmons.

> “We demonstrated two-dimensional nanooptics with graphene plasmons launched by metal antennas”

In order to test whether the two-dimensional propagation of light waves along a one-atom-thick carbon layer follow the laws of conventional optics, we tried to focus and refract the waves. For the focusing experiment, we curved the antenna. The images then showed that the graphene plasmons focus away from the antenna, similar to the light beam that is concentrated with a lens or concave mirror.

We also observed that graphene plasmons refract (bend) when they pass through a prism-shaped graphene bilayer (Figure 3), analogous to the bending of a light beam passing through a glass prism. The big difference here is that the graphene prism is only two atoms thick. By measuring the graphene plasmon wavelengths in the bi- and monolayer, λ_1 and λ_2, as well as the propagation angles α_1 and α_2, we could demonstrate that the refraction of graphene plasmons qualitatively follows the fundamental law of refraction (Snell´s law): $\sin(\alpha_1)/\sin(\alpha_2) = \lambda_1/\lambda_2$.

Altogether, the experiments show that the fundamental and most important principles of conventional optics also apply for graphene plasmons, in other words, squeezed light propagating along a one-atom-thick layer of carbon atoms. Future developments based on these results could lead to extremely miniaturized optical circuits and devices that could be useful for sensing and computing, among other applications. Intriguingly, the graphene plasmons are refracted because the conductivity in the two-atom-thick prism is larger than in the surrounding one-atom-thick layer. In the future, local conductivity changes in graphene could be generated by simple electronic means, such as gating, allowing for highly efficient electrical control of refraction, among others, for steering applications.

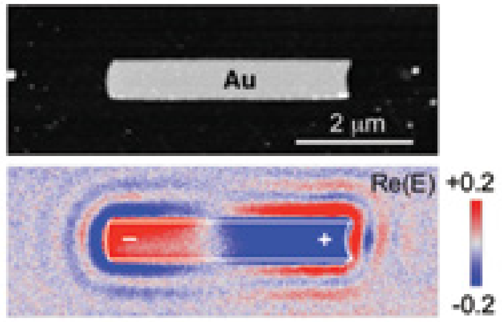


Figure 2
Top: Topography of a gold nanoantenna on graphene. Bottom: Near-field image showing the fields of the antenna and the graphene plasmons around the antenna. The image was taken at an illumination wavelength of 11.06 µm and shows the real part of the imaged field. The distance between fringes of the same color reveals the graphene plasmon wavelength.

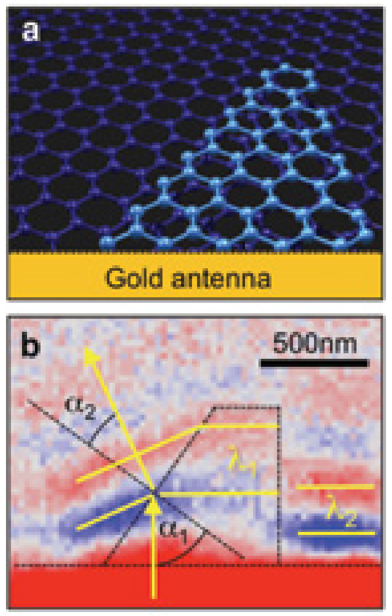


Figure 3
(a) Illustration of a graphene bilayer prism next to a gold antenna. (b) Near-field image (taken at an illumination wavelength of 10.20 µm) of graphene plasmons refracting at a graphene bilayer prism. The yellow lines and arrows illustrate the plasmon wavefronts and their refraction.

9

Impurity-assisted tunneling magnetoresistance under weak magnetic field

Physical Review Letters **113**, 146601 (2014)
O. Txoperena, Y. Song, L. Qing, *M. Gobbi, L. E. Hueso,* H. Dery, and *F. Casanova*

Injection of spins into semiconductors is essential for the integration of the spin functionality into conventional electronics. Insulating layers are often inserted between ferromagnetic metals and semiconductors for obtaining an efficient spin injection, and it is therefore crucial to distinguish between signatures of electrical spin injection and impurity-driven effects in the tunnel barrier. We have discovered a novel impurity-driven magnetoresistance effect that has been confusing scientists working in the field of spintronics.

For the realization of semiconductor spintronic devices, the conductivity mismatch problem and the difficulty of manipulating semiconductors at the nanoscale are the main issues delaying the progress of this research field. Employing the so-called three-terminal (3T) setup where a single ferromagnetic-insulator contact is used for both injection and detection of spin-polarized currents was a big step towards this purpose. Because of the simplicity of the micron-sized structures employed, this setup has gained popularity in semiconductor spintronics (Figure 1a). The Lorentzian-shaped magnetoresistance (MR) effect measured in 3T-semiconductor devices has been often attributed to spin injection on account of the resemblance to the Hanle effect -the precession and dephasing of the spins under a perpendicular magnetic field-. Many of the reported results disagree with the standard theory of spin injection and have put these measurements into question. However, physicists working in the field could not explain such a disagreement. In this article, we have put an end to this controversy by elucidating the physics behind such experiments: an impurity-assisted tunneling magnetoresistance effect which is universal to any tunnel barrier with impurities.

First, we fabricate ferromagnetic-insulator-nonmagnetic (FIN) 3T devices with metallic electrodes to avoid the complications brought by the Fermi-level pinning when using a semiconductor, and demonstrate that measured Hanle- and inverted Hanle-like features (Figure 1b) are not compatible with spin injection in these metals. Subsequently, we detect this effect in nonmagnetic-insulator-nonmagnetic (NIN) tunnel junctions for the first time (Figure 1c), ruling out spin injection as the origin of the effect, since a ferromagnetic material is needed to create spin currents. The magnitude of all measured MR effects scale with the interface resistance of the tunnel barrier, regardless of the metals used (Figure 1d). This scaling, together with an accurate analysis of the temperature dependence of the interface resistances, demonstrates experimentally beyond any doubt that the measured Hanle-like signals are due to impurities in the oxide layer. We support these results with a theory for impurity-assisted tunneling which takes into account spin interactions and Coulomb correlations. We conclude that this is actually a novel magnetoresistance effect, which is universal to any impurity-assisted tunneling process regardless of the oxide thickness or materials used.

> “We report a novel magnetoresistance effect, which is general to any impurity-assisted tunneling process”

This work will be used as a benchmark to spin injection experiments to any nonmagnetic material, and specially will redirect research of semiconductor spintronics, with all the implications in such a technologically relevant area.

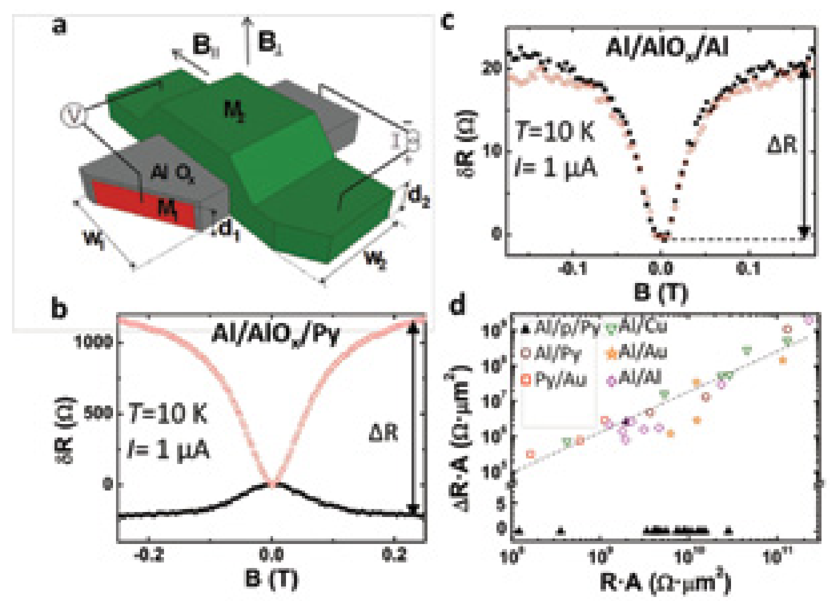


Figure
(a) Scheme of the 3T device and its operation conditions, with the electrode dimensions tagged. (b) Magnetoresistance of the FIN device for out-of-plane (solid symbols) and in-plane (empty symbols) fields measured at 10 K and 1 µA. The magnitude ΔR is tagged. (c) Magnetoresistance of the NIN device. (d) ΔR multiplied by the junction area as a function of the resistance area product for different NIN and FIN devices, measured at 10 K and optimum bias conditions for each device. Solid (open) symbols correspond to tunnel barriers without (with) impurities. Dashed black line is an exponential fit to the data.

10

Probing the effect of force on HIV-1 receptor CD4

ACS nano **8**, 10313-10320 (2014)

R. Perez-Jimenez, A. Alonso-Caballero, R. Berkovich, D. Franco, M. Chen, P. Richard, C. L. Badilla, and J. M. Fernandez

In this paper, we have tested the hypothesis that HIV may apply force on the cell-surface receptor CD4 during the initial steps of the infection. We used single-molecule atomic-force spectroscopy to demonstrate that mechanical forces trigger conformational and chemical changes on CD4 that may help HIV to invade cells. This study represents the first analysis of the effect of mechanical forces on a viral receptor, which may provide new information for the development of novel treatments of diseases.

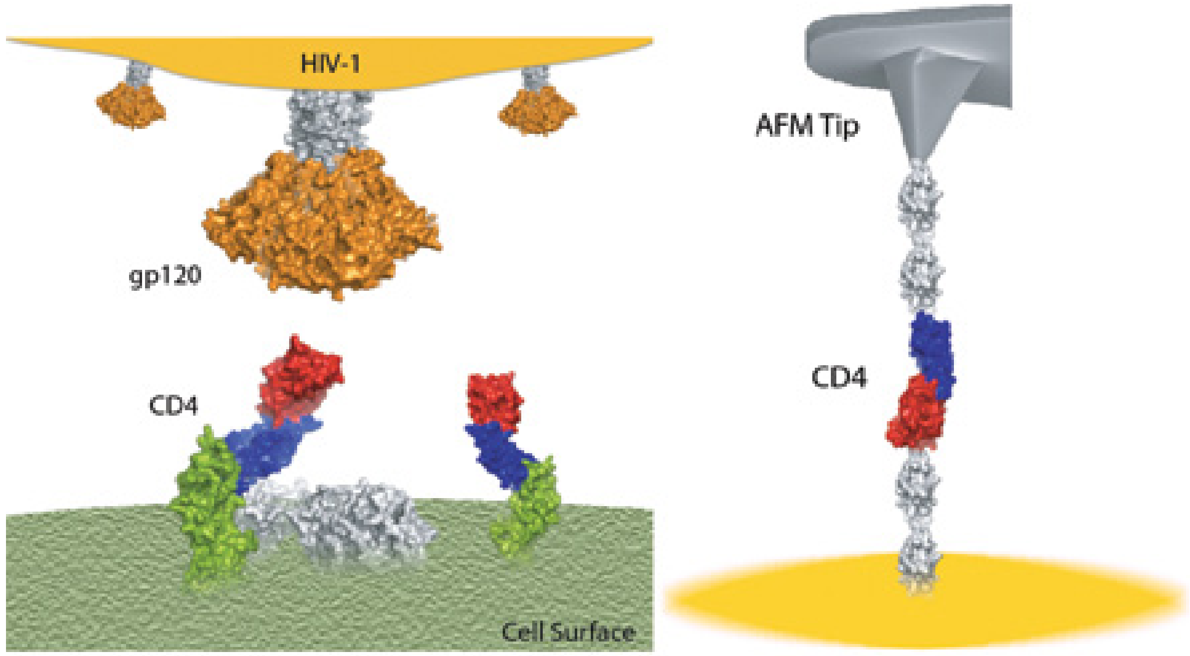
The HIV infection initiates when the viral glycoprotein gp120 interacts with the cell-surface receptor CD4. This interaction triggers a cascade of conformational changes that leads to the fusion of the viral membrane with the cell membrane. However, the origin of these conformational and chemical changes is not clear. We have investigated whether forces can actually trigger these conformational and chemical alterations.

During the past years, we have performed experiments on isolated CD4 using atomic-force spectroscopy. We engineer a polyprotein containing domains 1 and 2 of CD4 connected to linker proteins. The resulting polyprotein is attached to a gold surface and a cantilever probe is used to pull on then and observe how forces produce physical and chemical changes. Forces of just a few picoNewtons are enough to elongate CD4 domains becoming more flexible. We also observed that disulfide bonds normally hidden within the CD4 structure are exposed under forces becoming more reactive. This supports the view that redox regulation of CD4 disulfide bonds is necessary to help HIV entry into T cells. Overall, we predict that very small forces can trigger conformational and chemical changes that may happen during HIV interaction with the cell.

We finally tested whether the anti-CD4 blocking antibody Ibalizumab, currently in use for AIDS treatment, had a mechanical effect on CD4. Ibalizumab binds in the interface between domain 1 and 2 of CD4. We found that the antibody makes CD4 stronger and more rigid. This may prevent conformational changes under force and may explain, in part, the blocking power of this antibody.

Overall, our work sheds light into one of the most discussed problems that scientists in the field have studied in the past two decades: the initial interaction of HIV and the cell. We believe that our technique can reveal aspects of HIV infection that may change our understanding of viral infections.

“Our work sheds light into the initial interaction of HIV and the cell”



Figure

Representation of an HIV particle interacting with a cell-surface CD4. On the right, schematic representation of an atomic-force microscopy experiment using a polyprotein containing CD4.

Conferences and Workshops

Conferences and Workshops

Imaginenano
(23-26/04/2013)

- The largest European event on nanoscience and nanotechnology
- Organizers: Phantoms Foundation, DIPC, UPV/EHU, BEC, and nanoGUNE
- More than 1 200 participants

2nd nanoIKER Workshop
(10/06/2013)

- Strategic nanoscience research in the Basque Country
- Organizer: nanoGUNE (held at Tecnalia)
- 50 participants

Nobel Pitch
(01/10/2013)

- In the framework of the Passion for Knowledge - Quantum13 science festival, young researches presented their work to Nobel Laureates with an Elevator-Pitch format.
- Organizers: DIPC, Euskampus, and Tecnalia, with the collaboration of Ikerbasque and nanoGUNE (held at nanoGUNE).
- 16 young researchers and 4 Nobel Laureates

University of Liverpool - nanoGUNE Workshop
(21/10/2013)

- Organizer: nanoGUNE
- More than 70 participants

Nanoscience: The big challenge of the small
(2013 and 2014)

- Lectures about state-of-the-art nanoscience research for university students
- Organizer: UPV/EHU, BCMaterials, and nanoGUNE

nanoGUNE 5th-year Anniversary Workshop
(30/01/2014)

- Organizer: nanoGUNE
- 90 participants

QNET training workshop
(20/02/2014)

- Quantum Nanoelectronics Training network of experts
- Organizer: Coordinator of the project Prof. Courtois from Institut Neel (CNRS) and nanoGUNE
- 35 participants

RNRI Workshop
(07/03/2014)

- Responsible Nanotechnology Research and Innovation
- Organizers: Miguel Sánchez-Mazas Chair UPV/EHU, Post-Graduate Program in Philosophy, Science, and Values (UPV/EHU and UNAM), and nanoGUNE (held at nanoGUNE).
- 20 participants

ETPN Annual Meeting
(15-16/10/2014)

- European Technology Platform on Nanomedicine
- Organizers: ETP Nanomedicine, nanoBasque Agency, and nanoGUNE (held at nanoGUNE).
- 120 participants

2013

Real-space mapping of infrared plasmons in metal nanostructures and graphene
06/01/2013, **Rainer Hillenbrand**
Physics of Quantum Electronics 2013, Snowbird (USA)

Magnetoplasmonic effects in pure ferromagnetic nanostructures
17/01/2013, **Paolo Vavassori**
12th Joint MMM/Intermag Conference, Illinois (USA)

Plant virus drug delivery and virus-based ferrofluids
18/01/2013, **Alexander Bittner**
12th Joint MMM/Intermag Conference, Illinois (USA)

Tuning of optical properties by Atomic Layer Deposition
05/02/2013, **Mato Knez**
SPIE Photonics West 2013, San Francisco (USA)

The structure of water from first-principles simulations with van der Waals interactions
07/02/2013, **Fabiano Corsetti**
Waterspain 2013 Workshop, Zaragoza (Spain)

Spintronics with fullerenes
13/02/2013, **Luis Hueso**
NanoPortugal 2013 - Nanoscience and Nanotechnology International Conference, Porto (Portugal)

Loading and unloading of a platinum drug in a plant virus
20/02/2013, **Alexander Bittner**
Final International Workshop of the European Project MAGNIFYCO, Barcelona (Spain)

Nanodevices with electron beam lithography: applications and tricks
25/02/2013, **Fèlix Casanova**
19th Seminar on Electron and Ion Beam Fabrication for Nanotechnology, Dortmund (Germany)

Diffraction, absorption and scattering in structures with graphene plasmons
03/03/2013, **Alexey Nikitin**
Graphene Nanophotonics 2013, Benasque (Spain)

Real-space mapping of graphene plasmons by near-field microscopy
05/03/2013, **Rainer Hillenbrand**
Graphene Nanophotonics 2013, Benasque (Spain)

Sensing elementary processes in a molecular junction through force and light spectroscopy
08/03/2013, **José Ignacio Pascual**
CECAM Conference on Molecular Electronics: Quo vadis?, Bremen (Germany)

Functionalization of biomaterials with inorganics by Atomic Layer Deposition
10/03/2013, **Mato Knez**
SPIE Smart Structures/NDE, San Diego (USA)

Liquid water from first principles
11/03/2013, **Emilio Artacho**
Second Workshop on High-Performance Computing in Geophysics Applications, Bilbao (Spain)

Antenna-based infrared nanoscopy - From nanoscale chemical identification to real-space mapping of graphene plasmons
18/03/2013, **Rainer Hillenbrand**
4th International Conference on Metamaterials, Photonic Crystals and Plasmonics, Sharjah (Saudi Arabia)

Experimental verification of the shift between near-field and far-field peak intersities in plasmonic nanoantennas
18/03/2013, **Rainer Hillenbrand**
4th International Conference on Metamaterials, Photonic Crystals, and Plasmonics, Sharjah (Saudi Arabia)

Scattering problem in s-SNOM: novel model for interaction between near-field probe and inhomogeneous 3D sample
24/03/2013, **Alexander Govyadinov**
Progress in Electromagnetics Research Symposium, Taipei (Taiwan)

Fabrication of individual nanomagnets and nanomagnet arrays by electron-beam-induced deposition and focused-ion-beam modification
08/04/2013, **Andreas Berger**
Latin American Workshop on Magnetism, Buenos Aires (Argentina)

Real-space mapping of infrared plasmons in graphene
10/04/2013, **Rainer Hillenbrand**
International Workshop "Building Blocks for Carbon-based Electronics: From Molecules to Nanotubes", Regensburg (Germany)

CIC nanoGUNE
17/04/2013, **Alexander Bittner**
Workshop ECB/bioGUNE/bioMaGUNE/nanoGUNE, Bordeaux (France)

The physics of tobacco mosaic virus
18/04/2013, **Alexander Bittner**
Biofivinet meeting, Madrid (Spain)

Key challenges from the materials point of view
20/04/2013, **Mato Knez**
DARPA Workshop on Future of ALD, Chicago (USA)

Forces and photons in molecular tunneling junctions
23/04/2013, **José Ignacio Pascual**
Imaginenano 2013, Bilbao (Spain)

Density-functional-theory calculations on graphene and related materials
23/04/2013, **Emilio Artacho**
Imaginenano 2013, Bilbao (Spain)

Molecular nanomechanics in human health
25/04/2013, **Raúl Pérez-Jiménez**
Imaginenano 2013, Bilbao (Spain)

Synthesis and manipulation of nanoparticle assemblies by Atomic Layer Deposition
25/04/2013, **Mato Knez**
Korean ALD Conference, Seoul (Korea)

Spin, forces, and photons in molecular tunneling junctions
15/05/2013, **José Ignacio Pascual**
Controlled atomic dynamics on solid surfaces: Atom and molecular manipulation, Donostia - San Sebastian (Spain)

Non-adiabatic effects in radiation damage: electronic stopping power from first principles
16/05/2013, **Emilio Artacho**
2013 International Energy Agency Fusion Modeling Workshop, Alicante (Spain)

Infrared near-field spectroscopy: From nanoscale chemical mapping to real-space imaging of graphene plasmons
22/05/2013, **Rainer Hillenbrand**
School of Photonics 2013, Cortona (Italy)

Infrared nanospectroscopy
28/05/2013, **Rainer Hillenbrand**
57th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication, Nashville (USA)

Hydration and wetting of a plant virus
09/06/2013, **Alexander Bittner**
XII Congreso Nacional de Virología, Burgos (Spain)

Graphene @ nanoGUNE
25/06/2013, **Luis Hueso**
Semana de Proyectos Europeos Flagship: Grafeno y Cerebro Humano, Santander (Spain)

Antenna-based infrared nanoscopy - From nanoscale chemical identification to real-space mapping of graphene plasmons
30/06/2013, **Rainer Hillenbrand**
7th International Conference on Materials for Advanced Technologies, Singapore

Liquids on and in nanoscale fibres
08/07/2013, **Alexander Bittner**
"Active Particles and Microswimmers" Workshop, Schloss Ringberg (Germany)

Magnetic storage: Past and future
15/07/2013 **Andreas Berger**
Summer School 2013 Nanofabrication: Concepts, Techniques, and Applications in Nanotechnology, Zaragoza (Spain)

Precise control of NiO nanomaterial growth through ALD and the substrate chemistry
31/07/2013, **Mato Knez**
International AVS-ALD Conference, San Diego (USA)

Origin of the 2DEG at oxide interfaces, relation with topology, and possibility of a 1DEG
11/08/2013, **Emilio Artacho**
XXII International Materials Research Congress, Cancun (Mexico)

Advances in non-adiabatic computational materials science: electronic stopping power from first principles
12/08/2013, **Emilio Artacho**
XXII International Materials Research Congress, Cancun (Mexico)

How reliable are Hanle measurements in metals in a three-terminal geometry?
25/08/2013, **Fèlix Casanova**
SPIE Nanoscience + Engineering 2013, San Diego (USA)

Fabrication of individual nanostructures and measurements of their magnetic properties
25/08/2013, **Andreas Berger**
XXV Congreso Nacional de Física, Armenia (Colombia)

Molecular electronics
28/08/2013, **Luis Hueso**
European School on Nanosciences & Nanotechnologies, Grenoble (France)

Infrared nanoscopy and nanospectroscopy - From nanoscale chemical identification of polymers to real-space imaging of graphene plasmons
01/09/2013, **Rainer Hillenbrand**
38th Annual International Conference on Infrared, Millimeter, and Terahertz Waves, Mainz on the Rhine (Germany)

Spin transport in metals using different experimental approaches
02/09/2013, **Fèlix Casanova**
International Conference on Nanoscale Magnetism 2013, Istanbul (Turkey)

Synthesis of Nanoparticle assemblies supported by Atomic Layer Deposition
03/09/2013, **Mato Knez**
EURO CVD 19 Conference, Varna (Bulgaria)

Room-temperature spin transport in molecular devices
03/09/2013, **Luis Hueso**
12th European Conference on Molecular Electronics, London (UK)

Invited Talks

Electronic effects in radiation damage
09/09/2013, **Emilio Artacho**
CECAM Research Conference on Multiscale Modelling, Platja d'Aro (Spain)

Infrared nanoimaging and nano-FTIR spectroscopy - From nanoscale chemical identification of polymers to real-space imaging of graphene plasmons
01/10/2013, **Rainer Hillenbrand**
37th Annual Meeting NNV AMO LUNTEREN 2013, Lunteren (The Netherlands)

Forces and photons from molecular tunneling junctions
14/10/2013, **José Ignacio Pascual**
Modeling Single-Molecule Junctions: Novel Spectroscopies and Control 2013, Berlin (Germany)

Spin, forces, and photons in molecular tunneling junctions
31/10/2013, **José Ignacio Pascual**
WE-Heraeus-Seminar on Electron Transport through Atoms, Molecules, and Nanowires: Advances in Experiment and Theory, Bad Honnef (Germany)

Spin, forces, and photons in molecular tunneling junctions
04/11/2013, **José Ignacio Pascual**
12th International Conference on Atomically Controlled Surfaces, Interfaces, and Nanostructures in Conjunction with the 21st Internationl Colloquium on Scanning Probe Microscopy, Tsukuba (Japan)

Novel applications of magnetic nanostructures to biochemosensing and biomedicine
02/12/2013, **Paolo Vavassori**
VI Escuela de Nanoestructuras, Valparaíso (Chile)

Probing magnetization reversal at the nanoscale: Understanding frustrated interactions using nanotechnology
02/12/2013, **Paolo Vavassori**
VI Escuela de Nanoestructuras, Valparaíso (Chile)

2014

Infrared nanoimaging and nano-FTIR spectroscopy - From nanoscale chemical mapping to real-space imaging of graphene plasmons
13/01/2014, **Rainer Hillenbrand**
4th Molecular Materials Meeting, Singapore

Probing magnetic phenomena of single molecules on metal and superconducting surfaces
14/01/2014, **José Ignacio Pascual**
6th School & Workshop on Time-Dependent Density-Functional Theory: Prospects and Applications, Benasque (Spain)

Using TDDFT to calculate the electronic stopping power for ions shooting through solids from first principles
22/01/2014, **Emilio Artacho**
VI International Conference of the Institute for Biocomputation and Physics of Complex Systems, Zaragoza (Spain)

Optical nanoimaging of gate-tuneable graphene plasmons
22/01/2014, **Pablo Alonso-González**
GEFES 2014, Ciudad Real (Spain)

Infrared spectroscopy well beyond the diffraction limit
03/03/2014, **Rainer Hillenbrand**
PITTCON Conference & Expo 2014, Chicago (USA)

One-dimensional electron gas at the steps of a $LaAlO_3$-$SrTiO_3$ interface
04/03/2014, **Emilio Artacho**
APS March Meeting 2014, Denver (USA)

Tip-enhanced infrared spectroscopy - From plasmons to proteins
05/03/2014, **Rainer Hillenbrand**
Nanolight 2014, Benasque (Spain)

Role of surface defects on the formation of the 2DEG at polar interfaces
06/03/2014, **Emilio Artacho**
APS March Meeting 2014, Denver (USA)

Enzyme mimetic bioinorganic nanoparticles: Tuning, inhibiting, and restoring of catalytic activities
09/03/2014, **Mato Knez**
SPIE Smart Structures 2014, San Diego (USA)

Real-space mapping of graphene plasmons
10/03/2014, **Rainer Hillenbrand**
International Winter School on Electronic Properties of Novel Materials, Kirchberg (Germany)

Molecular-based hot electron devices
10/03/2014, **Luis Hueso**
Nano and Giga Challenges in Electronics, Photonics, and Renewable Energy, Phoenix (USA)

Viruses as templates for solid and liquid nanostructures
08/04/2014, **Alexander Bittner**
Observatory of Micro and Nano Technologies - CNRS/CEA, Paris (France)

Infrared nanospectroscopy: From plasmons to proteins
10/04/2014, **Rainer Hillenbrand**
Analytik auf der Nanometerskala mittels Infrarotlicht Workshop, Aachen (Germany)

Nanophotonics with SiC surface phonon polaritons and graphene plasmons
24/04/2014, **Rainer Hillenbrand**
MRS Spring Meeting 2014, San Francisco (USA)

Truly two-dimensional programmable nanomanipulation of magnetic particles on-chip
27/04/2014, **Paolo Vavassori**
4th International Conference on Superconductivity and Magnetism, Antalya (Turkey)

Tip-enhanced infrared nanospectroscopy of organic nanostructures and individual protein complexes
23/05/2014, **Rainer Hillenbrand**
5th International Conference on Metamaterials, Photonic Crystals, and Plasmonics, Singapore

Real-space mapping of graphene plasmons
24/05/2014, **Rainer Hillenbrand**
5th International Conference on Metamaterials, Photonic Crystals, and Plasmonics, Singapore

Room temperature spin transport in molecular devices
26/05/2014, **Luis Hueso**
E-MRS Spring Meeting 2014, Lille (France)

Infrared near-field nanoscopy of plasmons in metal nanostructures and graphene
02/06/2014, **Rainer Hillenbrand**
Electron Beam Spectroscopy for Nanophotonics, Amsterdam (The Netherlands)

Electron microscopy of liquids on the nanoscale
09/06/2014, **Alexander Bittner**
XXIV Sitges Conference on Statistical Mechanics, Barcelona (Spain)

Imaging water on biological nanostructures
12/06/2014, **Alexander Bittner**
WaterEurope 2014, Zaragoza (Spain)

Nanomechanics of Viral and Bacterial Infections
16/06/2014, **Raúl Pérez-Jiménez**
The Protein Multiverse, Madrid (Spain)

Nano-FTIR spectroscopy of individual protein complexes
22/06/2014, **Rainer Hillenbrand**
8th IUPAP International Conference on Biological Physics, Beijing (China)

Infrared nanoimaging and nanospectroscopy
30/06/2014, **Rainer Hillenbrand**
Low-Energy Electrodynamics in Solids, Loire Valley (France)

Spin-Hall magnetoresistance in non magnetic/ferromagnetic Hybrids
30/06/2014, **Saül Vélez**
10th International Conference on Nanomagnetism and Superconductivity, Coma-Ruga (Spain)

Molecular-based hot-electron devices
30/06/2014, **Luis Hueso**
International Conference on the Science and Technology of Synthetic Metals, Turku (Finland)

Spin, forces, and photons in molecular tunneling junctions
14/07/2014, **José Ignacio Pascual**
XXI International Summer School Nicolas Cabrera, Miraflores de la Sierra (Spain)

Magnetoplasmonic nanoantennas metasurfaces for sensing and active control of light polarization
24/07/2014, **Paolo Vavassori**
Trends in NanoPhotonics, Donostia - San Sebastian (Spain)

Infrared nanoimaging and nanospectroscopy
24/07/2014, **Rainer Hillenbrand**
Trends in NanoPhotonics, Donostia - San Sebastian (Spain)

Tip-enhanced infrared spectroscopy
07/08/2014, **Rainer Hillenbrand**
Surface-Enhanced Spectroscopies 2014, Chemnitz (Germany)

Single molecule engines
08/08/2014, **José Ignacio Pascual**
27th International Conference on Low Temperature Physics 2014, Buenos Aires (Argentina)

Controlling the propagation of graphene plasmons with nanoantennas
25/08/2014, **Pablo Alonso-González**
Progress in Electromagnetics Research Symposium 2014, Guangzhou (China)

Controlling graphene plasmons with resonant metal antennas and spatial conductivity patterns
12/09/2014, **Pablo Alonso-González**
DIPC School and Workshop on Surface Probe Microscopy, Donostia - San Sebastian (Spain)

Nano-FTIR in minerals
28/09/2014, **Rainer Hillenbrand**
2014 Workshop of the International Research Network GdRi - M2UN, Donostia - San Sebastian (Spain)

Proyecto EVOLGENE
01/10/2014, **Raúl Pérez-Jiménez**
Jornada de Energía y Emprendimiento, Zamudio (Spain)

Hybrid materials by Atomic Layer Deposition
12/10/2014, **Mato Knez**
Materials Science and Technology 2014, Pittsburgh (USA)

Liquids on protein nanostructures
21/10/2014, **Alexander Bittner**
Bioinspired Materials Conference, Ankara (Turkey)

Invited Talks

nano-FTIR spectroscopy of individual protein complexes
23/10/2014, **Rainer Hillenbrand**
CEITEC Annual Conference 2014: Frontiers in Material and Life Sciences, Brno (Czech Republic)

Magnetic molecules on the surface of a superconductor
29/10/2014, **José Ignacio Pascual**
Spintronic and magnetochemistry on the atomic and molecular level, Axsona (Switzerland)

Nanofabrication for nanophotonics
29/10/2014, **Rainer Hillenbrand**
6th Spanish Workshop in Nanolithography, Zaragoza (Spain)

Molecular spintronics: Charge and spin transport in molecular spin valves
29/10/2014, **Amilcar Bedoya-Pinto**
7th European School on Molecular Nanoscience, Gandía (Spain)

Two-dimensional optics with graphene plasmons launched by metal antennas
30/10/2014, **Rainer Hillenbrand**
Trends in Nanotechnology 2014, Barcelona (Spain)

Origin of Hanle-like signals in 3-terminal devices
03/11/2014, **Fèlix Casanova**
59th Annual Magnetism & Magnetic Materials Conference, Honolulu (USA)

Applications and manufacturing of devices on paper and textiles
09/11/2014, **Mato Knez**
AVS 61th International Symposium & Exhibition, Baltimore (USA)

Nano-FTIR spectroscopy of individual protein complexes
10/11/2014, **Rainer Hillenbrand**
ALSCTIM: Advances in Live Cell Thermal Imaging and Manipulation, Okinawa (Japan)

Nanostructured magneto-plasmonic metamaterials: a promising route for label-free molecular sensing applications
22/11/2014, **Paolo Vavassori**
Energy Materials Nanotechnology 2014 Fall Meeting, Florida (USA)

Organic spintronic devices
22/11/2014, **Luis Hueso**
Energy Materials Nanotechnology 2014 Fall Meeting, Florida (USA)

Infrared nanoscopy and nanospectroscopy - From plasmons to proteins
01/12/2014, **Rainer Hillenbrand**
5th International Symposium on Terahertz Nanoscience, Martinique (France)

Magneto-optical plasmonics of nano-structured magnetic materials
04/12/2014, **Andreas Berger**
5th Workshop on Nanomagnets, Barcelona (Spain)

Liquids at biomolecular nanostructures
08/12/2014, **Alexander Bittner**
International Conference on Small Science, Hong Kong (China)

Molecular nanomechanics in human health: Towards a new medicine
11/12/2014, **Raúl Pérez-Jiménez**
Workshop on "Mechano-Biology: New Paradigms for the 21st Century", Santiago de Chile (Chile)

First-principles simulations of condensed matter in energy research. Radiation damage
13/12/2014, **Emilio Artacho**
International Workshop on Computational Science and Engineering, Hong-Kong (China)

Seminars

NanoGUNE organizes research seminars to be given by both nanoGUNE personnel and external invited speakers. All these seminars take place at the nanoGUNE seminar room and are announced at **www.nanogune.eu**

2013

A cutting edge electrospinning technique made in nanoGUNE
07/01/2013, **Wiwat Nuansing**
nanoGUNE

Hybrid materials with potential application in nanodevices by means of Atomic Layer Deposition
14/01/2013, **Mabel Moreno**
nanoGUNE

Advances in atomic-force microscopy and spectroscopy with sub-molecular resolution
22/01/2013, **Martina Corso**
Materials Physics Center (CFM), Donostia - San Sebastian (Spain)

NanoGUNE Colloquium: Cooperative phenomena at electrode surfaces: From macroscopic self- organization to fluctuation enhanced reaction rates at nanoelectrodes
28/01/2013, **Katharina Krischer**
Technischer Universität München (Germany)

Dynamic phase transition in magnetic systems
04/02/2013, **Olatz Idigoras**
nanoGUNE

Nanostructures of diphenylalanine-porphyrin peptide hybrids
05/02/2013, **Evangelos Georgilis**
University of Crete (Greece)

X-ray absorption study of magnetic iron oxide nanoparticles
11/02/2013, **Ana Espinosa**
Institute of Materials Science (ICMM), Madrid (Spain)

Application of simultaneous AFM and STM measurements for the better understanding of surface chemistry
15/02/2013, **Zsolt Majzik**
Institute of Physics and Academy of Sciences of Cukrovarnicka (Czech Republic)

Molecular semiconductors for spintronics
18/02/2013, **Michel De Jong**
University of Twente (The Netherlands)

Seminars

Electronic structure at organic semiconductor interfaces: insights for interfacial electron and spin transfer
25/02/2013, **Oliver Monti**
University of Arizona (USA)

Near-Field mapping with s-SNOM
04/03/2013, **Pablo Alonso-González**
nanoGUNE

Isothermal electric control of exchange bias near room temperature
11/03/2013, **Christian Binek**
University of Nebraska (USA)

Kelvin probe force microscopy: From atomic scale imaging to application on solar cell materials
18/03/2013, **Sascha Sadewasser**
International Iberian Nanotechnology Laboratory (Portugal)

Molecular-dynamics simulation of shock waves
08/04/2013, **Oliver Strickson**
nanoGUNE

Magnetic dynamic phenomena at low temperatures
15/04/2013, **Saül Vélez**
University of Barcelona (Spain)

Electrospinning: A tissue engineering opportunity
22/04/2013, **Amaia Rebollo**
nanoGUNE

Graphene, an ideal material for spintronics
29/04/2013, **Ivan Vera-Marun**
University of Groningen (The Netherlands)

Functional metal oxide nanoparticles: Design and applications
03/05/2013, **Noelia Sanchez**
National Institute of Materials Science (NIMS), Tsukuba (Japan)

The structure of the 1DCuI@SWCNT and 3DCuI@SWCNT nanocomposites
13/05/2013, **Victoria Zhigalina**
nanoGUNE

Apoferritin camouflaged nanoparticles: Inhibitor-resistant ferroxidase
20/05/2013, **Lianbing Zhang**
nanoGUNE

Colloidal synthesis and growth mechanisms of metal nanoparticles
27/05/2013, **Luis Liz-Marzan**
CIC biomaGUNE, Donostia - San Sebastian (Spain)

Strain control of local magnetism in manganite films on barium titanate substrates
03/06/2013, **Xavier Moya**
University of Barcelona (Spain)

Nanoscale layering of superconducting and antiferromagnetic phases in Rb2Fe4Se5
17/06/2013, **Aliaksei Charnukha**
Max Planck Institute for Solid State Research, Stuttgart (Germany)

Magnetic relaxation in small nanoparticle clusters
18/06/2013, **Ondrej Hovorka**
University of York (UK)

Artificial ferromagnetic nanostructures: An experimental platform for magnonics
20/06/2013, **Adekunle Adeyeye**
National University Singapore

Bionanomaterial applications to MEMS devices
24/06/2013, **Shinya Kumagai**
Toyota Technological Institute, Nagoya (Japan)

NanoGUNE Colloquium: Probing correlated electron matter by infrared nanospectroscopy and nanoimaging
08/07/2013, **Dimitri N. Basov**
University of California San Diego (USA)

Optical tomography
10/07/2013, **John C. Schotland**
University of Michigan (USA)

A Journey from monolayer self-assembly to a patternable one-atom-thick superionic conductor
29/08/2013, **Jacob Sagiv**
Weizmann Institute, Rehovot (Israel)

Thermoelectric transport in semiconductor and ferromagnetic nanostructures
10/09/2013, **Kornelius Nielsch**
University of Hamburg (Germany)

Modifying magneto-optical effects and optical activities using plasmonic nanostructures
13/09/2013, **Satoshi Tomita**
Nara Institute of Science and Technology (Japan)

Magneto-optical activity and plasmonic resonances in pure ferromagnetic nanostructures
23/09/2013, **Nicolo Maccaferri**
nanoGUNE

Nanomechanics for proteomics
30/09/2013, **Robert Blick**
University of Wisconsin (USA)

NanoGUNE Colloquium: Transport through graphene - From suspended multi-terminal devices to graphene on new substrates
07/10/2013, **Alberto Morpurgo**
University of Geneva (Suiza)

NanoGUNE Colloquium: Reliability and scalability of spin transfer torque memories (STTRAM)
14/10/2013, **Bernard Dieny**
SPINTEC, CEA, Grenoble (France)

Predicting and understanding the anomalies of water from first principles simulation
11/11/2013, **Fabiano Corsetti**
nanoGUNE

Study of the luminescence mechanism of TPhB salts by EPR spectroscopy
18/11/2013, **Olga Antononova**
Institute of Inorganics Chemistry (Russia)

Exploring the magnetism of molecules on metallic and superconducting surfaces
25/11/2013, **Katharina J. Franke**
Free University Berlin (Germany)

NanoGUNE Colloquium: Nature's nanocomposite materials - Structural design principles and mechanical performance
27/11/2013, **Peter Fratzl**
Max Planck Institute for Colloids and Interfaces, Potsdam (Germany)

Titin: Molecular evolution and nanomechanics
02/12/2013, **Aitor Manteca**
nanoGUNE

NanoGUNE Colloquium: Appealing to Nature Materials? An editor's view
09/12/2013, **Pep Pàmies**
Nature Materials, London (UK)

Low-voltage polymer field-effect transistors with patterned molecular gate dielectrics
16/12/2013, **Thales De Oliveira**
nanoGUNE

2014

Kondo effect in molecular devices from first principles
13/01/2014, **David Jacob**
Max-Planck Institute of Microstructure Physics, Halle (Germany)

Polymer processing: Introduction and challenges
27/01/2014, **José Javier Egurrola**
Leartiker, Markina-Xemein (Spain)

Atomically thin MoS_2: A two dimensional semiconductor beyond graphene
27/01/2014, **Andres Castellanos-Gomez**
Delft University of Technology (The Netherlands)

Protein engineering and biofunctional nanostructures
03/02/2014, **Aitziber L. Kortajarena**
IMDEA Nanociencia, Madrid (Spain)

Infrared near-field imaging and near-field spectroscopy of biological nanostructures
10/02/2014, **Iban Amenabar**
nanoGUNE

Strain induced magneto-optical anisotropy in epitaxial hcp Co-films
17/02/2014, **Jon Ander Arregi**
nanoGUNE

Seminars

From scientific research to industry, the birth and growth of a university spin-off
20/02/2014, **Khaled Karrai**
Attocube Systems AG, Munich (Germany)

Hot electron transport in metallic spin valve and graphene-silicon devices at the nanoscale
24/02/2014, **Subir Parui**
nanoGUNE

Bioinspired single-chain polymer nanoparticles
10/03/2014, **Josetxo Pomposo**
Materials Physics Center (CFM), Donostia - San Sebastian (Spain)

Metal-induced gap states in metal/oxide interfaces and their relation with the complex band structure
17/03/2014, **Pablo Aguado**
nanoGUNE

Single-molecule protein translocation through nanopores
24/03/2014, **David Rodriguez-Larrea**
University of Oxford (UK)

Polymer modification by means of Atomic Layer Deposition
31/03/2014, **Ana Zuzuarregi**
nanoGUNE

Probing graphene physics at the atomic scale
07/04/2014, **Ivan Brihuega**
Autonomous University of Madrid (Spain)

Volume regulation of the heart: Molecular mechanisms and strain sensing by the giant protein titin
28/04/2014, **Pieter de Tombe**
Loyola University, Chicago (USA)

Synthetic optical holography for rapid nanoimaging
05/05/2014, **Martin Schnell**
nanoGUNE

Probing magnetic interactions between single atoms
12/05/2014, **Zsolt Majzik**
nanoGUNE

Nanomechanics of cell-surface protein CD4
19/05/2014, **Álvaro Alonso**
nanoGUNE

Spin-Hall effect in metallic nanostructures
26/05/2014, **Miren Isasa**
nanoGUNE

Building enhanced ferroelectric materials through artificial layering
28/05/2014, **Matthew Dawber**
Stony Brook University, New York (USA)

Biotemplating process for fabrication of metallic spirals
02/06/2014, **Kaori Kamata**
Tokyo Institute of Technology (Japan)

Probing concepts in single-molecule wires: Diodes, electromechanics, FETs, spinterfaces, etc.
09/06/2014, **Ismael Diez**
University of Barcelona (Spain)

Research and development of advanced lithium ion batteries at IK4-CIDETEC
16/06/2014, **Andriy Kvasha**
CIDETEC, Donostia - San Sebastian (Spain)

Imaging electrically-induced interconversion between antiferromagnetism and ferromagnetism just above room temperature
23/06/2014, **Lee C. Phillips**
Unité Mixte de Physique CNRS, Palaiseau (France)

Bioinspired approach for the development of electronic devices and sensors
24/06/2014, **Nurit Ashkenasy**
Ben Gurion University of the Negev, Eliat (Israel)

Giant temperature sensitivity of the spin reversal field in epitaxial α-Cr_2O_3 (Chromia) thin films
30/06/2014, **Lorenzo Fallarino**
nanoGUNE

Multi-enzyme systems in solid phase: The new wave of the synthetic biology
28/07/2014, **Fernando López Gallego**
CIC biomaGUNE, Donostia - San Sebastian (Spain)

NanoGUNE Colloquium: Electron holography - Measuring potentials and strain in semiconductor structures by advanced TEM
04/08/2014, **Michael Lehmann**
Technical University Berlin (Germany)

Electronic stopping power in a narrow band gap semiconductor from first principles
08/09/2014, **Rafi Ullah**
nanoGUNE

Mineralization, self-assembly, and potential applications of nanoparticles through biomolecules
15/09/2014, **Mitsuhiro Okuda**
nanoGUNE

Spin-transfer-torque excitations in ferromagnetic nanostructures: spin torque oscillators
22/09/2014, **Ferran Macia**
University of Barcelona (Spain)

Dynamics of proteins at the nanoscale
29/09/2014, **David de Sancho**
University of Cambridge (UK)

Anisotropic nanomaterials: A new type of electrocatalyst
02/10/2014, **Mariana Chirea**
University of Vigo (Spain)

Structure and properties of atomic and molecular assemblies at surfaces
08/10/2014, **Sylvie Morin**
York University, Toronto (Canada)

Two-dimensional optics with graphene plasmons
13/10/2014, **Pablo Alonso-González**
nanoGUNE

Controlled patterning of graphene by hydrogen
20/10/2014, **Richard Balog**
nanoGUNE

Ancestral cellulases for bioenergy
27/10/2014, **Nerea Barruetabeña**
nanoGUNE

Nanozymes based on ferritin
03/11/2014, **Unai Carmona**
nanoGUNE

Electrochemical nanostructure formation and characterization
04/11/2014, **Mathias Graf**
University of Hamburg (Germany)

Nanomechanical characterization of E. coli surface attachment appendage
10/11/2014, **Simon Poly**
nanoGUNE

Magnetic gating of pure spin currents
17/11/2014, **Estitxu Villamor**
nanoGUNE

Charge ordering in high Tc Superconductors"
24/11/2014, **Santiago Blanco**
nanoGUNE

Smart materials in microfluidic devices: A toolbox for fluid control and sensing
01/12/2014, **Fernando Benito-López**
CIC microGUNE, Arrasate (Spain)

Photonic principle to determine the dynamics of the cardiovascular system
09/12/2014, **Andreas Seifert**
University of Freiburg (Germany)

Resistive switching: From devices to applications
10/12/2014, **Pablo Stoliar**
nanoGUNE

Towards novel Mott FET: Concept, present status, and future
11/12/2014, **Isao Inoue**
National Institute of Advanced Industrial Science and Technology (AIST), Tokyo (Japan)

	ISI Publications	Average Impact Factor	Citations
2013	72	5.8	1205
2014	71	5.4	1440

2013

V. Reboud, G. Leveque, M. Striccoli, T. Placido, A. Panniello, M. L. Curri, J. A. Alducin, T. Kehoe, N. Kehagias, D. Mecerreyes, S. B. Newcomb, D. Iacopino, G. Redmond, and C. M. Sotomayor Torres
Nanoscale **5,** 239 (2013)
Metallic nanoparticles enhanced the spontaneous emission of semiconductor nanocrystals embedded in nanoimprinted photonic crystals

X. Moya, L. E. Hueso, F. Maccherozzi, A. I. Tovstolytkin, D. I. Podyalovskii, C. Ducati, L. C. Phillips, M. Ghidini, O. Hovorka, A. Berger, M. E. Vickers, E. Defaÿ, S. S. Dhesi, and N. D. Mathur
Nature Materials **12,** 52 (2013)
Giant and reversible extrinsic magnetocaloric effects in La0.7Ca0.3MnO3 films due to strain

D. Wei, S. Haque, P. Andrew, J. Kivioja, T. Ryhaenen, A. Pesquera, A. Centeno, B. Alonso, A. Chuvilin, and A. Zurutuza
Journal of Materials Chemistry A **1,** 3177 (2013)
Ultrathin rechargeable all-solid-state batteries based on monolayer graphene

S. E. Grefe, D. Leiva, S. Mastel, S. D. Dhuey, S. Cabrini, P. J. Schuck, and Y. Abate
Physical Chemistry Chemical Physics **15,** 18944 (2013)
Near-field spatial mapping of strongly interacting multiple plasmonic infrared antennas

D. Melnikau, D. Savateeva, V. Lesnyak, N. Gaponik, Y. Nunez Fernandez, M. I. Vasilevskiy, M. F. Costa, K. E. Mochalov, V. Oleinikov, and Y. P. Rakovich
Nanoscale **5,** 9317 (2013)
Resonance energy transfer in self-organized organic/inorganic dendrite structures

P. Alonso-Gonzalez, P. Albella, F. Golmar, L. Arzubiaga, F. Casanova, L. E. Hueso, J. Aizpurua, and R. Hillenbrand
Optics Express **21,** 1270 (2013)
Visualizing the near-field coupling and interference of bonding and anti-bonding modes in infrared dimer nanoantennas

J. B. Gonzalez-Diaz, J. A. Arregi, E. Bergaretxe, M. J. Fertin, O. Idigoras, and A. Berger
Journal of Magnetism and Magnetic Materials **325,** 147 (2013)
Anomalous magneto-optical behavior of uniaxial Co/CoO bilayer films

M. Donolato, C. Tollan, J. M. Porro, A. Berger, and P. Vavassori
Advanced Materials **25,** 623 (2013)
Flexible and stretchable polymers with embedded magnetic nanostructures

I. Amenabar, F. Lopez, and A. Mendikute
Journal of Infrared Millimeter and Terahertz Waves **34,** 152 (2013)
An introductory review to THz non-destructive testing of composite matter

F. Spizzo, L. Patrignani, D. Bisero, P. Vavassori, and V. Metlushko
Acta Physica Polonica A **123,** 218 (2013)
Vortex-state suppression in an hexagonal array of interacting Py triangular rings

J. Bauer, J. I. Pascual, and K. J. Franke
Physical Review B **87,** 75125 (2013)
Microscopic resolution of the interplay of Kondo screening and superconducting pairing: Mn-phthalocyanine molecules adsorbed on superconducting Pb(111)

A. A. Khan, E. K. Fox, M. L. Gorzny, E. Nikulina, D. F. Brougham, C. Wege, and A. M. Bittner
Langmuir **29,** 2094 (2013)
pH control of the electrostatic binding of gold and iron oxide nanoparticles to tobacco mosaic virus

F. Huth, A. Chuvilin, M. Schnell, I. Amenabar, R. Krutohvostovs, S. Lopatin, and R. Hillenbrand
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Resonant antenna probes for tip-enhanced infrared near-field microscopy

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From fatty acid and lactone biobased monomers toward fully renewable polymer latexes

Collaboration agreements (in place)

University of the Basque Country (UPV/EHU)
08/02/2007 - 50 years
Land transfer for the nanoGUNE building
17/10/2008 - Unlimited
Cooperation and development of lecturers, researchers, and students
24/03/2011 - Unlimited
Collaboration agreement for the supervision of master and PhD students
01/09/2011 - 4 years
Commodatum contract for the use of computing nodes and data storage
09/10/2013 - Unlimited
Collaboration agreement for internship opportunities

Ikerbasque
10/01/2008 - Unlimited
Collaboration framework agreement

University of California San Diego
01/02/2008 - 5 years
Memorandum of Understanding

SPRI-nanoBasque
01/07/2008 - Unlimited
Development of nanotechnology-based projects

Iñaki Goenaga Foundation
14/10/2008 - Unlimited
Participation in calls for training and specialization

Max Planck Institute for Biochemistry
01/12/2008 - Unlimited
Equipment non-permanent loan

Polimilano
31/03/2009 - 5 years
Agreement for the exploitation of a joint patent
12/02/2010 - 5 years
Agreement for the exploitation of a joint patent

Plataforma Española de Nanomedicina - Unidad de Innovación Internacional (NanoMed II)
30/11/2009 - Unlimited
Development of proposals for collaborative projects in the 7th Framework Program in the area of nanotechnology applied to life science

IBEC
30/11/2009 - Unlimited
Cooperation agreement

Biodonostia Research Institute
10/12/2009 - Unlimited
Collaboration in research projects

Biolan Microsensores
10/12/2009 - Unlimited
Foster collaboration, exchange, and integration

Euskampus
28/04/2010 - Unlimited
Development of a campus of International Excellence UPV/EHU-TECNALIA-DIPC

** FEI*
01/05/2010 - 31/03/2016
Development of the Electron-Microscopy Laboratory and related research projects

Main Nano
19/05/2010 - 4 years
Development of tools and instruments of collaborative and joint work between excellent institutions in the area of nanoscience and nanotechnology, financial institutions, and industry

Bic Gipuzkoa Berrilan
21/10/2010 - 10 years
Development of an incubator for nanotechnology-based new companies

University of Valladolid
04/05/2011 - Unlimited
Collaboration agreement for internship opportunities

University of Illinois
05/07/2011 - Unlimited
Collaborative research agreement
22/08/2013 - Unlimited
Exclusive license agreement

Massachusetts Institute of Technology (MIT)
01/08/2011 - 2 years
Partnership agreement

Collaboration agreements (in place)

University of Ferrara
02/08/2011 - Unlimited
Agreement for cultural, educational, and scientific cooperation

Brookhaven Science Associates
12/09/2011 - Unlimited
Non-propietary user agreement

Inbiomed
01/11/2011 - Unlimited
Framework collaboration agreement
15/02/12 - 2 years
Development of a research project to grow neurons *in vitro* from stem cells

Fundación Empresa University of Navarra
30/05/2012 - 1 year
Collaboration agreement for internship opportunities

**Telstar Technologies*
09/09/2012 - 1 year
Collaboration agreement related to Atomic Layer Deposition

**Torresol Energy Investment*
01/11/2012 - 2 years
Research project

** Mondragón Componentes*
01/12/2012 - 31/12/2013
Research project

Mi.To. Technologies
01/12/2012 - Unlimited

** DAS-nano S. L.*
01/01/2013 – 5 years
Research project
01/09/2014
Research project

Nanotech
01/01/2010 - Unlimited
Partners agreement

Instituto Don Bosco
25/02/2013 - Unlimited
Collaboration agreement for internship opportunities

University of Deusto
10/07/2013 - Unlimited
Framework agreement
17/10/2013 - Unlimited
Collaboration agreement for internship opportunities

**WIMA*
23/07/2013 - Unlimited
Material transfer agreement

**Tecnologías Avanzadas Inspiralia*
20/10/2013 - 30/09/2014
Research project

Francisco de Vitoria University
28/10/2013 - Unlimited
Framework partnership agreement

CIC biomaGUNE
01/01/2014 - Unlimited
Framework collaboration agreement

CIC energiGUNE
10/01/2014 - Unlimited
Framework collaboration agreement

Argonne National Laboratory
16/05/2014 - 5 years
Non-propietary user agreement

Cluster Food-i
14/07/2014 - Unlimited
Research project

Helmholtz-Zentrum Berlin
23/09/2014 - Unlimited
Research project

* [Contracts with companies]

3

Technology Transfer

1 consolidated start-up

3 new spin-offs

Bridging the gap between fundamental science and industry

In the framework of the Research and Innovation strategy for Smart Specialization (RIS3) that the European Commission is boosting, the Basque Government is focusing on three areas that are considered to be strategic for the Basque Country: advanced manufacturing, energy, and biosciences and health. In this framework, nanotechnology has been identified as an important Key Enabling Technology (KET), because of its horizontal nature and transformative potential.

NanoGUNE, focused on nanoscience and nanotechnology, aims at working hand-in-hand with companies and bridging the gap between fundamental science and industry, in order to provide integrated innovative solutions that will contribute to a competitive growth of our economy. With this objective in mind, we have been collaborating with a number of local and foreign companies; in particular, we have been working on a few so-called seed projects, as a first step for collaboration within a market-driven research framework.

We have also cultivated an entrepreneurial environment and have always seeked for innovative ideas that might lead to new scientific discoveries and nanotechnology-based developments. We have founded four new companies so far: Graphenea, Simune, Ctech-nano, and Evolgene, all located at the nanoGUNE facilities.

Graphenea (www.graphenea.com), nanoGUNE's first start-up company, was launched in April 2010 as a joint venture of private investors and nanoGUNE. The company was created with the mission of producing high-quality graphene wafers and developing graphene-based technologies. In January 2012, Graphenea became partner of the Graphene Flagship of the European Commission, as the main graphene supplier of the consortium. In December 2013, the Spanish oil company Repsol and the Spanish Center for Industrial Technological Development (CDTI) became shareholders of Graphenea.

SIMUNE Atomistics (www.simune.eu) was launched in January 2014 as a joint venture of four leading scientists and nanoGUNE. The company was created with the mission of commercializing atomic-scale and electromagnetic simmulations. In July 2014, a group of private investors became shareholders of Simune.

Ctech-nano (ctechnano.com) was launched in July 2014 as a joint venture of two local companies (AVS and Cadinox) and nanoGUNE. This company exploits the ability and expertise that we have at nanoGUNE to do Atomic Layer Deposition (ALD) of thin films in order to provide custom coating services and specific coating tools.

Evolgene (www.evolgene.com), nanoGUNE's fourth spin-off company, was launched in September 2014 in the framework of an *Idea* that is being supported by the Entrepreneurs Fund of the Spanish oil company Repsol. The mission of this company is related to the reconstruction of ultraeficient ancestral enzymes that have a wide range of industrial applications, biofuel and cosmetics for example.

4

External Services

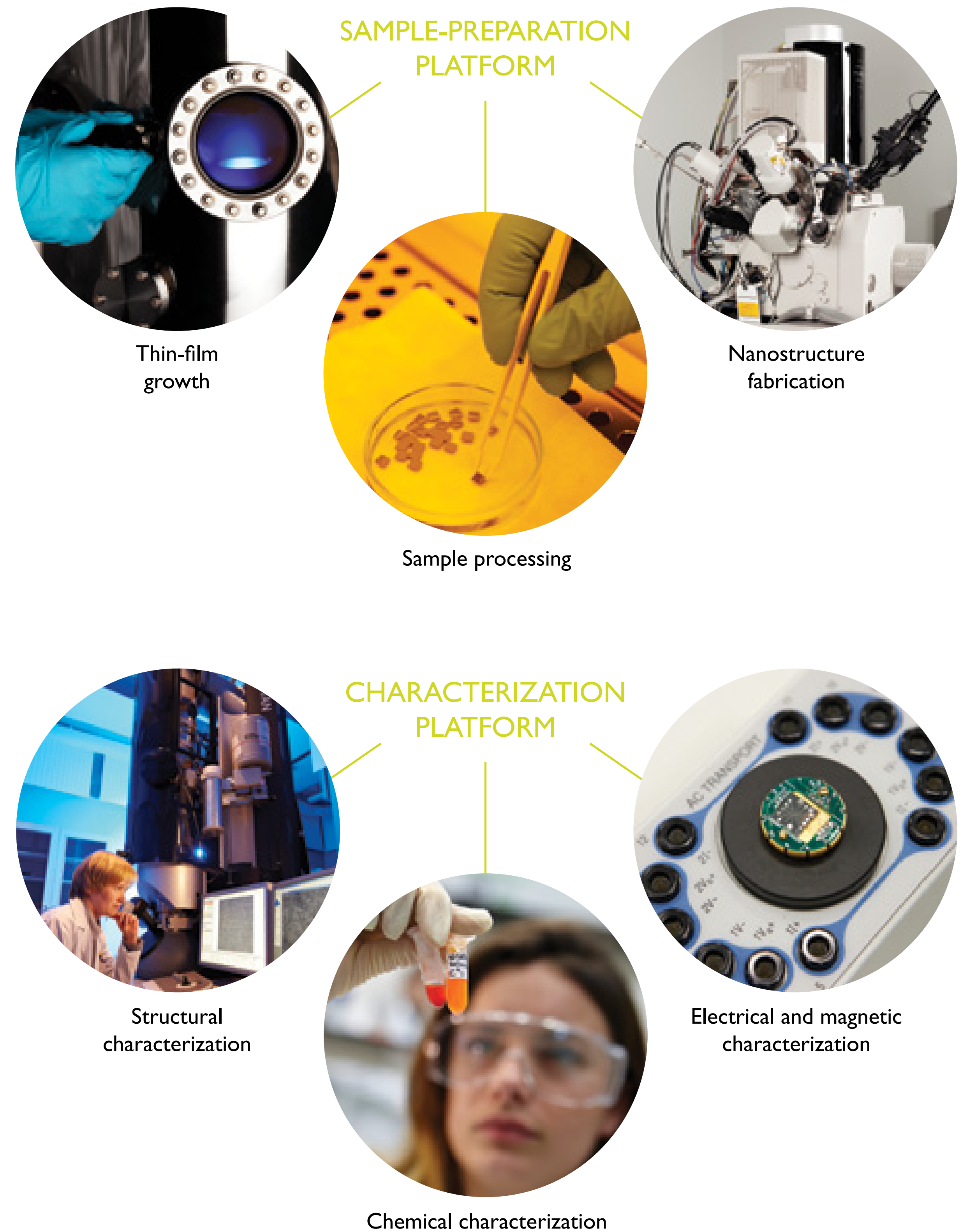
- Sample-fabrication platform
- Characterization platform

External Services

NanoGUNE offers a wide range of nanofabrication and characterization services to external users, both academic and industrial. A state-of-the-art infrastructure and cutting-edge equipment are offered, such as an electron-microscopy laboratory, a cleanroom, and various nanofabrication and characterization laboratories guaranteeing the strict environmental conditions that are necessary for nanotechnology developments.

Our services are divided in two platforms: sample preparation and characterization. All services can be carried out either by qualified nanoGUNE personnel or under a self-service operation.

Our External-Services Department also offers, in collaboration with nanoGUNE's researchers, various training courses related to the use of a wide range of advanced microscopies.



5

Connecting with society

6 open events

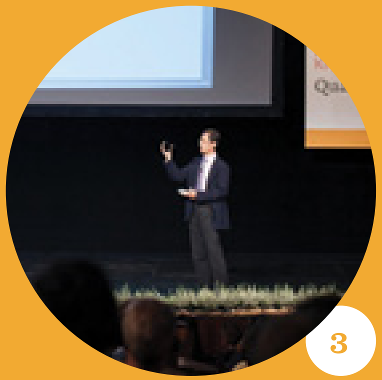
830 visitors from high schools and universities

340 times in the media

Connecting with society

1

2



3

4

The role of science and technology in society has never been so relevant. Science and technology are well known to be directly related to social and economic development. Nanotechnology, in particular, has revealed itself as a key enabling technology. The number of jobs in the field of nanoscience and nanoengineering, which has increased considerably worldwide, is expected to increase tenfold by the year 2020.

After a couple of decades of great progress in nanoscience research, nanotechnology is already playing an important role in the technological development. There is no doubt that, little by little, nanotechnology will be incorporated into a wide range of markets, as well as 'supermarkets'. This is the reason why it is so important to share the scientific challenges of nanoscience and nanotechnology with the society, to inform about the scientific effort that is being promoted by our institutions, and also to inform about the latest technological developments, their advantages, and their risks, thereby contributing to a society capable of building a sustainable future.

With this objective in mind, we have been participating in a good number of initiatives targeted to high-school and university students, as well as to the general public.

Connecting with society

Education-driven activities

Undergrads: summer internship and final project
Undergraduate students are welcome to spend up to two months at nanoGUNE in the framework of our summer-internship program. Undergraduate students are also welcome to join us in order to do their final project under the supervision of one of our principal investigators.

Master
We participate in the Master in Nanoscience and the Master in New Materials, both offered by the University of the Basque Country (UPV/EHU), by giving master students the opportunity to join us in order to do their master thesis under the supervision of one of our principal investigators.

PhD
PhD thesis projects are offered to physics, chemistry, biology, engineering, and materials-science graduates. We closely collaborate, in particular, with the PhD program "Physics of Nanostructures and Advanced Materials (PNAM)" offered by the UPV/EHU.

Nanotechnology course for high-school teachers (1)
NanoGUNE offers a nanotechnology introductory course to high-school science teachers in the framework of the 'Prest Gara program' promoted by the Department of Education, Language Policy, and Culture of the Basque Government.

Visits for educational centers
Following our open-doors policy, we run a program for high-school and university students to visit our facilities, thus offering them the opportunity to have a closer look at nanoscience research. 830 students have visited nanoGUNE during the period 2013-2014.

Open events

Science Week and Playnano (2)
Since 2013, nanoGUNE, together with the Donostia International Physics Center (DIPC) and the Materials Physics Center (CFM), has been collaborating in the Science Week organized by the UPV/EHU through a nanoscience exhibition space. In 2013, we also organized, with the collaboration of the nanoBasque Agency, a so-called Playnano Event, where 50 individuals played in a participating game based on a European-Union initiative to learn and discuss about the challenges faced by nanotechnology.

Passion for Knowledge - Quantum 13 (3)
NanoGUNE collaborated in the organization of "Passion for Knowledge - Quantum 13", a festival organized by the DIPC with the aim of (i) promoting science as a key activity for the well-being of future generations, and (ii) highlighting the thirst of knowledge as the driving force behind scientific, technological, and cultural progress.

OpenLab (4)
In January 2014, coinciding with nanoGUNE's 5th-year anniversary, more than 200 people participated in our first OpenLab event: an open lecture of Prof. Felix Yndurain about "Nanoscience and future energy technologies" followed by a visit to our state-of-the-art laboratories.

In the media

All our communication efforts would have not been so successful without the collaboration of the media, which has covered our activity through more than 340 media-impacts during the period 2013-2014. In addition to this, nanoGUNE (together with other Cooperative Research Centers) is actively involved in the edition of the "CIC Network" magazine. We acknowledge the interest -sometimes even enthusiasm- of the journalists that usually have the complex task of translating complicated scientific results into simple messages. Thanks to their work, the gap between science and society becomes smaller every day!

6 Organization & Funding

66 grants in place

2 ERC

1 Graphene Flagship

2 cooperation & Capacities

11 Marie Curie

Organization and Funding

Organization and Funding

Itziar Otegui Outreach Manager
Carlos Garbayo Maintenance Technician
Ralph Gay Cleanroom Manager
María Rezola Director's Assistant
Miguel Odriozola Finance Director
Gorka Arregui Facilities Manager
Eider García Secretary
Julene Lure Secretary
Yurdana Castelruiz Projects Manager

NanoGUNE is a non-profit making Association that was promoted by the Basque Government in 2006 and officially inaugurated in 2009. In the period 2013-2014, we have accomplished the main objectives that were described in our 2011-2014 Strategic Plan.

All our achievements would have not been possible without the strategic support of the Basque Government and also the Basque Science Foundation (Ikerbasque) through its program to attract talented researchers from all over the world. This effort has contributed to the building of a solid project in the fundamental and technological development of nanoscience and nanotechnology, thus bringing nanoGUNE to international recognition. The strategic support of the Basque Government has been combined with our ability to attract a considerably large amount of external competitive funding from the Spanish Government, the European Comission, and private initiatives, thus making a good progress towards a balanced and sustainable funding structure.

With 2020 in the horizon, the important progress that we have made during these past two years places the Basque Country at the forefront of nanoscience and nanotechnology. It has always been our commitment to take advantage of this in order to contribute to the competitiveness of the Basque economy and the well-being of our society.

Personnel on 31 December 2014	Planned	Executed
Research (including students, technicians, and guests)	80	97
Management & Services	10	10
TOTAL	**90**	**107**

		Executed
New jobs in spin-off companies (2013-2014)		8

Origin (M€) 2013-2014	Planned	Executed
Europe	2.2	2.3
Spanish Government	0.2	0.6
Basque Government - DDEC	8.2	8.4
Basque Government - DEPLC*	1.9	2.0
Industry & Others	0.4	0.2
TOTAL	**12.9**	**13.5**

Destination (M€) 2013-2014	Planned	Executed
Infrastructure	1.1	2.0
Operational costs	11.8	11.5
TOTAL	**12.9**	**13.5**

* Including the cost of the assignment by the Basque Science Foundation of 10 Ikerbasque Research Professors and 4 Ikerbasque Research Fellows
DDEC, Department of Economic Development and Competitiveness
DEPLC, Department of Education, Linguistic Policy, and Culture

GOVERNING BOARD

"nanoGUNE has accomplished its objective of placing the Basque Country at the forefront of nanoscience research. Its extremely creative team is achieving important scientific breakthroughs in the field of nanoscience and innovative nanotechnology-based spin-off companies are already competing in the global market. Basque society can now benefit from nanogGUNE's knowledge and leadership in order to build a new generation of competitive industry."

Chairman

Donostia International Physics Center
Pedro Miguel Echenique

Vice-chairman

Tecnalia Technology Corporation
Joseba Jauregizar

Secretary - Treasurer

IK4 Research Alliance
Jose Miguel Erdozain

Board members

University of the Basque Country (UPV/EHU)
Iñaki Goirizelaia (until 18/06/2013)
Fernando Plazaola (from 18/06/2013)

Regional Council of Gipuzkoa
Oscar Usetxi

Guest members, on behalf of the Basque Government

Department of Industry, Innovation, Trade, and Tourism
Edorta Larrauri (until 08/01/2013)

Department of Economic Development and Competitiveness
Leire Bilbao (from 08/01/2013)

Department of Education, University, and Research
Pedro Luis Arias (until 16/01/2013)

Department of Education, Linguistic Policy, and Culture
Itziar Alkorta (from 16/01/2013)

INTERNATIONAL ADVISORY COMMITTEE

The International Advisory Committee gives advice on the orientation that should be given to the center

Prof. Sir John B. Pendry (Chairman), *Imperial College, London (UK)*

Prof. Anne Dell, *Imperial College, London (UK)*

Dr. José Maiz, *Intel Fellow, Intel, Oregon (USA)*

Prof. Emilio Mendez, *Center for Functional Nanomaterials, Brookhaven Nat. Lab., NY (USA)*

Prof. John Pethica, *CRANN, Dublin (Ireland), and University of Oxford, Oxford (UK)*

Prof. Jean Marie Lehn (Chemistry Nobel Laureate, 1987), *Universite Louis Pasteur, Strasbourg (France)*

FUNDING INSTITUTIONS

FEDER

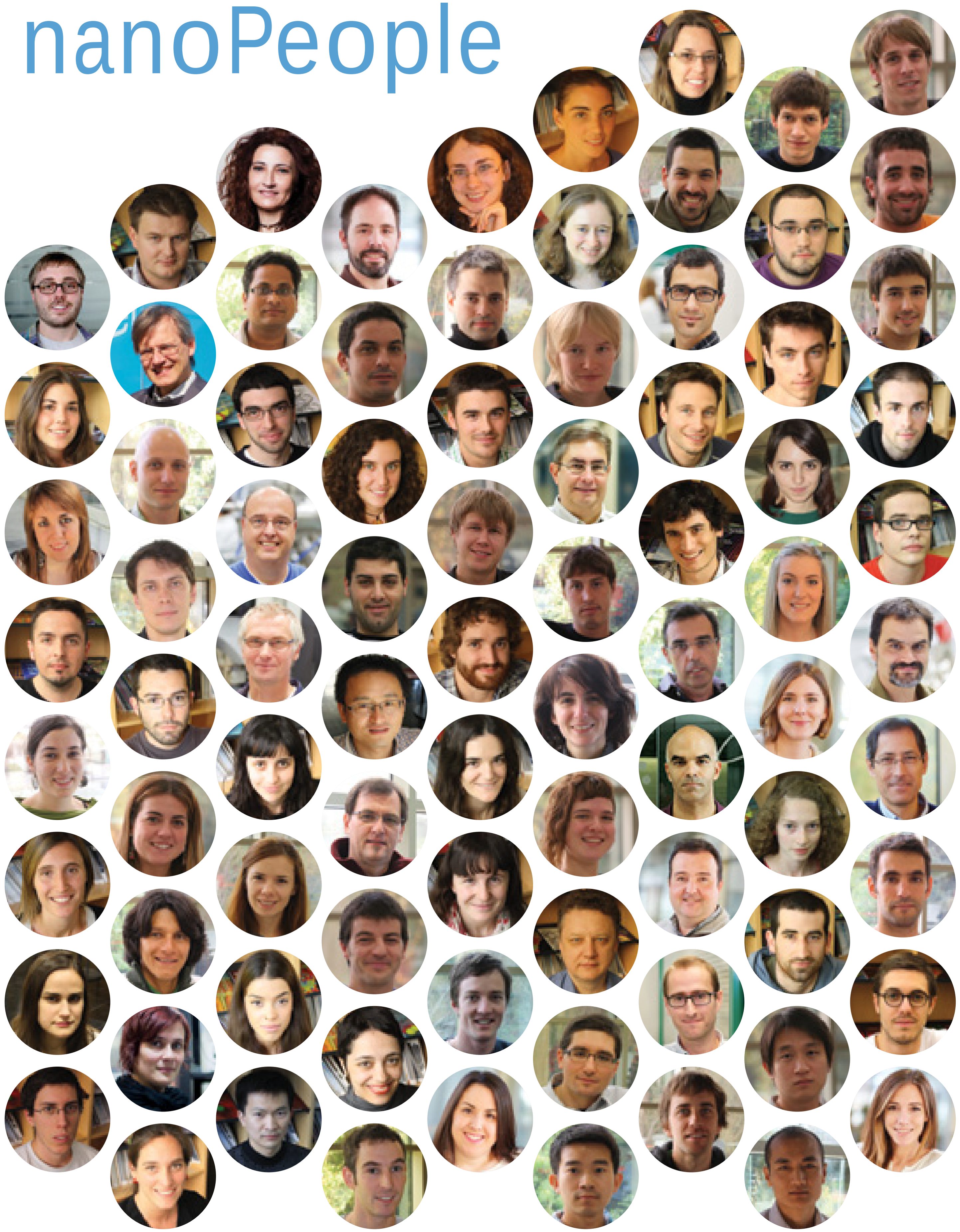
Gobierno de España — Ministerio de Economía y Competitividad

Gipuzkoako Foru Aldundia

Eusko Jaurlaritza — Gobierno Vasco

ikerbasque — Basque Foundation for Science

nanoPeople



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nanoscience cooperative research center