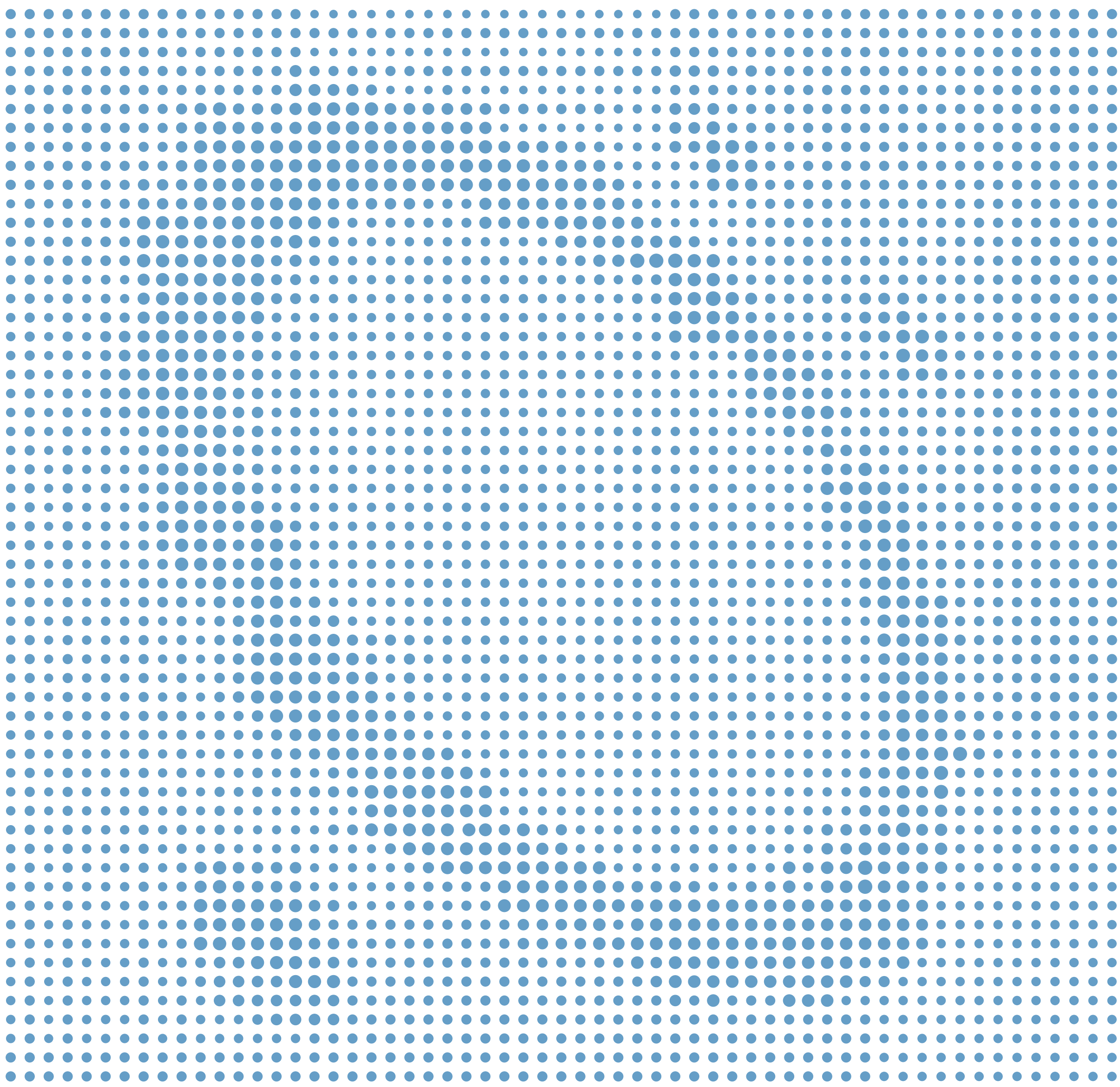
CIC nanoGUNE Consolider

2007-2010

Activity Report



The big challenge of the small

CIC nanoGUNE
nanoscience cooperative research center

2007-2010
Activity Report

Message from the Director

This document represents the first Activity Report of a nanoscience cooperative research center (CIC nanoGUNE Consolider) that was launched from scratch back in September 2006. NanoGUNE was created in the framework of two important initiatives launched by the Department of Industry, Innovation, Trade, and Tourism of the Basque Government. The first is the so-called nanoBasque strategy, promoted for the development of a new industrial sector in the Basque Country enabled by nanotechnology. The second is a network of Cooperative Research Centers (CIC's), launched in order to create an effective framework of cooperation in strategic research areas. NanoGUNE is also a Consolider Center; this means that its creation was partially funded in the framework of the Spanish Consolider program, which is aimed at big projects at the frontiers of science performed by consolidated research groups that are expected to lead Spanish science in a given field.

NanoGUNE was created with the mission of performing world-class nanoscience research for the competitive growth of the Basque Country, thereby combining basic research with the objective of boosting nanotechnology-based market opportunities and contributing to the creation of an enabling framework to remove existing barriers between the academic and business worlds. Being a Cooperative Research Center, new infrastructures and researchers have been put together, with the aim of opening new areas of strategic research, and, at the same time, cooperation has been fostered among existing research groups at the Donostia International Physics Center (DIPC), the University of the Basque Country (UPV/EHU), and Technological Centers. This Activity Report describes the activity of the newly created research groups at nanoGUNE.

The equipment necessary to carry out world-class research in the field of nanoscience and nanotechnology required the construction of a state-of-the-art facility properly isolated from external disturbances (vibrations, noise, electromagnetic interference, and dirt) that would prevent us from obtaining the high precision required at the nanoscale. We proceeded with the construction of a building that includes avant-garde architectural and engineering solutions; and, thanks to the efforts of a complex working team (composed of experienced architects and engineers), the official opening of nanoGUNE took place on 30 January 2009, hardly two years after the project had been launched. Since then, we have succeeded in putting together five research groups (as many as we had been planning to build for the first stage of our activity), in addition to an advanced electron-microscopy laboratory. These groups have opened new areas of strategic research in the Basque Country in the fields of nanomagnetism, nanooptics, self-assembly, nanobiotechnology, and nanodevices, and comprise a team of more than 50 researchers, including graduate students, post-docs, technicians, and visitors coming from 15 different countries all around the world.

During this launching period of four years, the bases have been set for nanoGUNE to evolve into an internationally recognized center of excellence that should contribute to the translation of basic research into innovation. This would not have been possible without the joint effort of many people involved in this challenging project. We have benefited from the generous support of a good number of individuals and public institutions. NanoGUNE was launched from an idea that arose in 2005 within a strategy set up by the Department of Industry, Innovation, Trade, and Tourism of the Basque Government and an initiative promoted by the Donostia International Physics Center led by Pedro Miguel Echenique. I would also like to express my gratitude to the Department of Education, Universities, and Research of the Basque Government, the Tecnalia Corporation, the IK4 Alliance, the University of the Basque Country, the Regional Council of Gipuzkoa, the Ikerbasque Foundation, the Spanish Ministry of Science and Innovation, our International Advisory Committee, and all outstanding researchers and employees who have believed in our project and have contributed so much to it.

The expectations are high. Researching the small and extracting technological performance that can be converted into new products and more efficient processes, whilst at the same time being sustainable, is a huge challenge for a small center in a small country. This is the big challenge of the small.

José M. Pitarke
Director

Donostia - San Sebastian, December 2010

1

Strategic definition of nanoGUNE

World-class Research

Technology Transfer

Cooperation

Strategic definition of nanoGUNE

Definition of nanoGUNE

The Science, Technology, and Innovation Plan launched by the Basque Government for the period 2001-2004 included nanotechnology as an strategic research area, due to its potential for having a major impact on the competitiveness of Basque companies. As a result, nanoscience research was promoted by the Basque Government in the framework of the so-called Etortek strategic research program.

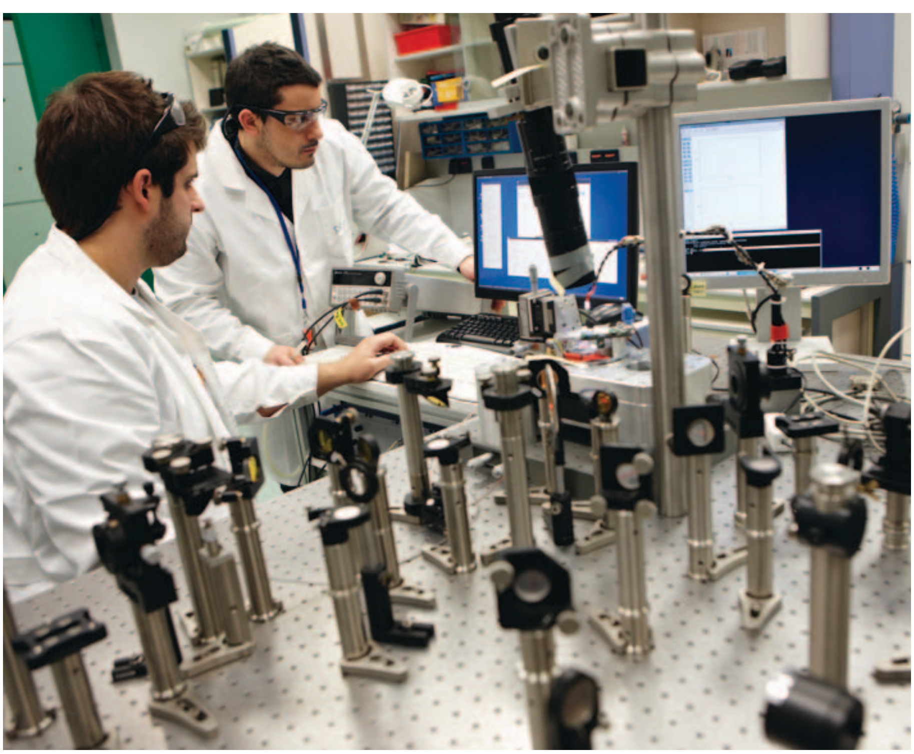
In 2005, a strategy was set up by the Department of Industry, Innovation, Trade, and Tourism of the Basque Government for the promotion of a Nanoscience Cooperative Research Center; a few months later, on 28 February 2006, nanoGUNE was legally established as a non-profit making Association; and on 1 September 2006 José M. Pitarke, Full Professor of Condensed Matter Physics at the University of the Basque Country, started his duties as Director of nanoGUNE.

NanoGUNE is a nanoscience cooperative research center that was created with the mission of addressing world-class nanoscience research for the competitive growth of the Basque Country. NanoGUNE also faces the challenge of fostering cooperation among various research and technological groups in the Basque Country and exploring new models to fill the gap between basic research and innovation.

With the aim of placing the Basque Country at the forefront of nanoscience research, it has been nanoGUNE´s commitment to incorporate highly-qualified outstanding researchers and state-of-the-art research equipment. In the launching period 2007-2010, we have been successful in putting together five research groups, in addition to an advanced electron-microscopy facility, which with researchers coming from 15 different countries are already fully operational and making important research contributions in the fields of nanomagnetism, nanooptics, self-assembly, nanobiotechnology, and nanodevices. New groups will be opened in the future, with a total of up to ten research laboratories.

NanoGUNE's research activity focuses not only on carrying out excellent research, but also on the transfer of knowledge and technology to our industrial environment. Graphenea, the first start-up of nanoGUNE, was launched in 2010 and is located at the nanoGUNE building, thereby taking advantage, in a start-up phase, of nanoGUNE's experience, knowledge, and state-of-the-art equipment.

NanoGUNE is also oriented towards the diffusion of knowledge, not only to the international scientific community but also to the society as a whole. In the launching period 2007-2010, a good number of initiatives have taken place at nanoGUNE, all related to the diffusion of a scientific culture, in general, and nanoscience and nanotechnology, in particular, with special emphasis on activities aimed at the education system. The challenge is taken of making nanoGUNE's work and the economic and social relevance of that work clearly understood by our society, with the conviction that an informed society is freer and more responsible to make the decisions that will shape our future.



Mission

To perform world-class nanoscience research for the competitive growth of the Basque Country

Vision

To become a multidisciplinary nanoscience excellence research center, which (i) efficiently promotes cooperation among existing research and technological agents of the Basque Innovation System, and (ii) acts as a catalyst of a Basque knowledge-based economy

Culture and Values

A constant search for excellence in all areas of activity: research, training, collaboration, service, and management

People in a participation environment; people represent our project's main guarantee of success

Openness and universality from a perspective of commitment to the Basque Country

Strategic Challenges

01. Provide a singular infrastructure, comparable to that of other world-class research centers internationally known in the field of nanoscience and nanotechnology.

02. Attract world-class researchers and establish a highly-qualified professional team.

03. Carry out a research activity of excellence in a number of strategic research areas.

04. Lead the integration of various Basque research and technological agents that are currently active in the field of nanoscience and nanotechnology.

05. Attract and train the best international postgraduates.

06. Strengthen international cooperation and, in particular, strive for the integration of nanoGUNE in the European Research Area in the field of nanoscience and nanotechnology.

07. Contribute to the consolidation and boosting of the diversification of the business environment towards the development of a knowledge-based economy.

08. Direct the ongoing research activity towards technology transfer and commercial use of scientific results.

09. Play an active leading role in the spreading of scientific knowledge to industry and to society, thus contributing to the understanding of the social dimension of science and projecting the expected image of an intellectually and technologically advanced country.

10. Establish a flexible and open organization, which adapts with ease to the changing conditions of its environment.

2

Organization

52
Researchers

15
Countries

Organization

Governing Board

NanoGUNE was established as a non-profit making Association on 28 February 2006. The Association is currently formed by the following partners:

promoted by

NanoGUNE's Governing Structure is set out over two bodies:

· **The General Assembly** is the Association's supreme governing body; it includes all members.

· **The Steering Committee** is the body in charge of the Association's administration; it safeguards that the Articles of the Association are complied and that the agreements reached at the General Assembly are fulfilled. These have been the members of the Steering Committee over the period 2007-2010:

Chairman

Donostia International Physics Center (DIPC)
Pedro Miguel Echenique

Vice-chairman

Tecnalia Technology Corporation
Roberto Gracia (until 27/02/2008)
Joseba Jaureguizar (from 28/02/2008)


Secretary

IK4 Research Alliance
Javier Rodríguez

Board members

University of the Basque Country (UPV/EHU)
Juan Ignacio Pérez (until 05/03/2009)
Iñaki Goirizelaia (from 06/03/2009)


Regional Council of Gipuzkoa
José Ramón Guridi (until 01/10/2007)
Joseba Iñaki Ibarra (from 02/10/2007)


Guest members, on behalf of the Basque Government

Department of Industry, Innovation, Trade, and Tourism
Joseba Jaureguizar (until 17/01/2008)
Alberto Fernández (from 18/01/2008 to 04/06/2009)
Edorta Larrauri (from 05/06/2009)



Department of Education, Universities, and Research
Alberto Ansuategi (until 05/06/2009)
Pedro Luis Arias (from 06/06/2009)


International Advisory Committee

The main role of the International Advisory Committee is to advise in the orientation and general strategy of the center. The International Advisory Committee is composed of internationally renowned researchers and professionals. These are the members of the International Advisory Committee over the period 2007-2010:

Prof. Sir John Pendry, Chairman
Imperial College, London, UK

Prof. Anne Dell
Imperial College, London, UK
(from 22/11/2010)

Prof. Jean-Marie Lehn
Chemistry Nobel Laureate, 1987
Université Louis Pasteur, Strasbourg, France

Dr. José A. Maiz
Intel Corporation, Oregon, USA

Prof. Emilio Mendez
Center for Functional Nanomaterials (CFN)
Brookhaven National Laboratory, New York, USA

Prof. John Pethica
CRANN – Trinity College, Dublin, Ireland,
and University of Oxford, Oxford, UK

Prof. Heinrich Rohrer
Physics Nobel Laureate, 1986
Switzerland

Human Resources

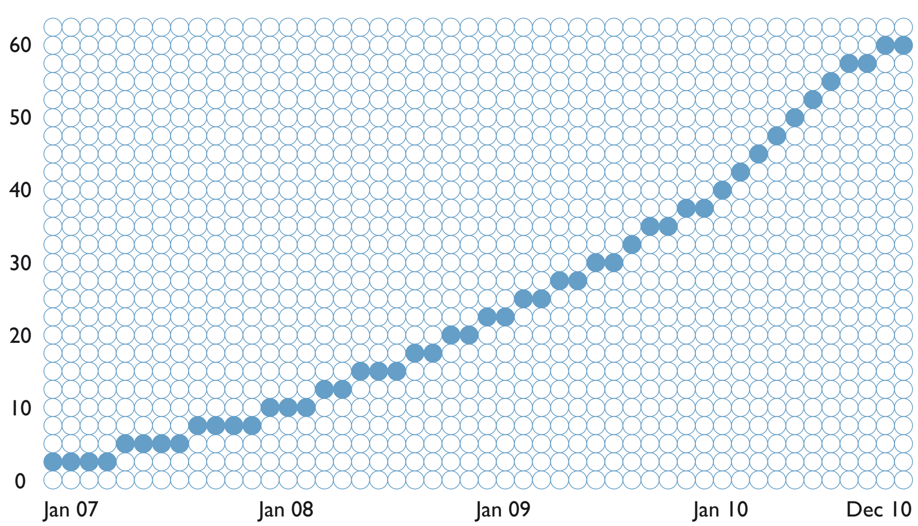
People are the main asset of nanoGUNE, which has faced the challenge of attracting excellent scientists and professionals from all over the world. At the beginning of 2007, the seed of nanoGUNE was composed of 3 people: the Director, the Projects and Outreach Manager, and the Director's Assistant. In March 2007, the Finance Director joined nanoGUNE, and a few months later the Research Director and the Facilities Manager joined the team, playing a fundamental role in the development of the facilities. Afterwards, a world-wide selection process took place, in order to recruit a number of leading scientists that would lead the research activity of nanoGUNE.

The selection process started with a world-wide call for applications in the most prestigious scientific media. The selection process was carried out in two stages. In a first stage, the candidates' curricula vitae were assessed and a short list was prepared based on scientific excellence. In a second stage, the short list was reviewed by the International Advisory Committee, and some of the candidates were called for an interview. The interview, including a research seminar and a second less formal presentation about the candidate's research plan, took one full day for each candidate. We succeeded in configuring a multidisciplinary research team composed of five research groups and an advanced electron-microscopy laboratory. In the period 2007-2010, nine tenured scientists were hired; eight of them were awarded an Ikerbasque Research Professorship (to work at nanoGUNE) by the Ikerbasque Basque Foundation for Science. Ikerbasque was created by the Basque Government to develop scientific research in the Basque Country by attracting senior researchers and creating new research capacities.

Each research group was originally composed by a group leader, one post-doctoral researcher, two pre-doctoral researchers, and one technician. NanoGUNE opened its doors in 2009 with a research team composed of nearly 25 researchers that has been growing steadily to reach 52 researchers (including guests and the technical team) by the end of 2010.

Apart from the research team, nanoGUNE incorporated a small management team that gives support to the research groups and to the outreach activities of the center. The following chart shows the evolution of the nanoGUNE personnel since the beginning of 2007.

Evolution of the nanoGUNE personnel



NanoGUNE personnel on 31 December 2010

Director

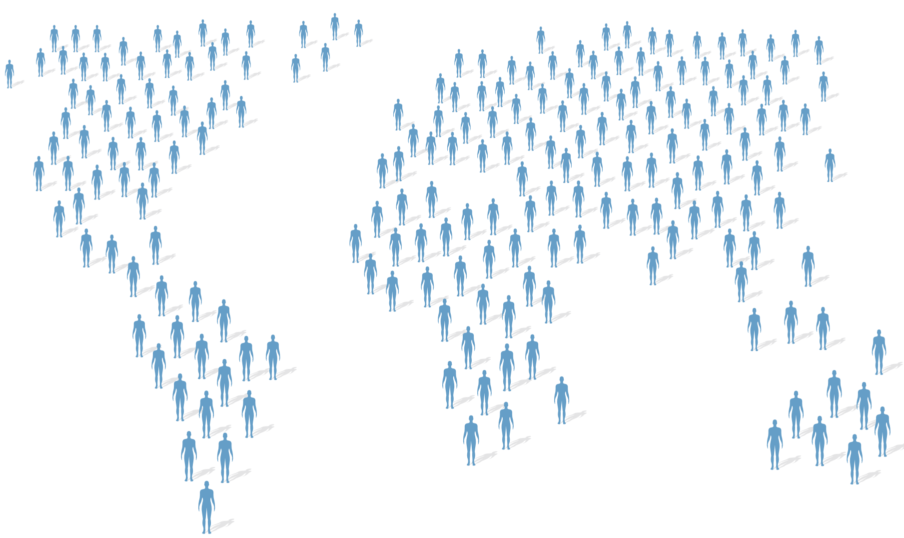
Pitarke, José María	UPV/EHU Full Professor

Group Leaders

Berger, Andreas	**Research Director**
Bittner, Alexander	Ikerbasque Research Professor
Hillenbrand, Rainer	Ikerbasque Research Professor
Hueso, Luis	Ikerbasque Research Professor

Staff Scientists

Casanova, Fèlix	Ikerbasque Research Professor
Chuvilin, Andrey	Ikerbasque Research Professor
Vavassori, Paolo	Ikerbasque Research Professor and Group Coleader



Spain	*31*	*Russia*	*3*	*Brazil*	*1*	*Poland*	*1*
Germany	*7*	*United Kingdom*	*2*	*China*	*1*	*Slovakia*	*1*
Italy	*5*	*Argentina*	*1*	*Latvia*	*1*	*Thailand*	*1*
France	*4*	*Belarus*	*1*	*Pakistan*	*1*	***TOTAL***	***61***

Post-doctoral Researchers

Alonso, José María	nanoGUNE Fellow
Alonso, Pablo	FP7 Fellow
Chen, Jianing	CSIC-nanoGUNE Fellow
Demont, Yohann	CENIT Fellow
Fernández, Mercedes	Consolider Fellow
Golmar, Federico	nanoGUNE Fellow
González, Imanol	Consolider Fellow
Hovorka, Ondrej	Marie Curie Fellow
Melnikau, Dimitry	nanoGUNE Fellow
Nikulina, Elizaveta	FEI Fellow
Suszka, Anna	nanoGUNE Fellow

Pre-doctoral Researchers

Arregi, Jon Ander	FPI Fellow
Arzubiaga, Libe	PFPI Fellow
Berriozabal, Gemma	Consolider Fellow
De Oliveira, Thales	nanoGUNE Fellow
Gobbi, Marco	nanoGUNE Fellow
Idigoras, Olatz	PFPI Fellow
Khan, Abid Ali	FP7 Fellow
Krutohvostovs, Roman	nanoGUNE Fellow
Le Cigne, Anthony	FP7 Fellow
Nuansing, Wiwat	nanoGUNE Fellow
Poly, Simon	nanoGUNE Fellow
Porro, Txema	PFPI Fellow
Sarriugarte, Paulo	PFPI Fellow
Schnell, Martin	PFPI Fellow
Stiegler, Johannes	nanoGUNE Fellow
Villamor, Estitxu	PFPI Fellow
Zazpe, Raúl	nanoGUNE Fellow

Technical Team

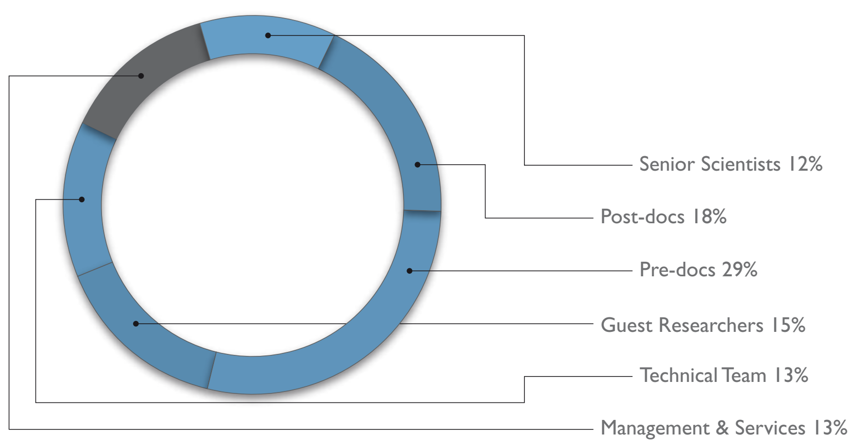
Crespo, Carlos	Technician
Fertin, Marie	Technician
Gay, Ralph	Cleanroom Manager
Llopis, Roger	Technician
Pazos, Gorka	Equipment Engineer
Rebollo, Amaia	Technician
Rufo, César	Technician
Tollan, Christopher	Technician

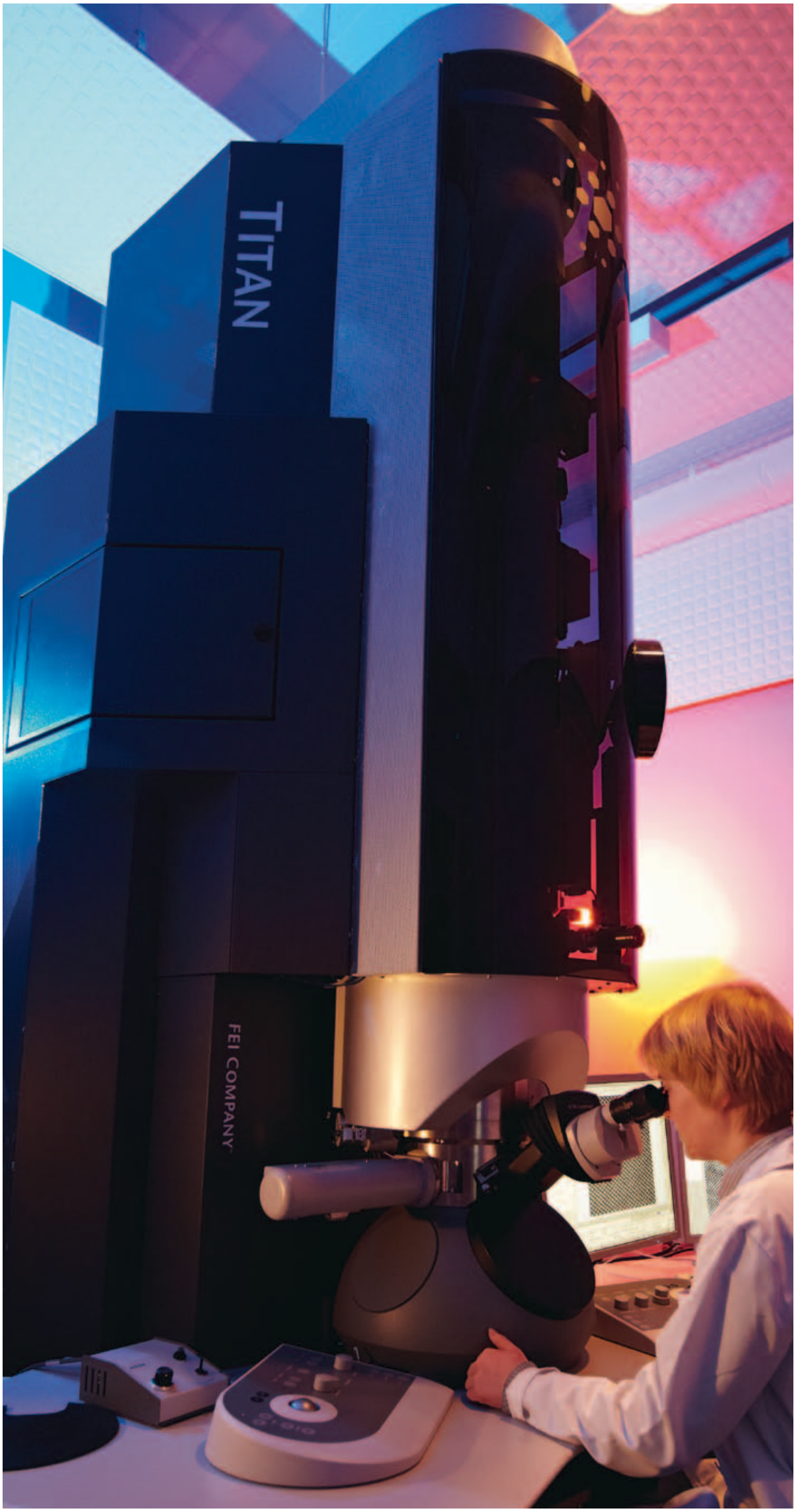
Guest Researchers

Albella, Pablo	CSIC post-doc
Huth, Florian	Neaspec pre-doc
Ilin, Maxim	Juan-de-la-Cierva Fellow
La Porta, Andrea	Master student
Marcano, Xabier	Diploma student
Marchesin, Federico	Master student
Rodal, Pablo	Pre-doc
Stenner, Charlotte	Master student
Verduci, Tindara	Master student

Management & Services

Odriozola, Miguel	**Finance Director**
Arregui, Gorka	Facilities Manager
Asunción, Miryam	Projects and TechTransfer Manager
Garbayo, Carlos	Maintenance Technician
García, Eider	Secretary
Lure, Julene	Research Secretary
Rezola, María	Director's Assistant
Zarate, Enrique	Outreach Manager

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CIC
nanoGUNE
nanoscience cooperative research center

3

Infrastructure

6,200 m²
building

15
ultra-sensitive laboratories

300 m²
cleanroom

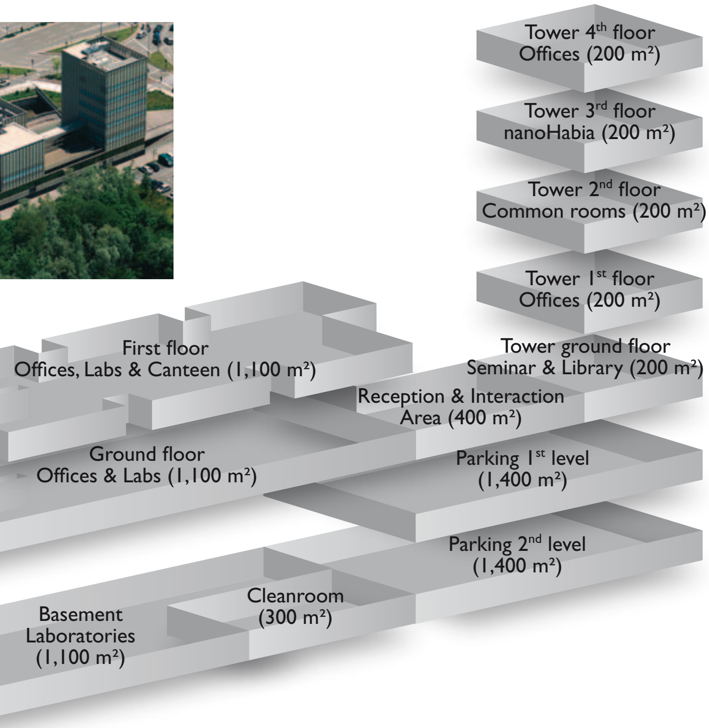
Infrastructure

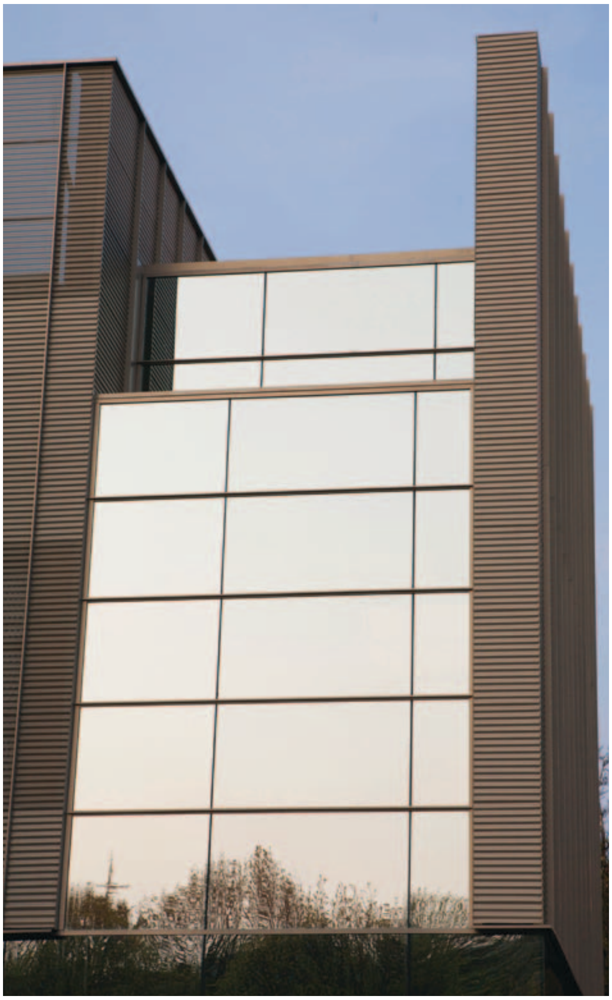
Building

Progress in nanoscience research is only possible if one can actually fabricate nanoscale materials and measure their properties on the nanometer scale and with sufficiently high sensitivity. Thus, one key challenge was to build a unique infrastructure, free of electromagnetic interference (EMI), with an ultra-low level of vibration and acoustical noise, and ultra-clean rooms.

In order to achieve this goal and host state-of-the-art facilities for nanoscience research, some of the key nanotechnology centers in Europe and the USA were visited and analyzed, and the conclusions were discussed with a complex working team which involved experienced architects and engineers as well as vibration, EMI, and cleanroom consultants.

During the design and the first stage of the construction, this working team kept a tight control and supervision of the project in order to guarantee the fulfillment of the desired requirements. This task included more than ten monthly intensive two-days workshops in San Sebastian, which made the project a success in an incredibly short period of time.





A unique infrastructure,
free of electromagnetic
interference, with an
ultra-low level of vibration
and acoustical noise,
and ultra-clean rooms

The walls and the doors
in the laboratories were
designed as active elements
of noise and electromagnetic
isolation, in order to avoid
undesired interference between
the equipments themselves

The desing took into
account the vibrational noise
created by someone walking
along the corridor

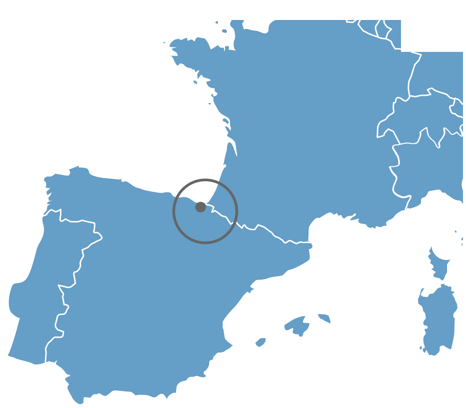
The nanoGUNE building is located at the Ibaeta Campus of the University of the Basque Country in San Sebastian, next to the Donostia International Physics Center, the Faculty of Chemistry, the Materials Physics Center (which is a joint research center of the University of the Basque Country and the Spanish Research Council), and the Korta research building, all with a considerable activity in the field of nanoscience and nanotechnology.

The Basque architect (based in Barcelona) Javier San José took on the challenge of the design of a unique scientific infrastructure that should get integrated in a natural way with the city landscape. This is a building of 6,200 m^2 that includes a five-floors tower and a research area composed by six cubes, allocating in the basement the necessary space for 15 ultra-sensitive laboratories and a nanofabrication cleanroom of about 300 m^2.

The whole research area is constructed on a concrete slab of 1,500 m^2 that is 1.5 m thick and is fixed to the ground rocks for the building to be isolated from external vibrations. All laboratories were carefully designed following the specific requirements of the research tools to be installed. The walls and the doors in the laboratories were designed as active elements of noise and electromagnetic isolation, in order to avoid undesired interference between the equipments themselves. A service corridor was added to supply services to the laboratories without affecting the most sensitive measurements.

A good number of laboratories and offices were kept as shell space for future expansion. The expansion possibilities of the building, which could be increased to up to 10,000 m^2 in a second stage of the construction, guaranteed the development of the center with plenty of room for still-to-be-defined further laboratories, offices, and future projects.

The nanoGUNE building was inaugurated officially on 30 January 2009.



The cleanroom is an area of 300 m^2 where air purity is under strict control

Air filtering guarantees the absence of dust particles larger than 500 nm, which would make the fabrication of nanostructures and nanodevices impossible

Official opening of nanoGUNE, 30 January 2009

In September 2006, nanoGUNE started operation in a small office space at the San Sebastian Technology Park. It was there where the nanoGUNE future headquarters were conceived and designed, in a process that led to the construction of a state-of-the-art facility in a record time.

On 30 January 2009, the nanoGUNE facilities were officially inaugurated in an event that was chaired by Juan José Ibarretxe (President of the Basque Country), Markel Olano (President of the Regional Council of Gipuzkoa), Carlos Martínez (State Secretary for Research of the Spanish Government), Pedro Miguel Echenique (President of nanoGUNE), and José M. Pitarke (Director of nanoGUNE). This new facility, which was the result of the effort of the participant institutions and was intended to reach the level of other international centers of reference, brought a substantial advance to the existing research capabilities of the Basque Country.

The meaning of this event was beyond the opening of the new building; it represented a milestone in the strategic view and commitment of the Basque Country towards Science and Technology as a way to leverage its industrial, economical, and social development.

In the celebration of this important event, more than 300 people participated, including representatives of a good number of government institutions, universities, research and technological centers, industry, the financial sector, and the media, as well as some of the main characters of the Basque cultural community.

The opening ceremony included speeches by the authorities chairing the inauguration and the projection of a video with interviews to the members of the nanoGUNE International Advisory Committee. After the speech of the President of the Basque Country, Juan José Ibarretxe, a plaque was engraved *in situ* with a laser machine. At this point, the building was officially inaugurated. The event ended with a visit to the new laboratories and with a cocktail being served at the interaction area of nanoGUNE.

"Industry lies in the heart of our economy and our community. Therefore, the development of nanoscience and nanotechnology, the nanorevolution, represents a fundamental ingredient for our future activity"

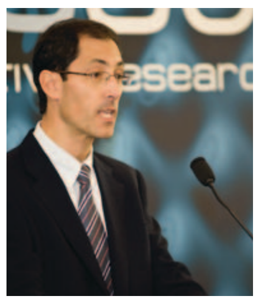
Juan José Ibarretxe
President of the Basque Country

"It is necessary to open the doors of our country to the rest of the world, and nanoGUNE will enable synergy and cooperation"

Markel Olano
President of the Regional Council of Gipuzkoa

"This represents a big challenge for a small but successful country, the Basque Country, which is currently aiming at becoming the innovation reference in Europe"

José María Pitarke
Director of nanoGUNE



"Research in the frontiers of knowledge, with the highest quality and with the mission of translating ideas into products, into wealth; thus contributing to the diversification and competitiveness of our industry"

Pedro Miguel Etxenike
President of nanoGUNE

"Scientific knowledge much more than a collection of systematically structured knowledge, meaningful only for the research community, is a source of social development that fosters wealth and employment"

Carlos Martínez
State Secretary for Research of the Spanish Government

Cleanroom

The cleanroom, installed in the basement research area close to the laboratories, covers an area of nearly 300 m^2, with classes ranging from class 10,000 (ISO 7) up to class 100 (ISO 5). It is divided into four bays:

Electron-Beam Lithography Bay   ISO 5 – (Class 100)   ISO 6 – (Class 1000)

Research operation

Fabrication of nano-scale structures

Nano-scale imaging

Equipment

e-beam Lithography

Photo Bay   ISO 5 – (Class 100)   ISO 6 – (Class 1000)

Research operation

Optical-lithography structurization

Nano-scale fabrication processing

Lithography process control

Equipment

Photolithography

Etching Bay   ISO 7 (class 10000)

Research operation

Wet and dry etching

Nano-scale fabrication processing

Equipment

Reactive and Ion-Beam Etcher

Deposition Bay   ISO 7 (class 10000)

Research operation

Growth of nano-scale film and multilayer structures

Nano-scale materials characterization

Growth and structuration process control

Equipment

e-beam/thermal deposition tool

Atomic Layer Deposition

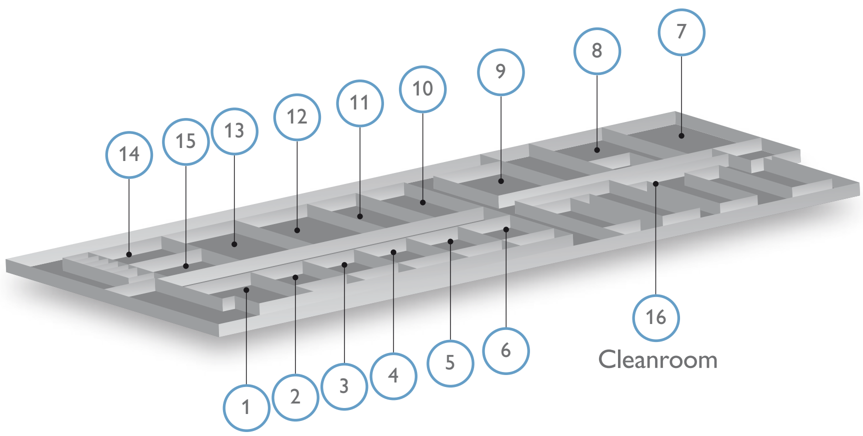
Profilometer

Variable-Angle Spectroscopic Ellipsometer

Bench-top SEM

Laboratories & Non-Cleanroom Equipment

Most operational laboratories are placed in the basement, where the best isolation conditions are achieved. NanoGUNE laboratories are equipped with state-of-the-art scientific tools, with the aim of being an advanced technological platform that should give service not only to nanoGUNE's research groups but also to other research groups and companies that seek access to the latest experimental solutions in the field of nanoscience and nanotechnology.



The following list summarizes the laboratories and the most important non-cleanroom tools installed at nanoGUNE:

1 Transmision Electron Microscopy

- High-Resolution (Scanning) Transmission Electron Microscope (HR-TEM/STEM) image-aberration corrected Titan™ 60-300

2 Environmental Scanning Electron Microscopy

- Environmental Scanning Electron Microscope (ESEM) Quanta™ FEG

3 Graphenea Laboratory

4 Dual-Beam Focused-Ion-Beam Nanofabrication

- Dual-Beam Focused-Ion-Beam (FIB) instrument Helios NanoLab™

5 Scanning Tunneling Microscopy I

6 Scanning Tunneling Microscopy II

7 Chemical Synthesis

- Electrospinning Setup
- Evaporator
- Lyophilizator
- Dynamic Light Scattering
- Infrared Spectrometer
- Ellipsometer
- High-speed Camera






8 Nanobiotechnology

- Real-Time PCR System

9 Biochemical Characterization

- Confocal Laser Microscope
- Laser Flow Cytometer
- Polarimeter
- Fluorimeter
- UV-VIS Spectrophotometer
- Isoelectric Focusing System
- Microsquid
- Microcalorimeter

10 Nanooptics I

- Scattering-type Near-Field Optical Microscopes
- Supercontinuum Infra-Red and THz Lasers

11 Nanooptics II

- Scattering-type Near-Field Optical Microscope
- Raman Spectrometer with an AFM setup
- Supercontinuum Infra-Red and THz Lasers

12 Deposition and Magneto-Optic Characterization

- Ultra-High-Vacuum Sputter System
- Dual-Chamber Organic/Metallic Ultra-High-Vacuum Evaporator System
- Magneto-Optical Kerr-Effect Setup for reflection, diffraction, and ellipsometry

13 Advanced Physical Characterization

- Physical Properties Measurement Systems (PPMS)
- SQUID - Vibrating Sample Magnetometer
- Variable Temperature Probe Station
- System for semiconducting characterization
- Nanovoltmeter and Keithley source
- X-Ray Diffractometer

14 Sample Preparation

15 Probe Microscopy

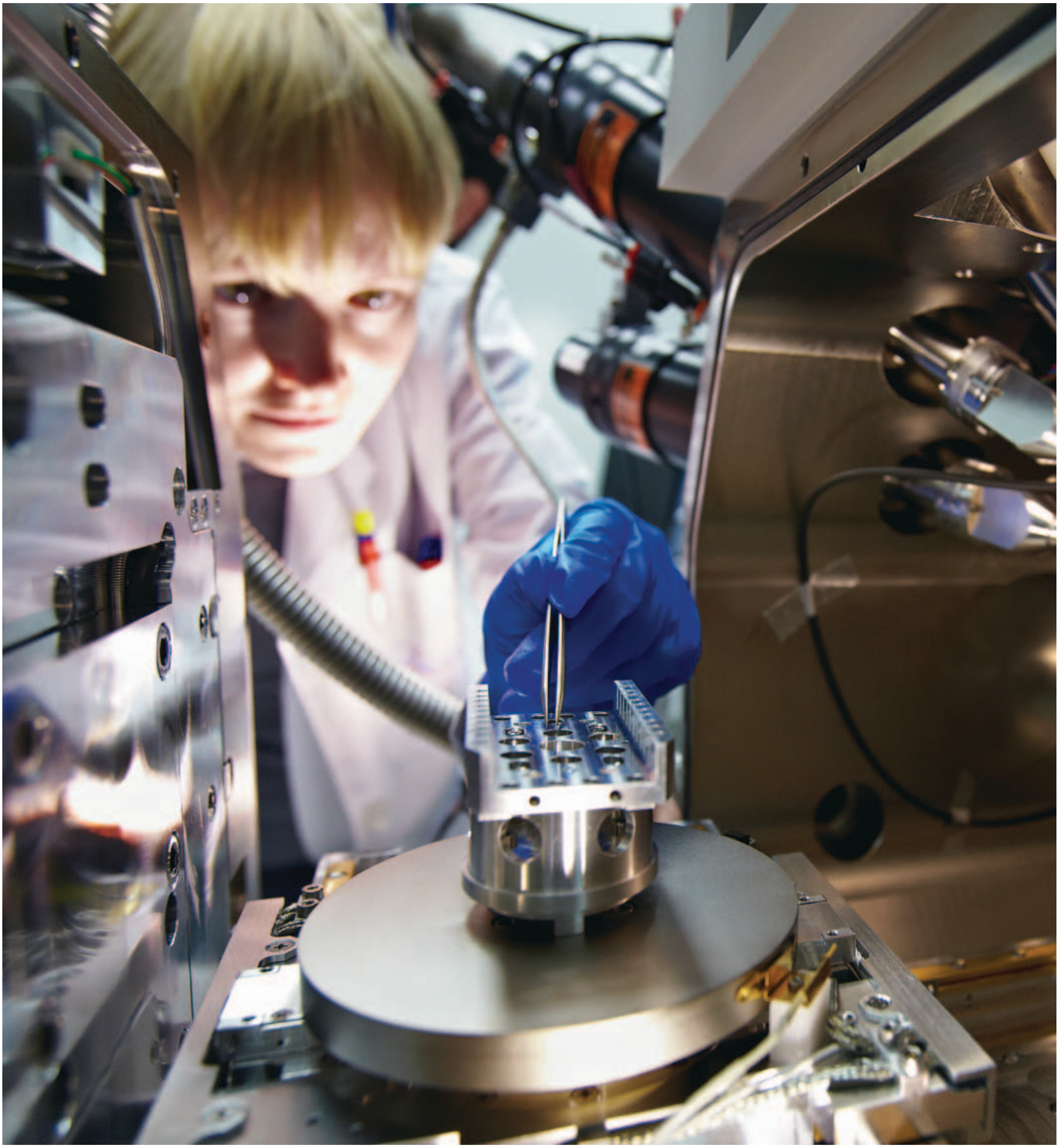
- Atomic/Magnetic Force Microscopes
- Magneto-Optical Kerr-Effect Microscope

Cell-culture

A mammalian cell-culture laboratory is operational in the ground floor

- Sterilizer
- CO_2 incubator
- Biological Hood
- Washing Machine
- Ultra-centrifuge
- Microscope for cell lab
- Fluorescence microscope

Other laboratories in the ground floor and first floor are being kept as shell space for future expansion.



4

Research

5

Research Groups

1

Electron-Microscopy Laboratory

9

Senior Scientists

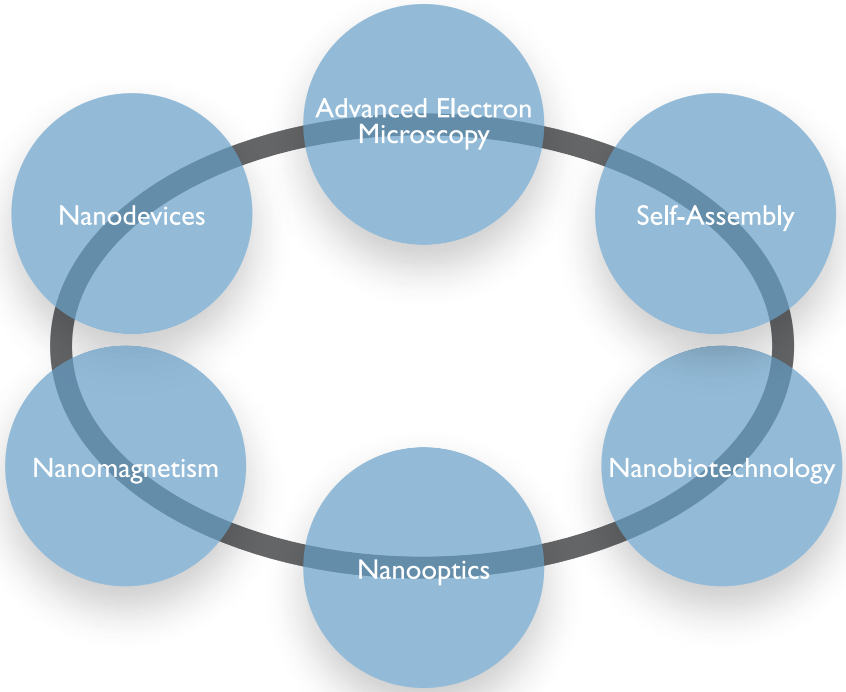
Research

Nanoscience research is the core activity of nanoGUNE. One of the main challenges in the launching stage of nanoGUNE was to put into place a research activity of excellence in the strategic research fields that had been identified in the definition of the strategic plan of the center.

The general objective pursued in the period 2007-2010 was to place nanoGUNE as a research center of excellence in nanoscience and nanotechnology. This objective could only be reached by (i) putting together a team of scientists that are well-recognized leaders in their respective fields and (ii) designing and implementing a number of multidisciplinary research programmes at the frontiers of knowledge.

The research activity at nanoGUNE is coordinated by the Research Director of nanoGUNE, Dr. Andreas Berger, who, working closely with the Director, Prof. José M. Pitarke, is responsible for the design, coordination, and operation of the research groups, formulating the research vision of the center and providing the research leadership.

The research activity is organized into five interdisciplinary research groups and an advanced electron-microscopy laboratory, which, led by world-class scientists, carry out interdisciplinary research in an open environment for communication, discussion, and collaboration.



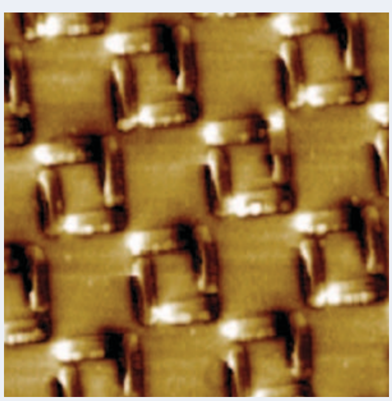
Nanomagnetism

The nanomagnetism group is led by Andreas Berger jointly with group coleader Paolo Vavassori. Focused on the fabrication and characterization of new nanolayered materials and magnetic nanostrutures, the research program for the nanomagnetism group is divided into three main themes of research.

The first area concerns the understanding of magnetization reversal, its dynamics, and its correlation with other materials properties. The process of magnetization reversal is the core of the write-erase process in hard disks and other magnetic memory technologies. Improvements on the technological capability to control the magnetization in smaller areas, with higher velocities and less noise, will have a fundamental impact onto the development of new storage materials and technologies.

The second area of interest explores the fabrication of new multilayered magnetic materials using the most advanced deposition techniques. Multilayered magnetic materials are present in hard disks, and are also widely used in security and labeling applications where the possibility of fine tuning the magnetic properties opens a wide range of applications. In the nanomagnetism group, new nanolayered materials are fabricated and characterized looking for new ultra-small grain materials (smaller grains allow higher storage densities) and metamagnetic films (the combination of magnetic and non-magnetic layers can produce new interesting properties).

Finally, new magnetic nanostructures, such as arrays of nanomagnets, and new characterization techniques based on magneto-optic scattering and diffraction are being developed. The displacement of domain walls in nanostructures opens the possibility of its use for field pulse generation and particle transport, an aspect that is of interest in biomedical applications. On the other hand, patterned magnetic surfaces are promising candidates for the development of new non-volatile memory devices that could substitute or complement other technological alternatives. In this area, new nanofabrication techniques are being explored, such as electron and ion-beam techniques.



Andreas Berger
Group Leader

PhD in Physics in 1993, RWTH Aachen University (Germany)
Research experience at USA Universities, Argonne National Laboratory, IBM Almaden Research Center, and Hitachi Global Storage Technologies
Research interests: Thin-film deposition techniques for disk storage applications. Fabrication and characterization of novel magnetic materials. Physics of magnetization reversal
Comes from Hitachi Global Storage Technologies (USA)
Joining date: 1 July 2007

Paolo Vavassori
Ikerbasque Research Professor and Group Coleader

PhD in Physics in 1994, Politecnico di Milano (Italy)
Research experience in Italy and the USA
Research interests: Magnetization reversal, dynamics, and related characterization methods. Fabrication and characterization of magnetic nanostructures
Comes from the Physics Department of the University of Ferrara and the CNR-INFM National Research Center S3, Modena (Italy)
Joining date: 1 October 2007

Post-doctoral Researchers
- **Ondrej Hovorka,** Marie Curie Fellow
- **Anna Suszka,** nanoGUNE Fellow

Pre-doctoral Researchers
- **Jon Ander Arregi,** FPI Fellow
- **Olatz Idigoras,** PFPI Fellow
- **José María Porro,** PFPI Fellow

Technician
- **César Rufo**

Guest Researchers
- **Rodrigo Alcaraz,** Pre-doc (until 30 Nov 2010)
- **Marcos Grimsditch,** Ikerbasque Visiting Fellow (until 31 May 2009)
- **Maxim Ilin,** Juan-de-la-Cierva Fellow
- **Andrea La Porta,** Master student
- **Iker Sánchez,** Diploma student (until 31 Aug 2010)
- **Telem Ünsal,** Master student (until 15 Sep 2010)
- **Tindara Verduci,** Master student

Highlighted Equipment
- Sputter Deposition System
- Magneto-optical Kerr-Effect (MOKE) microscope
- SQUID-VSM EverCool
- Magneto-optical Kerr-Effect set-ups for magnetometry, diffraction, and ellipsometry

Andreas Berger new board member of JMMM

Andreas Berger was selected as an editorial board member of the Journal of Magnetism and Magnetic Materials, one of the world-wide leading journals on magnetism related research published by Elsevier. Since 1 January 2010 he is serving a three-year term in this capacity.

Patents by Paolo Vavassori

Part of the work by Paolo Vavassori, in collaboration with Ricardo Bertacco from the Politechnical of Milano, has been protected by two patents entitled "Spintronic magnetic nanoparticle sensors with an active area located on a magnetic domain wall" and "Manipulation of Magnetic Particles in Conduits for the Propagation of Domain Walls". The inventions refer to magnetic nanoparticle sensors and manipulation procedures, suitable for applications in various fields.

Nanooptics

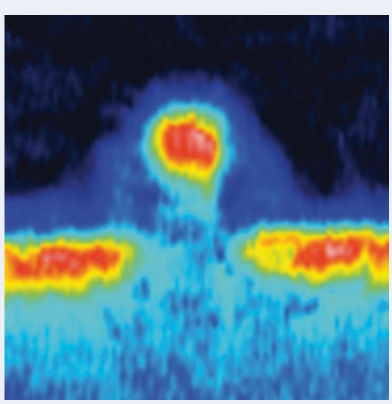
The nanooptics group, led by Rainer Hillenbrand, is focused on near-field optics, plasmonics, and the development of advanced near-field microscopy techniques. The group is interested particularly in applications in the infrared and terahertz spectral range, which allows for highly-sensitive materials characterization.

Our technique is based on a metalized AFM tip that is illuminated with a focused laser beam (scattering-type Scanning Near-field Optical Microscopy, s-SNOM). The light elastically scattered from the tip is detected simultaneously to topography. Acting as an optical antenna, the tip converts the incident light into a strongly confined near-field spot (nanofocus) at the tip apex, which locally illuminates the sample surface. Because of the strong optical near-field interaction between tip and sample, the elastically scattered light contains information about the local optical properties of the sample surface. Thus, by recording the scattered light –while scanning the sample– the local dielectric properties can be mapped with nanoscale spatial resolution.

The nanooptics group works in three complementary areas, being the first of them the development of near-field optical microscopy, exploring new configurations and improvements in the instrumentation and in the analysis of the signal, and spreading the application range of the technique.

Secondly, the group is applying near-field optical microscopy for the characterization of nanoscale materials and semiconductor devices, areas where industry has a big demand for more accurate techniques to characterize and develop quality control of semiconductor devices. Near-field optical microscopy offers the possibility to perform free-carrier profiling and strain mapping in semiconductor nanostructures such as the ones present in modern chips.

Finally, the group is very active in the near-field characterization and development of plasmonic structures such as nanoantennas or metamaterials. These kind of nanostructures can be tuned to interact strongly with light, which makes them interesting candidates for a variety of novel applications including devices for controlling light on the nanometer scale or for (bio)chemical sensing.



Rainer Hillenbrand

Ikerbasque Research Professor and Group Leader

PhD in Physics in 2001, Technical University of Munich (Germany)
Prizewinner of the "Young Scientist Competition in Nanotechnology 2002", awarded by the Bundesministerium für Bildung und Forschung (BMBF), and Cofounder of Neaspec GmbH
Research interests: Development of near-field optical nanoscopy and its application in materials science and nanophotonics
Comes from the Max Planck Institut for Biochemie in Martinsried (Germany)
Joining date: 1 February 2008

Post-doctoral Researchers

- Pablo Alonso, FP7 Fellow
- Jianing Chen, CSIC-nanoGUNE Fellow

Pre-doctoral Researchers

- Paulo Sarriugarte, PFPI Fellow
- Martin Schnell, PFPI Fellow
- Johannes Stiegler, nanoGUNE Fellow

Technician

- Carlos Crespo

Guest Researchers

- Pablo Albella, CSIC post-doc
- Florian Huth, Neaspec pre-doc
- Xabier Marcano, Diploma student
- Eneko San Sebastián, Master student (until 31 Jul 2010)

Highlighted Equipment

- Scattering-type Scanning Near-Field Optical Microscopes
- Supercontinuum Infra-Red and THz Lasers

Rainer Hillenbrand receives ERC Starting Grant

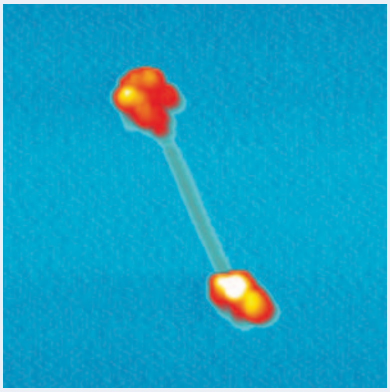
The European Research Council (ERC) has awarded a Starting Grant to the TERATOMO proposal presented by Rainer Hillenbrand. The grant has a budget of nearly 1.5 M€ for a five-years work program. TERATOMO is the acronym for Near-field Spectroscopic Nanotomography at Infrared and Terahertz frequencies. The core objective of the project is the development of a novel microscopy technique for the three-dimensional imaging of nanostructures with infrared and terahertz light.

Self-Assembly

The self-assembly group is led by Alexander Bittner. Its activity is focused on the exploration of new strategies to assemble and functionalize nanostructures, based on proteins and peptides. The research program explores two bottom-up approaches.

The first employs a plant virus, the tobacco mosaic virus (TMV), as a scaffold for the fabrication of nanostructures. TMV is a helical tubular assembly of 2100 proteins (and RNA). The length is 300 nm, the diameter is 18 nm, and the internal tube measures 4 nm. Modifying and functionalizing TMV is based on combining (bio)chemistry with materials science, to produce nanocontainers, nanopipes, nanowires, or nanomagnets. In this way, nearly atomic-scale wires and coatings can be assembled (conductive, magnetic, bio-functionalized). Important goals are drug delivery, biomolecular electronics, ferrofluids, and nanofluidics.

The second alternative uses electrospinning to produce peptide fibers with diameters in the nanometer scale. The technique makes use of a high electrical field to create a fast, thinning jet of peptide solution. Choosing self-assembling peptides and controlling the process yields fibers of undamaged molecules. The scientific goal is speeding up and understanding the formation of amyloid fibers. Application targets include biocompatible scaffolds for tissue engineering.



Alexander M. Bittner

Ikerbasque Research Professor and Group Leader

PhD in Chemistry in 1996, Free University of Berlin (Germany)
Research experience, mainly in Germany and Switzerland
Research interests: Solid/liquid interfaces, plant viruses, electrospinning, and soft matter
Comes from the Max Planck Institute for Solid State Research in Stuttgart (Germany)
Joining date: 1 June 2008

Post-doctoral Researchers

- **José María Alonso,** nanoGUNE Fellow
- **Sachin Shah,** FP7 Fellow (until 30 Nov 2010)

Pre-doctoral Researchers

- **Abid Ali Khan,** FP7 Fellow
- **Wiwat Nuansing,** nanoGUNE Fellow
- **Thales de Oliveira,** nanoGUNE Fellow

Technician

- Amaia Rebollo

Guest Researchers

- **Joseba Juaristi,** Diploma student (until 30 Aug 2009)
- **Pablo Rodal,** Pre-doc
- **Iñigo Romero,** Diploma student (until 3 Aug 2010)
- **Charlotte Stenner,** Master student

Highlighted Equipment

- Infrared and Raman spectrometers
- Electrospinning setup
- High-speed camera
- Dynamic Light Scattering
- Environmental electron microscope
- SQUID magnetometer

Magnetic nanocontainers for combined hyperthermia and controlled drug release (MAGNIFYCO)

The self-assembly group is one of the partners of the MAGNIFYCO project of the 7th Framework Program of the European Union. The aim of this project is the assembly and the fabrication of a new generation of multifunctional nanostructures. They will combine hyperthermia and controlled drug release, specifically targeted to ovarian cancer cells. This requires magnetic nanocontainers that can at the same time recognize cells, develop local heating in external magnetic fields, and release potent cytostatic drugs.

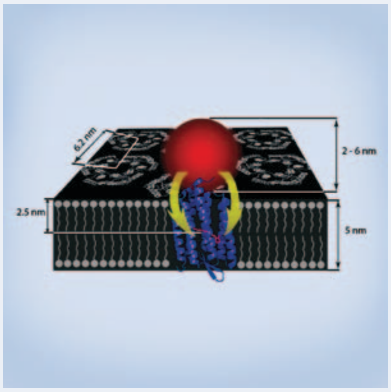
Nanobiotechnology

The nanobiotechnology group was led by Igor Nabiev until 18 October 2011. The research program of this group was divided into three main areas, all related to energy-transfer processes and to the use of functionalized quantum dots for various biomedical applications.

The first area was related to energy-transfer processes in hybrid materials for chemical and biological fuel production, biophotonics, and photovoltaic applications. It included the development of new hybrid materials, based on resonant energy transfer between semiconductor, metal or magnetic nanocrystals and photosensitive or hem-containing proteins. Alternatives to be explored were bacteriorhodopsin hybrid materials and hybrid materials made from the photosynthetic reaction centers of plants and bacteria.

The second area explored the potential of biomedical diagnostics using energy-transfer processes. It implied the development and exploitation of functionalized and bioadapted hybrid materials involving fluorescent or magnetic nanocrystals tagged with highly-active and specific capture molecules. This strategy offers interesting possibilities for the diagnostics of breast cancer using solid-state and liquid-state nanocrystal-based chips and for the diagnostics of auto-immune diseases.

Finally, the group explored the possibilities of achieving ultrasensitive nanocrystal-based pathogen detection employing energy transfer processes. Based on the same technology as in the previous research line, the goal was to develop new materials that can be introduced within lab-on-a-bead and lab-on-a-chip platforms in order to detect pathogens, which should be useful in the fight against bioterrorism. The final goal was to fabricate a nanolab-on-a-bead biodetecting system operating in the fluorescence resonance energy transfer (FRET) format.



Igor Nabiev
Ikerbasque Research Professor and Group Leader until 18 October 2010

PhD in Biophysics in 1983, Lomonosov Moscow State University (URSS)
Research experience in Russia, the USA, and France
Comes from the University of Reims (France)
Joining date: 1 September 2008

Alyona Sukhanova
Marie Curie Fellow until 19 October 2010

PhD in Molecular Biology in 1998, Engelhardt Institute of Molecular Biology, Moscow (Russia)
Research experience in Russia and France
Comes from the University of Reims (France)
Joining date: 1 June 2009

Post-doctoral Researchers
- Yohann Demont, CENIT Fellow
- Dimitry Melnikau, nanoGUNE Fellow
- Claudio Mendicute, nanoGUNE Fellow (until 31 Oct 2009)

Pre-doctoral researchers
- Romans Krutohvostovs, nanoGUNE Fellow
- Anthony Le Cigne, FP7 Fellow
- Simon Poly, nanoGUNE Fellow

Technician
- Marie Fertin

Guest Researchers
- Nicolas Bouchonville, Pre-doc (until 7 Dec 2009)
- Alexander Govorov, Ikerbasque Visiting Fellow (until 18 Nov 2009)

Highlighted Equipment
- Confocal Laser Microscope
- Laser Flow Cytometer
- Complete set of Optical Spectroscopy equipment
- State-of-the-art cell-culture and molecular-biology equipment and facilities

Nano-Bio integration to improve the quality of eyesight

The nanobiotechnology group contributed with its expertise to the CENIT project 'Customatized Eye Care (CeyeC)'. Granted by the Spanish Government, this group collaborated with bio-technological companies in the development of new diagnostic tools for the pathologies of the eye surface, as an example of nanothecnology interdisciplinarity.

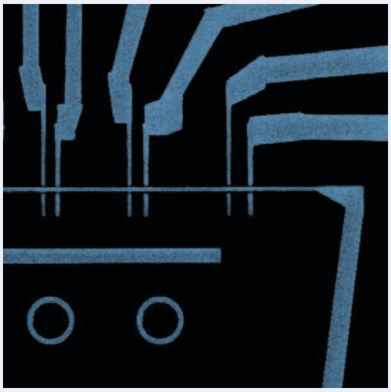
Nanodevices

The nanodevices group is led by Luis Hueso. Focused on the fabrication of nanodevices and on the investigation of the electronic properties of systems of reduced dimensions, the research program for this group is divided into the following three main areas.

The first area is related to spin transport and the development of nanodevices and architectures for their application in spintronics. Standard electronics is based on the use of the charge of the electron as the signal to be transmitted in order to process the information. Spintronics is based on the use (with the same purpose) of the spin of the electron, which represents an intrinsic quantum property of the electrons with no classical analogue. The quantum nature of the spin opens the doors for novel applications such as quantum computing, which are impossible to be developed in the framework of standard electronics. The development of spintronics very much depends on the understanding and control of the spin-transport process, the introduction of novel materials with good spin-transport properties, and the design of novel spintronic devices that would eventually substitute the current electronic devices.

The second area is related to the development of new multifunctional devices. Resistive non-volatile memory devices are being studied as an alternative to usual RAM memories. These new devices face the challenge of getting higher storage density, less energy consumption, and faster velocities for read-write processes. The group also explores new organic/inorganic hybrid multifunctional devices as the next logical step in the miniaturization race.

Finally, this group explores the capabilities of various nanofabrication techniques, including new strategies based on Atomic-Force-Microscopy nanofabrication and extreme electron-beam and focused-ion-beam nanofabrication.



Luis E. Hueso

Ikerbasque Research Professor and Group Leader

PhD in Physics in 2002, University of Santiago de Compostela (Spain)
Research experience at the University of Cambridge (UK), the Italian Consiglio Nazionale delle Ricerche, and the University of Leeds (UK)
Reseach interests: Electronic devices with organic semiconductors and nanowires. Memory devices
Comes from the University of Leeds (UK)
Joining date: 1 December 2008

Fèlix Casanova

Ikerbasque Research Professor

PhD in Physics in 2003, University of Barcelona (Spain)
Research experience at the University of California San Diego (USA)
Research interests: Study of spin currents in complex systems (metals, superconductors, organic semiconductors) by nanofabrication and characterization of spintronic devices
Comes from the University of California San Diego (USA)
Joining date: 1 July 2009

Post-doctoral Researcher

- Federico Golmar, nanoGUNE Fellow

Pre-doctoral Researchers

- Libe Arzubiaga, PFPI Fellow
- Marco Gobbi, nanoGUNE Fellow
- Estitxu Villamor, PFPI Fellow
- Raúl Zazpe, nanoGUNE Fellow

Technician

- Roger Llopis

Guest Researchers

- Federico Marchesin, Master student
- Ana Pascual, Master student (until 31 Oct 2010)
- Ander Retolaza, Diploma student (until 13 Aug 2010)

Highlighted Equipment

- Dual-Chamber Electron Evaporator System
- Variable-Temperature Probe Station

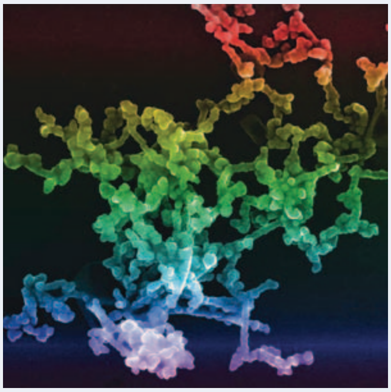
Luis Hueso receives ERC Starting Grant

The European Research Council (ERC) has awarded a Starting Grant to the SPINTROS proposal presented by Luis Hueso. The grant has a budget of 1.3 M€ for a five-years work program. SPINTROS is the acronym for SPIN TRansport in Organic Semiconductors. The core objective of this project is to understand and control spin transport in organic semiconductors.

Advanced Electron Microscopy

The Advanced Electron-Microscopy Laboratory, led by Andrey Chuvilin, represents a fundamental milestone in the infrastructure development of nanoGUNE and of the Basque Country. This new facility is open to other research and technological institutions and companies in the Basque Country, and puts nanoGUNE at the forefront of nanoscience research.

The Advanced Electron-Microscopy Laboratory incorporates three complementary tools: (i) an Environmental Scanning Electron Microscope, which provides access to the study of wet biological samples, nanobio composites, and nanofluidic phenomena, (ii) a Dual-Beam Focused Ion Beam, which combines high-resolution imaging capabilities with a focused-ion-beam column for nanodevice fabrication and characterization, and (iii) a spherical-aberration-corrected high-resolution transmission electron microscope, which reaches atomic resolution and allows the study of the electronic and magnetic properties as well as the chemical composition of nanomaterials and nanodevices.



Andrey Chuvilin

Ikerbasque Research Professor

PhD in Physics and Mathematics in 1998, Siberian Branch of the Russian Academy of Sciences, Novosibirsk (Russia)
Research experience in transmission electron microscopy in Russia, Italy, and Germany
Research interests: Low-voltage high-resolution TEM of nanocarbon materials, convergent beam electron diffraction, and image simulation and processing
Comes from the University of Ulm (Germany)
Joining date: 1 October 2009

Post-Doctoral Researcher

- Elizaveta Nikulina, FEI Fellow

Technician

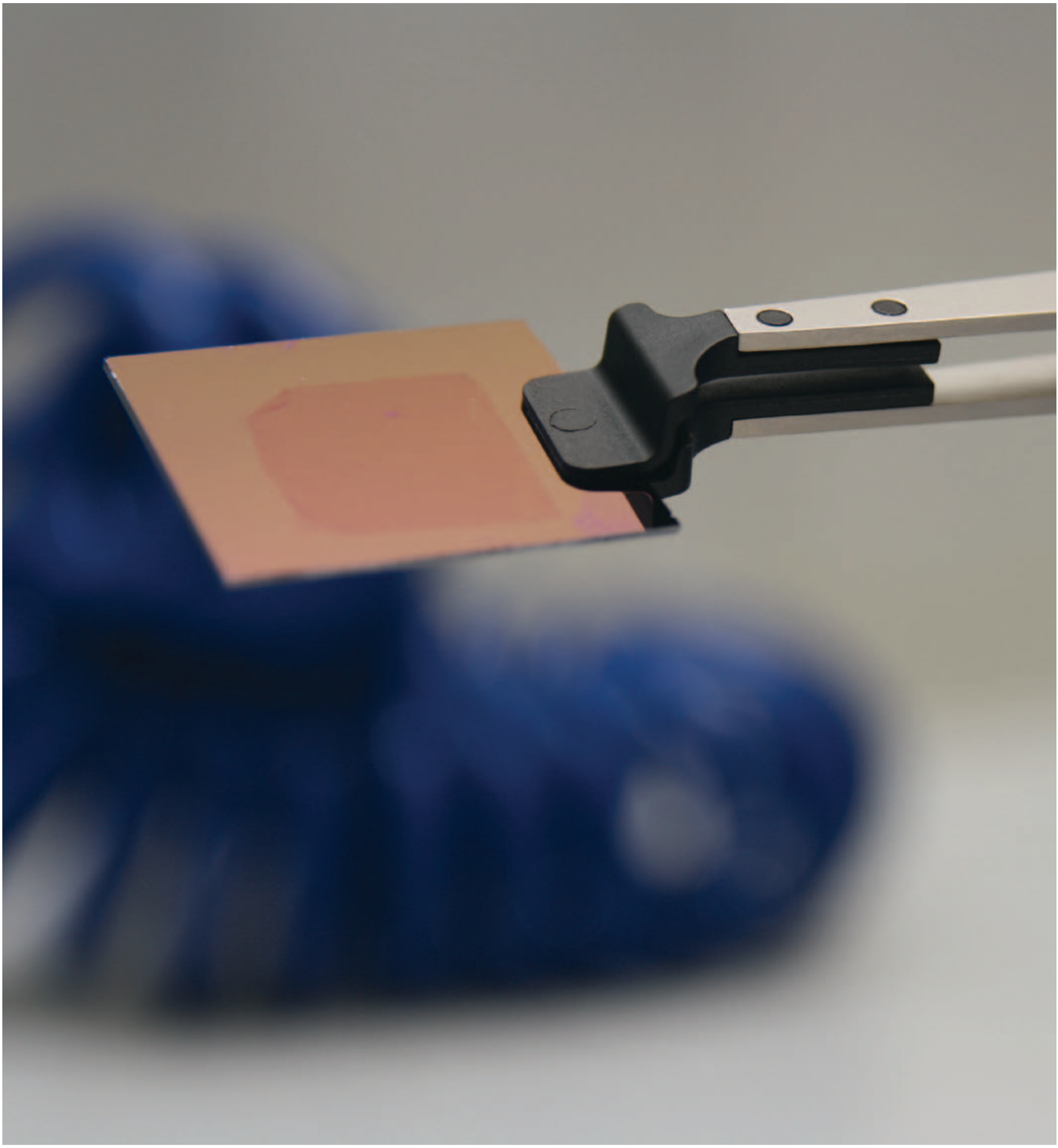
- Christopher Tollan

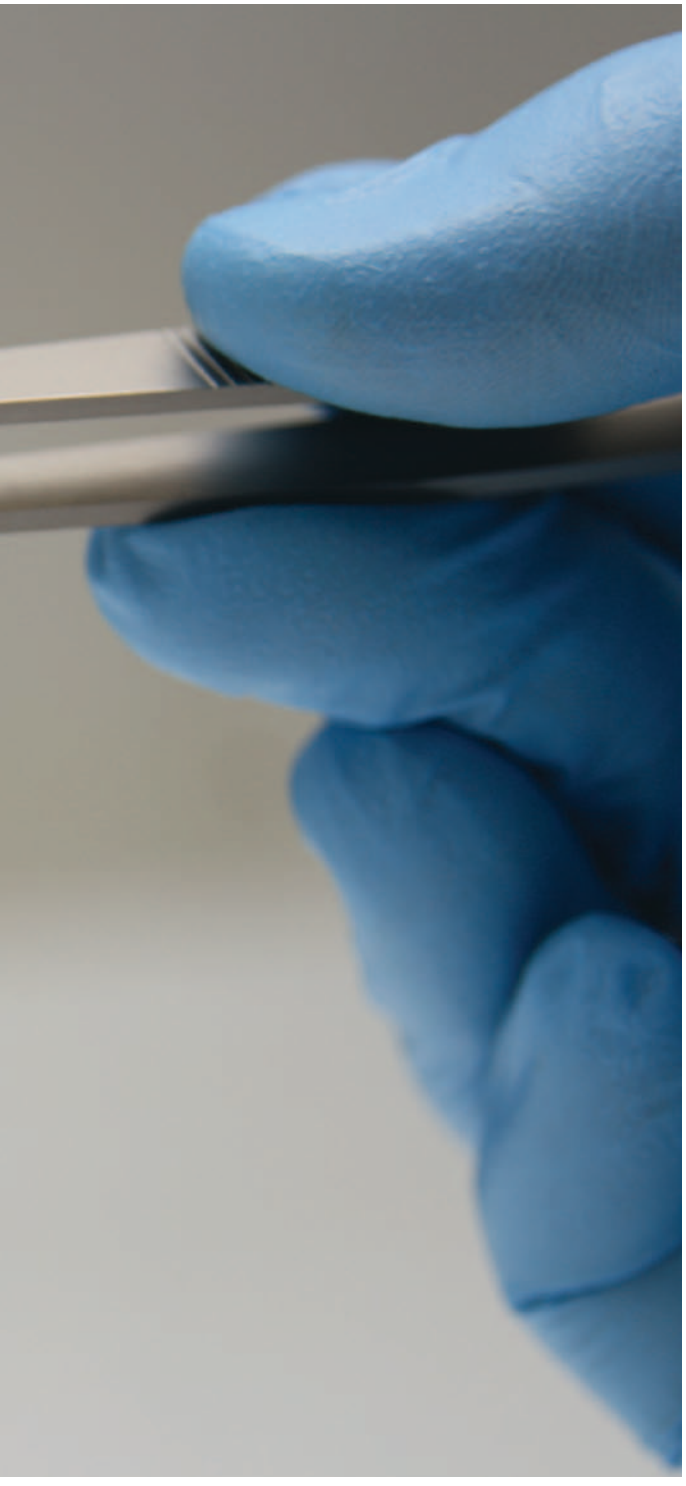
Highlighted Equipment

- Environmental Scanning Electron Microscope (ESEM) Quanta™ FEG
- Dual-Beam Focused-Ion-Beam (FIB) instrument Helios NanoLab™
- High-Resolution (Scanning) Transmission Electron Microscope (HR-TEM/STEM) image-aberration corrected Titan™ 60-300

NanoGUNE and FEI collaborate on Electron Microscopy

NanoGUNE and FEI, a leading supplier of high-end electron microscopes, have signed an ambitious cooperation agreement for the development of the Advanced Electron-Microscopy Laboratory. This three-years agreement establishes nanoGUNE as an active FEI reference and demonstration center and also includes the development of five research projects that will be carried out by teams involving researchers from both FEI and nanoGUNE. The contents of the projects are in close relation with current research interests of the nanoGUNE research groups, thereby establishing a cooperative framework for the benefit of both parties.





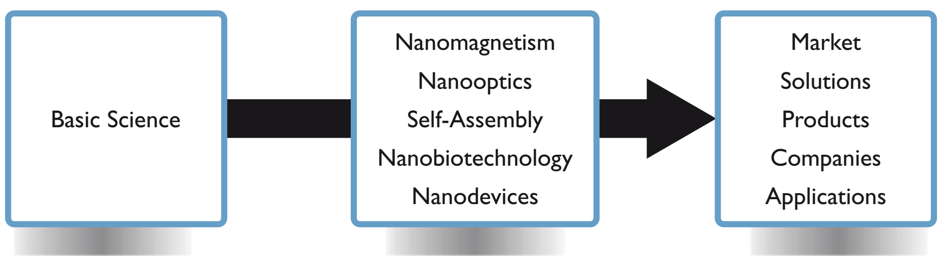
5

Industry Overview

Graphenea,
nanoGUNE's first
nanotechnology-based
start-up company
was launched
in April 2010

Industry Overview

One of the pillars of nanoGUNE´s strategy is to create the appropriate conditions for the promotion of Basque companies to the forefront of a knowledge-based economy. In this sense, nanoGUNE is always looking for new links and new ways of interacting with industry, being this issue one of the fundamental and differential aspects of nanoGUNE's strategy. Moreover, nanoGUNE's basic-research activity is driven by the aim of generating knowledge that should eventually be transformed into business opportunities and market applications. Therefore, the aim of nanoGUNE's activity goes far beyond generating new knowledge; nanoGUNE has a compromise with Basque industry.



This compromise is summarized into two challenges:

· To leverage competitiveness of Basque companies by the introduction of nanotechnology-enabled new products and services or by the introduction of nanotechnology-improved processes.
· To foster the development of new nanotechnology-based companies.

Facing these challenges requires a continuous assessment of the potential applications of current research, and an intense effort to translate those results into technological developments that Basque companies could incorporate to their products, processes, or services. Such a complex task can only be tackled in the framework of a close collaboration among the existing research and technological agents of the Basque Country, and between these agents and local industry. This will be possible thanks to the leadership of the nanoBasque Agency, which has been recently launched by the Department of Industry, Innovation, Trade, and Tourism of the Basque Country.

A great effort has been made to cross the gap between basic science and industrial applications. Our efforts have focused so far on the following challenges:

· To communicate to our companies the opportunities of nanotechnology, and to identify the interests and needs of our industrial environment.
· To use nanoGUNE's knowledge networks in order to give advice and support to our companies on available technological solutions and appropriate national or international technological partners.
· To promote the establishment of agreements between nanoGUNE and industry for the development of research projects focused on industrial applications.
· To support the launch of new entrepreneur projects based on nanotechnology.

Some of these activities are described as follows.

Linking with Basque companies

Various activities have been organized in order to approach Basque companies. On the one hand, a good number of events have been organized with the aim of approaching the basis of nanoscience and nanotechnology to local companies, and, on the other hand, nanoGUNE personnel have visited a good number of Basque companies in order to survey their activity and to identify the seed for potential projects for the near future.

Between 2007 and 2010, 65 local companies have been visited and a larger number of companies has been contacted in an effort led by the nanoBasque agency.

Getting closer to industrial speakers like ADEGI

NanoGUNE and ADEGI, the Gipuzkoan Employer's Organization, organized an event to introduce nanoscience and nanotechnology to the employers of local companies. The event included lectures given by Pedro Miguel Echenique, President of nanoGUNE, and José M. Pitarke, Director of nanoGUNE, as well as a round table with relevant businessmen of the region of Gipuzkoa. More than 40 companies were represented in the event, which was followed by a visit to the facilities of nanoGUNE.

Graphenea, nanoGUNE's first nanotechnology-based start-up company

On 9 April 2010, a new start-up company (Graphenea) was launched as a joint venture of private investors and nanoGUNE. The new company, which is located at the nanoGUNE building, was created with the mission of commercializing good-quality graphene wafers and developing graphene-based technology.

The staff of Graphenea includes a Chief Executive Officer, a Scientific Director, and International Scientific Advisors. Since the launching of the company, it has benefited immensely from the scientific advice of nanoGUNE, through collaboration with nanoGUNE researchers and from the infrastructure that is available at nanoGUNE. Graphene, which is an isolated atomic plane of graphite, exhibits extraordinary electronic and mechanical properties that point it as one of the most promising materials to have hit the market in years.

On 18 November 2009, a special mention by the jury of the 9th Manuel Laborde Werlinden prize went to the Graphenea initiative presented by José M. Pitarke (Director of nanoGUNE) for his business initiative on graphene.

Basque companies invited to introduce their expectations about nanotechnology

NanoGUNE's activity relies not only on the identification of potential industrial partners, but also on the creation of a model of collaboration where common strategies flow between the scientific community and industry. In this framework, two workshops were organized in 2010 in which both our scientific community and local companies participated. In these workshops, local companies had the opportunity to learn about the state of the art in nanoscience research, and they also had the chance to share their current interests and needs. Besides oral presentations, the program included some time for informal discussions, which allowed the participants to establish contacts that could act as a seed for future collaborations. Oral presentations were given by Likuid, Krafft, Maier, Calcinor, Tuboplast, and Wisco; other companies attended the sessions and the discussions as well.

Opening of nanoHabia, an incubator for nanotechnology-based new companies at nanoGUNE

As part of its commitment with entrepreneurship, on 21 October 2010 nanoGUNE opened nanoHabia, a nanotechnology-based incubator of new companies.

NanoHabia is the result of an agreement signed between nanoGUNE and Bic Gipuzkoa Berrilan, an institution devoted to innovation and entrepreneurship in Gipuzkoa, and represents a common effort to promote entrepreneurship and to boost, in the framework of the nanoBasque strategy, the development of a new industrial sector in the Basque Country that would be enabled by nanotechnology.

FEI Company

In 2010, FEI, a world-leading scientific instrumentation company and premier provider of electron and ion-beam microscopes and tools for nanoscale applications across many industries, and nanoGUNE signed a three-year agreement, concerning the purchase and development of nanoGUNE's Electron-Microscopy Laboratory. In the framework of this agreement, nanoGUNE is established as an active FEI reference and demonstration center. The agreement also includes the development of five research projects to be carried out by teams involving researchers from both FEI and nanoGUNE. Both research teams are expected to join their complementary expertise with the objective of exploring new methods and applications of electron microscopy and focused-ion-beam techniques. The contents of the projects are closely related to current research interests at nanoGUNE, thereby establishing a cooperative framework for the benefit of both parties.

The informal opening of nanoGUNE's Advanced Electron-Microscopy Laboratory was celebrated on 1 July 2010, following the installation of an Environmental Scanning Electron Microscope (ESEM) and a Dual-Beam Focused Ion Beam (FIB) nanofabrication tool. An spherical-aberration corrected high-resolution Transmission Electron Microscope (TEM) would be installed at the beginning of 2011.

Nano-Bio integration to improve the quality of eyesight

NanoGUNE contributed with its nanotechnology expertise to the CENIT project 'Customatized Eye Care (CeyeC)'. Granted by the Spanish Government, nanoGUNE collaborated with the biotechnology company Progenika in the development of new diagnostic tools for the pathologies of the eye surface, as an example of nanothecnology interdisciplinarity.

The objective of the project was to improve the patient's quality of eyesight, by covering three thematic areas: Implants/Lenses, Diagnosis, and Therapy.

Under the leadership of Vissum Corporation, the consortium was made up of 12 medical, pharma, and biotech companies representing the entire value chain in Ophthalmology, supported by 20 Research and Technology Centers (nanoGUNE being one of them) and 14 subcontracted companies.

Controlling nanoparticles for diagnostics

Small-size microfluidic systems in analytical applications have well-known advantages and are of special interest in future biomedical applications. NanoGUNE collaborates with Bioftalmik, a company developing new and innovative routine-use diagnostic services and products for eye diseases, through the Etorgai project Biodetec for the development of new techniques for the manipulation of nanostructures in suspension.

6

Scientific Outputs

124
ISI Publications

654
Citations

45
Invited Talks

Scientific Outputs

124 ISI publications

654 Cites

45 Invited talks

12 Conferences & Workshops

66 Seminars

19 Ongoing theses

12 Popularization articles

150 Press releases

2 Patents

1 Start-up

Highlighted publications

Highly-cited publications in high-impact journals represent important indicators of excellent research. Some of nanoGUNE's high-impact publications for the period 2007-2010 are the following:

- *Low-energy acoustic plasmons at metal surfaces*
  Nature **448**, 57–59 (2007)

- *Terahertz near-field nanoscopy of mobile carriers in single semiconductor nanodevices*
  Nano Letters **8**, 3766–3770 (2008)

- *Infrared nanoscopy of strained semiconductors*
  Nature Nanotechnology **4**, 153–157 (2009)

- *Controlling the near-field oscillations of loaded plasmonic nanoantennas*
  Nature Photonics **3**, 287–291 (2009)

- *Spin routes in organic semiconductors*
  Nature Materials **8**, 707–716 (2009)

- *Simultaneous determination of intergranular interactions and intrinsic switching field distributions in magnetic materials*
  Applied Physics Letters **95**, 192504-1 – 192504-3 (2009)

- *On-Chip Manipulation of Protein-Coated Magnetic Beads via Domain-Wall Conduits*
  Advanced Materials, **22**, 2706–2710 (2010)

- *Unraveling the role of the interface for spin injection into organic semiconductors*
  Nature Physics **6**, 615–620 (2010)

- *Enhancing the Magnetoviscosity of Ferrofluids by the Addition of Biological Nanotubes*
  ACS Nano **4**, 4531–4538 (2010)

- *Cumulative minor loop growth in Co/Pt and Co/Pd multilayers*
  Phys. Rev. B **82**, 104423-1 – 104423-9 (2010); Physics 3, 79-1 – 79-3 (2010)

Low-energy acoustic plasmons at metal surfaces

Nature **448**, 57-59 (2007)

B. Diaconescu, K. Pohl, L. Vattuone, L. Savio, Ph. Hofmann, V. M. Silkin, ***J. M. Pitarke****, E. V. Chulkov, P. M. Echenique, D. Farías, and M. Rocca*

Here we show that, in contrast to the until-now well-established belief, a low-energy collective excitation mode can be found on bare metal surfaces. This mode has an acoustic-like dispersion and was observed on Be(0001) using angle-resolved electron energy-loss spectroscopy. First-principles calculations show that (i) this mode is caused by the coexistence of a partially occupied quasi two-dimensional (2D) surface-state band with the underlying three-dimensional (3D) bulk electron continuum and (ii) the non-local character of the dielectric function prevents it from being screened out by the bulk states.

Nearly 2D metallic systems allow the existence of low-energy collective excitations, the so-called 2D plasmons, which are not found in a 3D metal. These excitations have caused considerable interest because their low energy allows them to participate in many dynamical processes involving electrons and phonons. On the other hand, metals often support electronic states that are confined to the surface, forming a nearly 2D electron layer. However, it had been argued that these systems could not support low-energy collective excitations, because these would be screened out by the underlying bulk electrons. Here we show that, in contrast to previous expectations, a low-energy collective excitation mode can be found on bare metal surfaces. The experiment was performed for Be(0001) at room temperature in an ultrahigh vacuum apparatus equipped with an angle-resolved high-resolution electron-energy-loss (EEL) spectrometer. Figure 1 shows typical angle-resolved EEL spectra taken along the M direction for positive values of the parallel momentum transfer $q_{\parallel}$. A broad peak is observed to disperse as a function of $q_{\parallel}$, and the energy of this mode is found to approach zero linearly for vanishing $q_{\parallel}$ values. Our experimental data clearly show the acoustic-like character of this excitation within the limits of the experimental error.

This new mode allows confinement of light on nanometric surfaces in a broad frequency range

Many metal surfaces such as Be(0001) and the (111) surfaces of the noble metals support a partially occupied band of Shockley surface states with energies near the Fermi level. Here we show that the experimental data can be interpreted as a novel collective electronic excitation, the acoustic surface plasmon (ASP), which appears as a consequence of the non-local dynamical screening at the surface. Information on collective electronic excitations at surfaces is obtained from the peak position of the imaginary part of the surface response function, which depends on $q_{\parallel}$ and frequency. We first calculate the single-particle energies and orbitals describing the surface band structure. With these single-particle energies and orbitals we then compute the surface response function. We are able to reproduce the experimental dispersion quantitatively by employing an ab-initio description of the surface electronic structure, which greatly increases our confidence in the interpretation of the experiment.

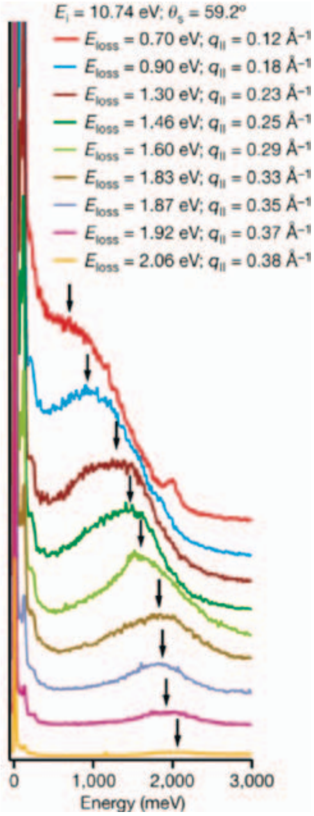


Figure 1

Families of angle-resolved EEL spectra. Each spectrum corresponds to a given parallel momentum transfer $q_{\parallel}$

Acoustic surface plasmons exist as a consequence of the interplay between a partially occupied electronic surface state (which acts as a 2D electron gas overlapping in the same region of space with the 3D bulk electron gas) and the long-range Coulomb interaction manifested in the form of 3D dynamical screening of the 2D surface electron gas. It corresponds to the out-of-phase charge oscillations between 2D and 3D subsystems at the metal surface and its dispersion is mainly determined by the surface-state Fermi velocity v_F. Figure 2 shows these oscillations in comparison with conventional Friedel charge oscillations. Acoustic surface plasmons, as reported here, owe their existence to the non-local screening of bulk electrons at surfaces characterized by a partially occupied surface-state band lying in a wide bulk energy gap; as such, they should represent a common phenomenon on various metal surfaces. Moreover, due to their acoustic-like dispersion, they will affect the electron dynamics near the Fermi level much more dramatically than regular 2D plasmons. The possibility to excite this collective mode at very low energies can lead to new situations at metal surfaces, as a result of the competition between the incoherent electron-hole excitations and the new collective coherent mode. Many phenomena, such as electron, phonon, and adsorbate dynamics as well as chemical reactions with characteristic energies lower than a few eV can be significantly influenced by the opening of a new low-energy decay channel. Of particular interest is the interaction of acoustic surface plasmons with light, as this new mode can serve as a tool to confine light on surface areas of a few nanometers in a broad frequency range up to optical frequencies.

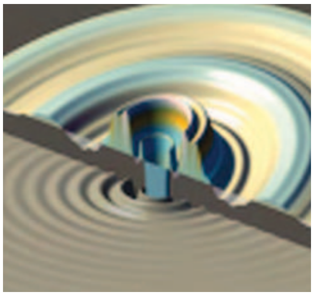


Figure 2

Charge density oscillations (at a metal surface) corresponding to the acoustic surface plasmon (top) in comparison with conventional Friedel oscillations (bottom).

Terahertz near-field nanoscopy of mobile carriers in single semiconductor nanodevices

Nano Letters **8**, 3766-3770 (2008)
A. J. Huber**, F. Keilmann, J. Wittborn, J. Aizpurua, and **R. Hillenbrand

The article reports the achievement of extremely high-resolution imaging using light in the Terahertz (THz) region (wavelengths between 30 and 1000 µm). Contrary to textbook wisdom, the unusually long illuminating wavelength of 118 µm allows to resolve details as small as 40 nm (= 0.04 µm). This was made possible by the use of extreme THz field concentration at the sharp tip of a scanning atomic force microscope (AFM). The THz nanoscope thus breaks the diffraction barrier by a factor of 1500, and with its 40 nm resolving power matches the needs of modern nanoscience and nanotechnology. As a first application, the mapping of free-carriers in state-of-the-art industrial transistors of the 65 nm-technology is obtained.

Although it was well established that near-field microscopy at both visible and infrared frequencies enables nanoscale resolved chemical recognition of nanostructured materials, it has been noticed that when imaging semiconducting nanostructures of state-of-the art processor chips THz illumination (the 118 µm wavelength radiation corresponds to 2.5 THz) offers a 100-fold increased sensitivity to the conductivity of semiconducting materials when compared to infrared light. This extreme sensitivity is difficult to achieve by any other optical microscopy technique, rendering the described microscopy technique highly desirable for quality assurance and analysis of failure mechanisms in industrially produced semiconductor nanodevices.

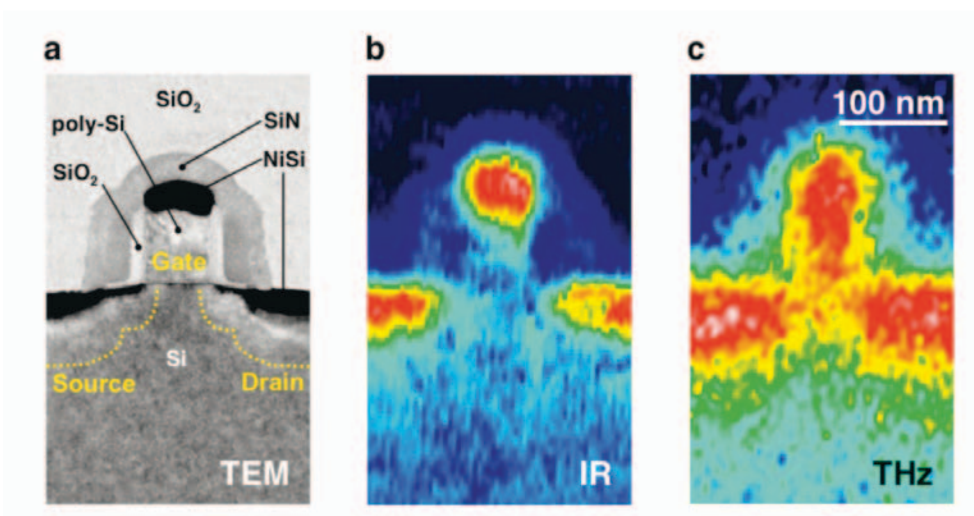


Figure 1

THz near-field image (right) of a single industrial transistor structure of the 65 nm technology (Infineon AG) reveals the central device components source, drain, and gate, and also visualizes the distribution of mobile carriers below the metallic NiSi contacts. For comparison, a TEM image (left) and an infrared near-field image (middle) of the transistor show the metallic NiSi contacts but not the mobile carriers.

As established by theoretical predictions, THz radiation develops a highly concentrated field right at the end of the scanning tip allowing to record the first THz images with 40 nm resolution. In collaboration with Infineon Technologies AG the new microscopy technique has been used to characterize state-of-the-art transistors of the 65 nm-technology that before had been inspected with a transmission electron microscope (TEM). Comparing THz and TEM images of the transistors, it can be shown that all major parts of the transistor (source, drain, and gate) can be seen in the THz image. Strikingly, the THz images reveal mobile carrier concentrations around 10^{18}cm^{-3} (that is one mobile carrier for each 100,000 Si atoms), which are essential for functional transistor devices. Mobile carriers are a central key for the practical transistor functionality but unfortunately they are not directly visible in TEM.

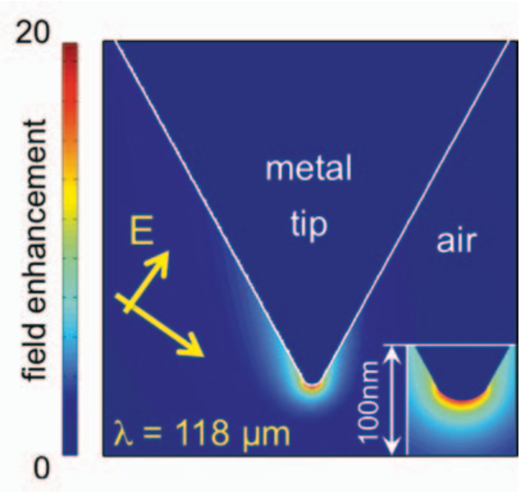


Figure 2

Calculated field distribution at the tip apex of a metal cone that is illuminated with terahertz radiation. It shows nanoscale field confinement and 25-fold field enhancement at the tip apex.

Hitherto, no powerful metrology tools are available allowing for simultaneous and quantitative mapping of both materials and carrier concentrations with nanoscale resolution. Therefore, the added values of seeing and even quantifying conducting carriers opens an enormous application potential for the THz near-field microscope. In fundamental physics research of conducting materials, the non-contact, non-invasive, and quantitative mapping of mobile carriers with nanoscale resolution should trigger crucial insights into open scientific questions from the areas of superconductors, low-dimensional conductors, and correlated conductors. THz nanosopy could be furthermore an interesting tool for chemical and structural analysis of compounds and biological systems, as THz radiation is also highly sensitive to vibrations of crystal lattices and molecules. Future improvements of the technique could allow for THz characterization of even single nanocrystals, biomolecules, or electrons.

Infrared nanoscopy of strained semiconductors

Nature Nanotechnology **4**, 153-157 (2009)
A. J. Huber, *A. Ziegler, T. Köck, and* ***R. Hillenbrand***

A new method for non-invasive and nanoscale-resolved infrared mapping of strain fields in semiconductors is described. The method, which is based on near-field microscopy, opens new avenues for analyzing mechanical properties of high-performance materials or for contact-free mapping of local conductivity in strain-engineered electronic devices.

Visualizing strain at length scales below 100 nm is a key requirement in modern metrology, because strain determines the mechanical and electrical properties of high-performance ceramics or modern electronic devices, respectively. The non-invasive mapping of strain with nanoscale spatial resolution, however, is still a challenge.

A promising route for highly sensitive and non-invasive mapping of nanoscale material properties is the scattering-type Scanning Near-field Optical Microscopy s-SNOM (see Figure 1). This technique has experienced a big development over the last decade, enabling chemical recognition of nanostructures and mapping of local conductivity in industrial semiconductor nanodevices. The technique makes use of extreme light concentration at the sharp tip of an Atomic Force Microscope (AFM) yielding nanoscale resolved images at visible, infrared, and terahertz frequencies. The s-SNOM thus breaks the diffraction barrier throughout the electromagnetic spectrum and with its 20 nm resolving power matches the needs of modern nanoscience and technology.

Infrared light visualizes nanoscale strain fields

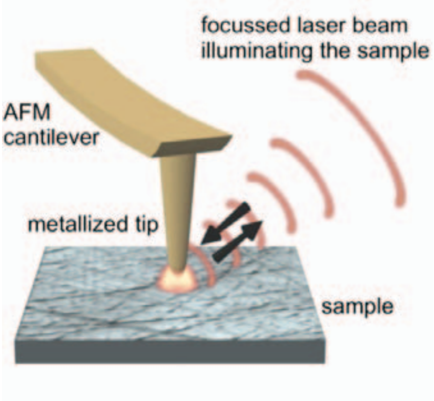


Figure 1

Illustration of s-SNOM imaging. A sharp tip that is illuminated by a focused laser beam is scanning a sample surface. The tip functions as an optical antenna concentrating the incident optical field to a small spot of only a few nanometers in diameter, which is used as a nanoscopic light source for illuminating the sample. Because of the optical near-field interaction between the tip and the sample, the backscattered light contains information about the local optical properties (e.g., refractive index) of the surface. By detecting the backscattered light at any pixel interferometrically, optical amplitude and phase images are acquired simultaneously to topography.

The article provides first experimental evidence that this microscopy technique is capable of mapping local strain and cracks of nanoscale dimensions. This was demonstrated by pressing a sharp diamond tip into the surface of a Silicon-Carbide crystal. With the near-field microscope it has been possible to visualize the nanoscopic strain field around the depression and the generation of nanocracks (see Figure 2). Compared to other methods such as electron microscopy, the technique offers the advantage of non-invasive imaging without the need of special sample preparation. Specific applications of technological interest could be the detection of nanocracks before they reach critical dimensions, e.g., in ceramics or Micro-Electro-Mechanical Systems (MEMS), and the study of crack propagation.

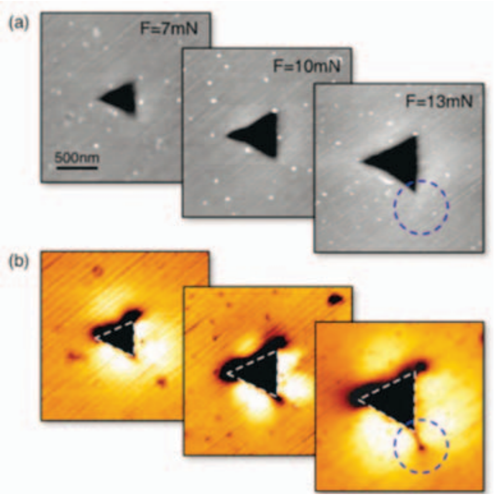


Figure 2

Infrared visualization of nanocrack evolution. a) Topography of triangular indents (depressions) at the surface of a SiC crystal. Indentation was performed by pressing a sharp diamond tip into the crystal surface. With increasing force F, the depression becomes larger and deeper. b) The infrared near-field images recorded at about 10 μm wavelength clearly show the regions around the indent where the crystal lattice is compressed (bright) or stretched (dark). Because of the exceptional high-spatial resolution, the images reveal the onset and formation of nanoscale cracks (marked by dashed blue circles) when the indentation force is increased.

The s-SNOM offers also the intriguing possibility of mapping free-carrier properties such as density and mobility in strained silicon. By controlled straining of silicon, the properties of the free carriers can be designed, which is essential to further shrink and speed-up future computer chips. For both development and quality control, the quantitative and reliable mapping of the carrier mobility is strongly demanded but hitherto no tool has been available. The results thus promise interesting applications of s-SNOM in semiconductor science and technology such as the quantitative analysis of the local carrier properties in strain-engineered electronic nanodevices.

Controlling the near-field oscillations of loaded plasmonic nanoantennas

Nature Photonics **3**, 287-291 (2009)
M. Schnell, *A. García-Etxarri, A. J. Huber, K. Crozier, J. Aizpurua, and* ***R. Hillenbrand***

An innovative method for controlling light at the nanoscale by adopting tuning concepts from radio-frequency technology is presented. The method opens the door for targeted design of antenna-based applications, including highly-sensitive biosensors and extremely fast photodetectors for biomedical diagnostics and information processing.

An antenna is a device designed to transmit or receive electromagnetic waves. Radio frequency antennas find wide use in systems such as radio and television broadcasting, point-to-point radio communication, wireless LAN, radar, and space exploration. In turn, an optical antenna is a device which acts as an effective receiver and transmitter of visible or infrared light. It has the ability to concentrate (focus) light to tiny spots of nanometer-scale dimensions, which is several orders of magnitude smaller than what conventional lenses can achieve. Tiny objects such as molecules or semiconductors that are placed into these so-called "hot spots" of the antenna can efficiently interact with light. Therefore, optical antennas boost single-molecule spectroscopy or signal-to-noise in detector applications.

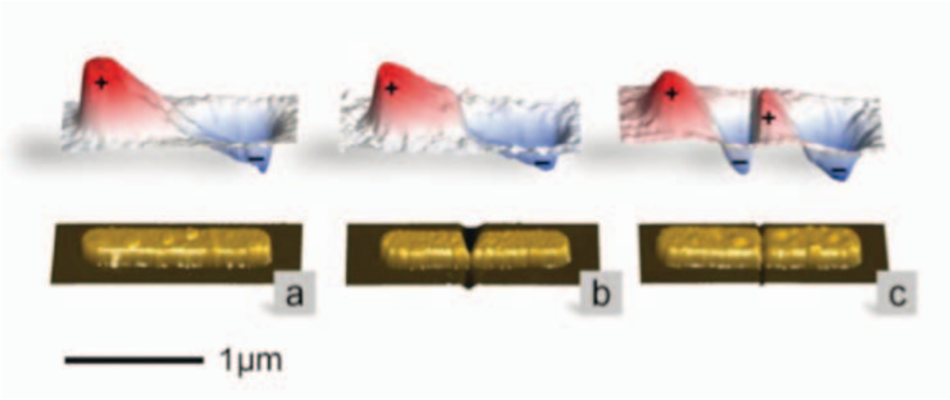


Figure 1

Near-field microscope images of loaded infrared antennas. The bottom line depicts the topography, whereas the upper line plots the scanned near-field images. Figure a) shows a metal nanorod that can be considered the most simple dipole antenna. The near-field image clearly shows the dipolar oscillation mode with positive fields in red and negative fields in blue color. By introducing a narrow gap at the center of the nanorod thus altering the "antenna load" (Figure c), two dipolar-like modes are obtained. When the gap is connected with a small metal bridge (Figure b), the dipole oscillation mode of Figure a) can be restored, as the near-field image clearly reveals.

In this study, a special type of infrared antennas is studied, featuring a very narrow gap at the center. These so called gap antennas generate a very intense “hot spot” inside the gap, allowing for highly efficient nano-focusing of light. To study how the presence of matter inside the gap (the “load”) affects the antenna behavior, the researchers fabricated small metal bridges inside the gap (Figure b). The near-field oscillations of the different antennas were mapped with a modified version of a scattering-type near-field optical microscope. For this work, dielectric tips were chosen and the operation was performed in transmission mode, allowing for imaging local antenna fields in details as small as 50 nm without disturbing the antenna. By monitoring the near-field oscillations of the different antennas with this novel near-field microscope, it was possible to directly visualize how matter inside the gap affects the antenna response. The effect could find interesting applications for the tuning of optical antennas.

A theoretical analysis fully confirmed and helped to understand the experimental results by means of full electrodynamic calculations. The calculated maps of the antenna fields are in good agreement with the experimentally observed images. The simulations add deep insights into the dependence of the antenna modes on the bridging, thus confirming the validity and robustness of the “loading” concept to manipulate and control nanoscale local fields in optics.

Furthermore, the well developed radio–frequency antenna design concepts were applied to visible and infrared frequencies, and the behavior of the loaded antennas was explained within the framework of optical circuit theory. A simple circuit model showed remarkable agreement with the results of the numerical calculations of the optical resonances. By extending circuit theory to visible and infrared frequencies, the design of novel photonic devices and detectors will become more efficient. This bridges the gap between these two disciplines.

With this work, experimental evidence that the local antenna fields can be controlled by gap-loading has been provided for the first time. This opens the door for designing near-field patterns in the nanoscale by load manipulation, without the need to change antenna length, which could be highly valuable for the development of compact and integrated nanophotonic devices.

Spin routes in organic semiconductors

Nature Materials **8**, 707-716 (2009)
*V. Dediu, **L. E. Hueso**, I. Bergenti, and C. Taliani*

This article represents a comprehensive review of the nascent field of organic spintronics. The advantages and opportunities of organic materials as a new environment for spin transport and manipulation are explained.

Research in organic semiconductors (OSs) has progressed impressively over the past few decades. The greatest success has undoubtedly been achieved in the field of optoelectronics, where display products based on hybrid light-emitting diodes with organic emitters (OLEDs) have become available to consumers, and organic photovoltaic devices are challenging existing commercial applications. These accomplishments generate a strong demand for other mainstream products based on new hybrid organic–inorganic devices. Considerable improvements have already been achieved in the field of organic field-effect transistors (OFETs), and fundamental research in the use of organic electric memories for data-storage applications has also made progress.

Organic semiconductors have recently caught the attention of the spintronics community, and significant efforts are being made towards their integration in this field. Spintronics is a branch of electronics that takes full advantage of not only the charge, but also the spin of the electron. Among the most fascinating examples of spintronic applications are giant magnetoresistance (MR) and tunnelling magnetoresistance (TMR). In both cases, a considerable variation of the electrical resistance can be achieved by switching the magnetization of the device's electrodes from parallel to antiparallel. These effects are currently used as the scientific basis of read-head in magnetic hard disks.

The most attractive aspect for spintronic applications in OS is the weakness of the spin-scattering mechanism, implying that the spin polarization of the carriers can be maintained for a very long time. Noticeably, spin-relaxation times in excess of 10 μs were obtained by different resonance techniques years before the first organic spintronic experiments; these values exceeded the characteristic times detected in inorganic materials by orders of magnitude.

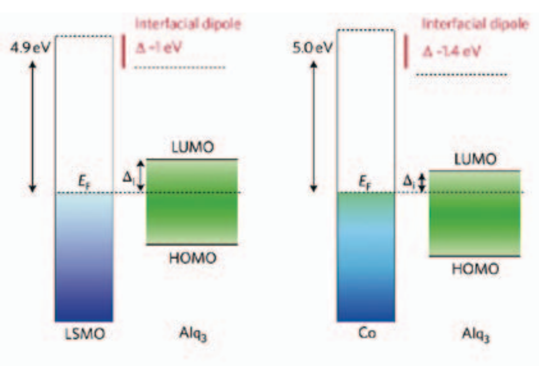


Figure 1

Schematic band diagram for two different ferromagnetic/organic interfaces: LSMO/Alq_3 and Co/Alq_3, as measured by x-ray photoemission spectroscopy. Δ_i represents the lowest injection barrier.

Although it is difficult at this stage to predict whether research efforts in organic spintronics will lead to their implementation into actual devices, the field can be regarded as a fascinating puzzle in which many pieces are still missing. The electronic properties of OSs are radically different from those of band semiconductors as Si or GaAs. Consequently, their spin properties are also different.

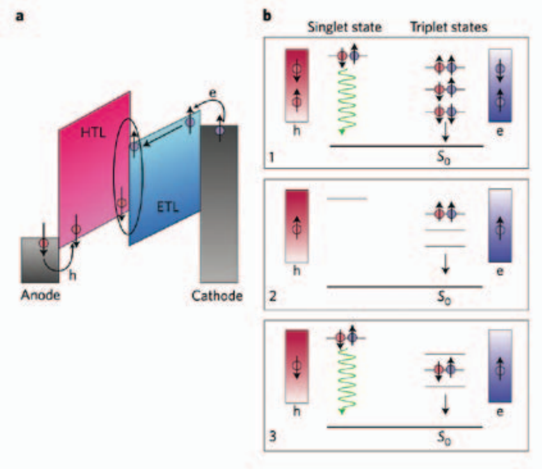


Figure 2

Spin-OLED. a) Schematic structure of a bilayered OLED. Electrons and holes are injected, respectively, by the cathode and the anode into the electron-transport layer (ETL) and the hole-transport layer (HTL). Exciton formation and recombination take place at the interface between the two organic layers. b) Spin statistics of the carrier recombination for the case of spin-polarized carrier injection: (1) One singlet and three triplet exciton states are expected for random orientation; the singlet state is responsible for light emission, whereas triplet states usually deactivate without emitting radiation with a 25% (1:3) efficiency. (2) Parallel spin states for electrons and holes produce only a non-emitting triplet state. (3) Antiparallel spin states for electrons and holes generate singlet and triplet states in a 1:1 ratio.

For example, OSs are not characterized by band conductivity, nor do they feature a significant spin–orbit interaction. Unveiling the fundamental aspects of these materials is therefore what makes the field simultaneously challenging and exciting, with the hope that improvements in understanding and technology will allow OSs to compete with and overtake other materials in the field of spintronics, or at least in some selected niche applications.

This review is focused on the main achievements and questions arising from spin injection and transport in OS materials. The concepts and facts that are widely accepted by the community are discussed, and the most controversial issues and open questions are addressed.

Simultaneous determination of intergranular interactions and intrinsic switching field distributions in magnetic materials

Applied Physics Letters **95**, 192504-1 – 192504-3 (2009)
O. Hovorka**, Y. Liu, K.A. Dahmen, and **A. Berger

A generally applicable method for the accurate measurement of intrinsic switching field distributions and the determination of exchange and dipolar interactions in granular magnetic materials is described. The method is based on the simultaneous analysis of hysteresis-loop and recoil-curve data. Its validity and practical implementation are demonstrated by means of computational modeling. The new methodology is shown to be numerically accurate in a wide parameter range, far exceeding the previously utilized mean-field interaction regime used in other methodologies.

This work addresses and solves a long-standing problem related to the characterization of nanoscale granular magnetic materials. Such materials are of crucial technological relevance, especially in hard-disk drives (HDDs), where they constitute the actual "memory" material of this non-volatile storage technology. The challenge to accurately characterize such materials is not so much related to the sheer number of these particles or grains (a conventional laptop computer drive contains about 250 trillion of them – compare Fig. 1 as illustration), but rather stems from the fact that these particles are coupled to each other by means of two separate mechanisms that furthermore have very different characteristics. Thus, the collective behavior is very complex and it is very difficult to extract reliable single-particle properties as well as details of the interactions themselves from macroscopic measurements. Nonetheless, grain-level characterization is of great importance, because only by having a nano-scale quantitative understanding of these magnetic materials it is possible to judge and improve their technical performance levels and reliability.

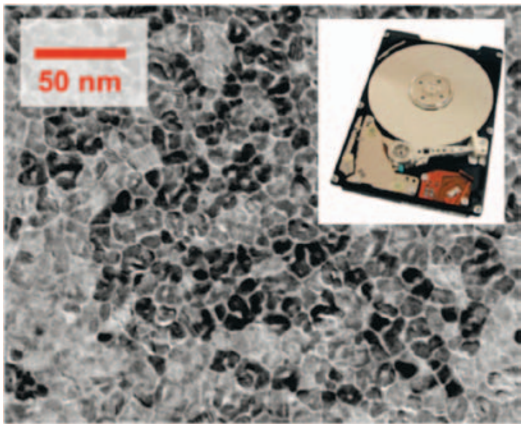


Figure 1

Transmission-Electron-Microscope picture of a nano-scale granular magnetic material for magnetic recording technology; the inset is a photo of a HDD, which is one of the main application areas for nanoscale granular magnetic materials.

The specific properties that determine the magnetic behavior of such coupled grain assemblies are the switching field distribution (SFD), the inter-granular exchange coupling constant J_{EX}, and the magnetostatic or dipolar coupling constant J_{DP}. The SFD is hereby defined as the probability distribution of the magnetic switching fields that the grains would exhibit by themselves, i.e. if no intergranular interaction were present. The SFD is typically quantified by its standard deviation σ. This quantity is particularly important because it defines the precision of bit transition placement in magnetic recording pattern and is ultimately responsible for the achievable data density and capacity of HDDs. While a number of previous approaches had already been developed to extract the SFD from macroscopic measurements, they had substantial reliability deficiencies and, moreover, they did not allow for a separate determination of the interaction strength J_{EX} and J_{DP}.

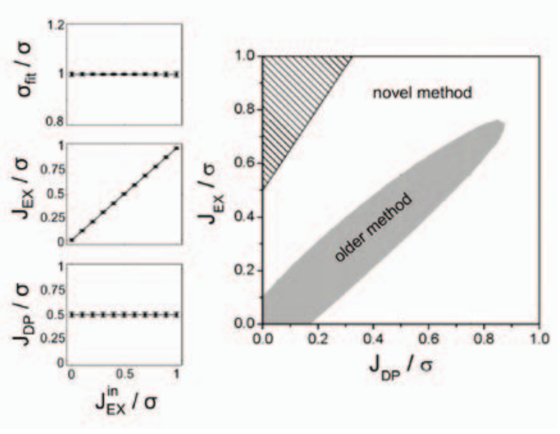


Figure 2

The left-hand viewgraphs demonstrate the accurate recovery of microscopic input parameters by using our novel characterization method for all the crucial input parameters that define granular magnetic materials with intergranular interaction. The data points are the recovered data analysis values, while the lines represent the input parameters of our numerical simulations for coupled nano-granular materials. The right hand side shows the parameter range in which our new method is reliable in comparison to the best previous methodology (called here older method).

In this work, a novel technique is developed, which not only improves the accuracy of SFD measurements in comparison to the previous state-of-the-art method rather dramatically, but it also enables for the first time the simultaneous determination of the interaction strengths J_{EX} and J_{DP} by means of a simple macroscopic measurement sequence. Our exhaustive numerical tests of this new methodology show excellent precision in the recovery of all microscopy input parameters, as can be seen exemplary in Fig. 2. Thus, our new method has wide ranging application potential, as it offers a complete solution to this long-standing problem. The technique is general, it is based only on easy-to-perform hysteresis loop measurements, and does not rely on specific modeling assumptions, which is an additional and crucial advantage over previous approaches.

On-chip manipulation of protein-coated magnetic beads via domain-wall conduits

Advanced Materials, **22**, 2706–2710 (2010)
P. Vavassori, M. Gobbi, *M. Donolato, M. Cantoni, R. Bertacco, V. Metlushko, and B. Ilic*

Geometrically constrained magnetic domain walls (DWs) in magnetic nanowires can be manipulated at the nanometer scale. The inhomogeneous magnetic stray field generated by a DW can capture a magnetic nanoparticle in solution. On-chip nanomanipulation of individual magnetic beads coated with proteins is demonstrated through the motion of geometrically constrained DWs in specially designed magnetic nanoconduits fully integrated in a lab-on-a-chip platform.

Recent developments on 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, such a control would open up new possibilities for medical and pharmaceutical applications, e.g., handling small volumes of bio-samples, performing sophisticated sorting of different molecules, or testing the effectiveness of a drug-delivery system. The tools developed so far to achieve single-molecule manipulation are

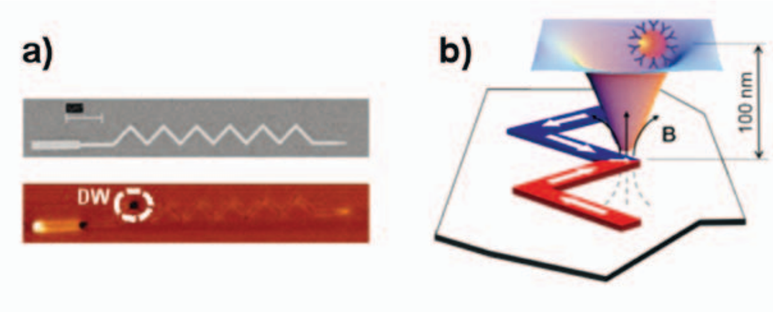


Figure 1

a) Scanning electron microscopy image of a Py zig-zag nanostrip, and magnetic force microscopy image showing the creation of a domain wall in the first corner of the structure. b) Sketch of a Py nanostrip with a magnetic domain wall in a corner and of the corresponding potential energy surface for a magnetic bead carrying antibodies on a plane at 100nm from the Py structure.

highly sophisticated, require accurate calibration, and can produce substantial heating. We have recently demonstrated a vastly improved approach to confine and control the position and movement of an individual bio-functionalized magnetic nano-particle in liquid by remotely controlling the motion of magnetic domain walls (DWs) in patterned nanowires. The approach is based on recent developments of nanolithography techniques that make it possible to fabricate sub-micrometer wires with geometrically well defined DWs pinning potential sites. In very narrow ferromagnetic nanowires a DW is a mobile interface, which separates regions of oppositely aligned magnetization (parallel to the wire axis due to shape anisotropy). In nano-wires, because of the geometrical confinement, the width of these DWs is in the range 10-100 nm and they can be manipulated with high precision between pinning sites. Each DW behaves much like a "magnetic monopole" that generates an intense and inhomogeneous magnetic stray field of up to several kOe, resulting in a strong magnetic coupling between DWs and bio-functionalized magnetic nanoparticles. This coupling and the highly controlled DW displacement enable control of the position and repetitive motion of biological entities at the nanoscale level. This novel methodology allows to overcome the limitations of standard methods employing magnetic beads and would open up new possibilities towards single-molecule biomedical applications as handling small volumes or performing sophisticated sorting of different targets attached to different particles on a chip device. Particularly relevant in view of medical applications is the easy integration of such a bio-manipulation system on a single chip with sensors able to detect the presence of magnetic nanoparticles for "lab-on-chip" diagnostic applications.

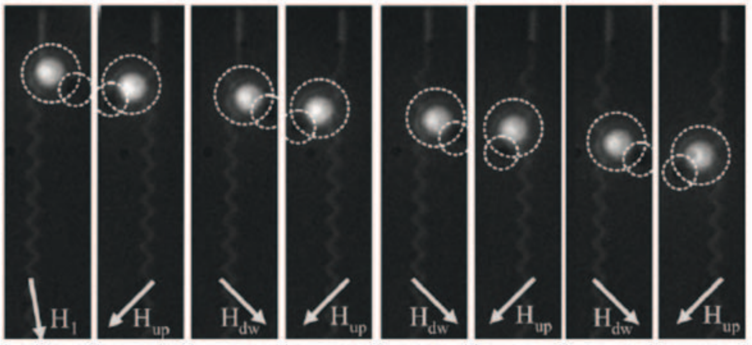


Figure 2

Sequence of fluorescence optical microscopy images showing the transport of a pair of magnetic beads, bound by chemical affinity between proteins initially loaded on them, in suspension above a Py zig-zag magnetic conduit as the one shown in Fig. 1a. The fluorescent bead (Dynabead, 2.8 μm diameter) carries anti-streptavidin antibodies, meanwhile the dark bead is surface coated with streptavidin (Dynabead MyOne, 1 μm). The zig-zag is prepared in the initial state with a domain wall placed in the first corner of the zig-zag conduit. Then the sequence of fields H_{up} and H_{dw}, with duration of 100 ms, are applied to move the pairs of beads in suspension, after capture by a domain wall in the first corner of the zig-zag.

Unravelling the role of the interface for spin injection into organic semiconductors

Nature Physics **6**, 615-620 (2010)
C. Barraud, P. Seneor, R. Mattana, S. Fusil, K. Bouzehouane, C. Deranlot, P. Graziosi, ***L. Hueso****, I. Bergenti, V. Dediu, F. Petroff, and A. Fert*

This article presents exceptionally large values of magnetoresistance across a few molecular layers. The realization of this experiment and its accompanying theoretical description opens the way to the realization of an active molecular barrier with the potential to change the field of spin transport.

Molecular spintronics, by combining the potential of spintronics and molecular/organic electronics, is now considered as a promising alternative to inorganic-materials based conventional spintronics. Besides flexibility, chemical engineering, and low production costs, the opportunity that spin relaxation times could be enhanced by several orders of magnitude compared to inorganic materials arouses a strong interest for organic semiconductors (OSs). Weak spin–orbit coupling associated with light-element compounds and electronic transport through π delocalized orbitals would be involved in explaining this gain of spin lifetime. At this point of evolution in the field, however, the mechanisms underlying the spin injection into the OSs are still to be unraveled and remain one of the main challenges of this new uprising field.

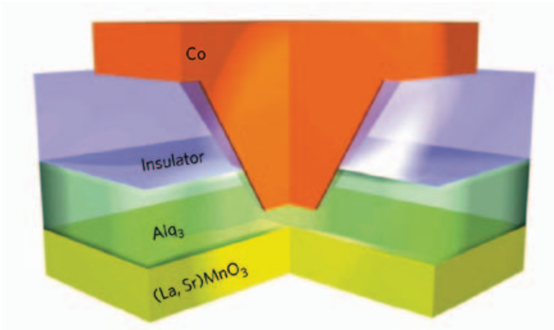


Figure 1

Schematic drawing of the organic magnetic tunnel juntion (MTJ). The device consists first of a $La_{0.7}$ $Sr_{0.3}$ MnO_3 / Alq_3 bilayer. A nanoindent in the Alq_3 layer is realized by a Contact-AFM, allowing us to control the organic tunnel barrier thickness. This nanohole is then filled with cobalt, leading to a $La_{0.7}$ $Sr_{0.3}$ MnO_3/Alq_3 / Co nanometric-size MTJ.

In this article, giant tunnel magnetoresistance of up to 300% is reported in Alq_3 –based nanojunctions using (La, Sr)MnO_3 (LSMO) and Co ferromagnetic electrodes. This value, by comparison, is as large as those reported with state-of-the-art preferential tunneling inorganic spin valves. Furthermore, we developed a spin-dependent transport model (taking into account interfacial spin hybridization), which gives us an understanding of spin injection into organic materials/molecules and opens new opportunities for chemically tailored spintronics devices. Ultimately, owing to molecular engineering, the physical properties of spintronic devices could be expected to be tailored through playing with the anchoring groups and the backbone of the molecules.

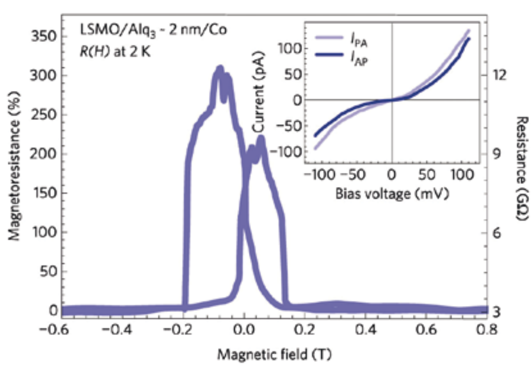


Figure 2

Magnetic-field dependence of the resistance. Magnetoresistance curve of the organic magnetic tunnel junction obtained at 2 K and −5 mV. The lower coercive field corresponds to the LSMO magnetic reversal and the higher coercive field to the Co magnetic switching. Inset: I(V) curves recorded at 2 K in the parallel (I_{PA}) and antiparallel (I_{AP}) magnetic configurations.

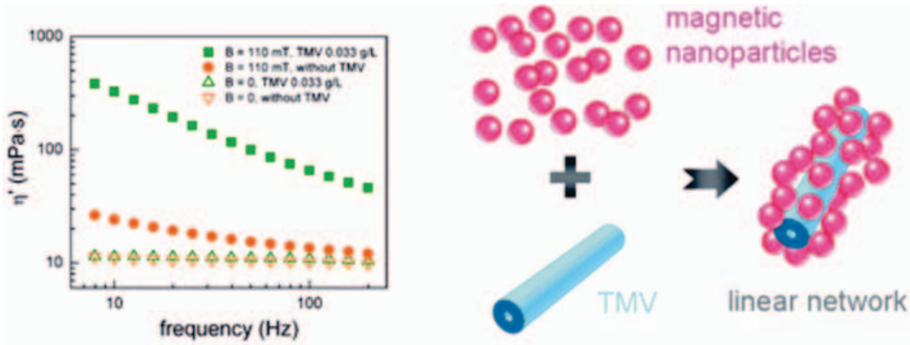
Enhancing the magnetoviscosity of ferrofluids by the addition of biological nanotubes

ACS Nano **4**, 4531–4538 (2010)
*Z. Wu, A. Mueller, S. Degenhard, S. E. Ruff, F. Geiger, **A. M. Bittner**, Christina Wege, and C. E. Krill*

The addition of plant-virus-derived nanotubes to a commercial ferrofluid can give rise to a dramatic enhancement in magnetoviscosity and a suppression of shear thinning.

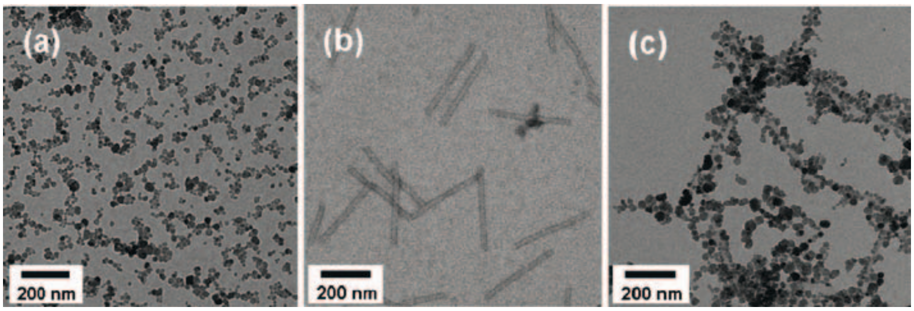
Ferrofluids

Ferrofluids are composite substances that combine the magnetic properties of magnetic nanoparticles with the fluid properties of the carrier liquid in which the nanoparticles are suspended. The latter are typically on the order of 10 nm in diameter, and either in the superparamagnetic or ferromagnetic state at room temperature. Ferrofluids can be held in place or manipulated by externally applied magnetic fields. This characteristic has led to niche applications of ferrofluids in areas as diverse as vacuum technology (creating low-friction, airtight seals around rotating shafts) and high-end audio systems (transferring heat from the voice coils of highpower loudspeakers). Recent interest in ferrofluids can be traced to their potential uses in biomedical contexts, such as attacking cancer cells via magnetic hyperthermia or in the detection and removal of pathogens from liquid suspensions by magnetic filtration. Furthermore, ferrofluids have found application in "lab-on-a-chip" devices as a key element in microfluidic valves and pumps.



The magnetoviscous effect

The technological exploitation of ferrofluids relies not only on the interaction between magnetic fields and nanoparticles, but also on the coupling between the suspended nanoparticles and the surrounding liquid. This coupling can be so strong that even modest externally applied magnetic fields suffice to increase the viscosity of the ferrofluid by orders of magnitude. This so-called magnetoviscous effect is generally attributed to the magnetic-field-induced formation of chainlike agglomerates of nanoparticles, which align themselves with the applied field and hinder the flow of carrier fluid in the transverse direction. Indeed, in magnetorheological (MR) fluids (liquid suspensions of magnetic particles orders of magnitude larger than those of ferrofluids) the formation of such chains has been demonstrated experimentally. The magnetoviscosity of MR fluids is so strong that it has found commercial use in electromagnetically switchable shock absorbers in automobiles, vibration dampers for suspension bridges, and (potentially) aircraft landing gear.



Bright-field TEM micrographs of (a) pure LCE-25 ferrofluid, showing the $CoFe_2O_4$ nanoparticles that remain after drying the carrier fluid; (b) TMV particles prior to suspension in the ferrofluid; and (c) the LCE-25/TMV mixture. In image c, the magnetic nanoparticles are seen to have clustered preferentially on the surface of the virus particles.

Shear thinning and the remedy

Even weak shear flows suffice to decrease the viscosity to merely some percent of the orginal value. This so-called shear thinning is a major obstacle to the use of ferrofluids in situations calling for the transmission of forces or torques, such as in active damping systems. The addition of plant-virus-derived nanotubes to a commercial ferrofluid can give rise to a dramatic enhancement in magnetoviscosity and a suppression of shear thinning. The dependence of this effect on nanotube aspect ratio and surface charge, both of which were varied biotechnologically, is consistent with a “scaffolding” of magnetic particles into quasi-linear arrays. Direct support for this explanation is derived from transmission electron micrographs, which reveal a marked tendency for the magnetic nanoparticles to decorate the outside surface of the virus nanotubes. Forces as the latter are able to overcome the weak interactions holding the chain-like nanoparticle clusters together, thus breaking them apart and thwarting the mechanism for viscosity enhancement. One surprising consequence of this coupling is the fact that even modest magnetic fields have the potential to increase the viscosity of a ferrofluid by several orders of magnitude. This so-called magnetoviscous effect has recently found application, for example, in the suspension systems of automobiles outfitted with MagneRide(TM) shock absorbers, which feature a damping behavior (i.e., stiffness) that is tunable via a built-in electromagnetic coil.

Cumulative minor loop growth in Co/Pt and Co/Pd multilayers

Phys. Rev. B **82**, 104423-1 - 104423-9 (2010); Physics 3, 79-1 – 79-3 (2010)
***A. Berger**, S. Mangin, J. McCord, O. Hellwig, and E. E. Fullerton*

The behavior of minor hysteresis loops in perpendicular anisotropy [Co/Pt] and [Co/Pd] multilayers has been investigated. Upon applying a succession of identical magnetic field cycles, we observe a very substantial cumulative growth of the minor loop area. The cumulative behavior persists up to a sample-dependent threshold value above which this effect disappears. In all samples, the cumulative minor loop growth is correlated with a small reduction in the maximum magnetization value in each cycle. All experimental observations can be consistently explained as an accumulation of small nucleation domains that aid subsequent reversals and facilitate the cumulative minor loop growth.

A key aspect of ferromagnetic materials is the occurrence of hysteresis, which is generally observed as a branching of the magnetization M vs. external field H dependency. This behavior is caused by the fact that the magnetic free energy exhibits more than one stable or metastable state, making the state occupied by a ferromagnet dependent on its field history. M(H) becomes a single-valued function only for fields large enough to suppress the population of all metastable states in the time frame of the measurement. The minimum field, at which such a single-valued relation is reached, is the closure field H*.

While it is well established that hysteresis loops show a pronounced temperature and frequency dependence, **it is generally assumed that a single ferromagnetic sample produces a unique hysteresis loop under identical conditions.** This perceived uniqueness allows the utilization of hysteresis loops measurements as a material characterization method and is furthermore of crucial relevance for the many applications of magnetic materials. However, absence of repeatability had already been observed when measuring minor loops (measured with H_{max} < H*), although the M(H) curve is generally unique for major loops (measured with H_{max} > H*). These previously reported deviations from repeatability were nevertheless small, being only a minimal perturbation to the accepted idea of repeatability of macroscopic hysteresis loops.

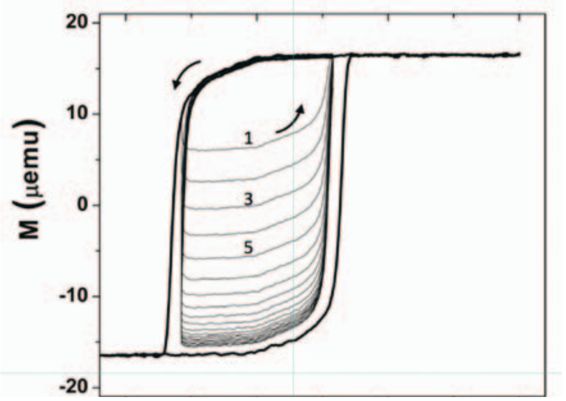


Figure 1

Field dependence of the magnetization for a $(Co/Pt)_8$-multilayer. The thick solid line represents the major loop behavior, while the thin solid line shows a sequence of successive minor loops upon applying a symmetric field amplitude of 290 Oe. The first, third, and fifth minor loops are labeled.

Figure 1 clearly shows the dramatic increase in minor loop area with successive field cycles. Two additional critical observations emerge from the study. First, this effect disappears for maximum fields that exceed the closure field, reassuring the repeatability of major loops. Second, a correlation exists between the growth of the minor loops and a small but noticeable decrease in the maximum magnetization observed in each cycle. This second fact gives an important clue for the understanding of the mechanism driving this minor loop growth. Magnetic domain imaging, shown in Fig. 2, demonstrates that the minor loop expansion is caused by the successive accumulation of small nucleation domains, which assist in the reversal of the magnetization, even though they nearly disappear during the positive half of the field cycle.

350% increase in hysteresis loop size is observed upon multiple cycling

While this effect is probably present in many magnetic materials, it appears to be particularly pronounced in perpendicular magnetized films of a certain thickness. The effect was not observed in extremely thin $[Co/Pt]_3$ multilayers, and found only to a much smaller degree in thicker $[Co/Pd]_{50}$ multilayer samples. So, even though cumulative minor loop growth might be a general phenomenon, it may be a rather small effect in many cases.

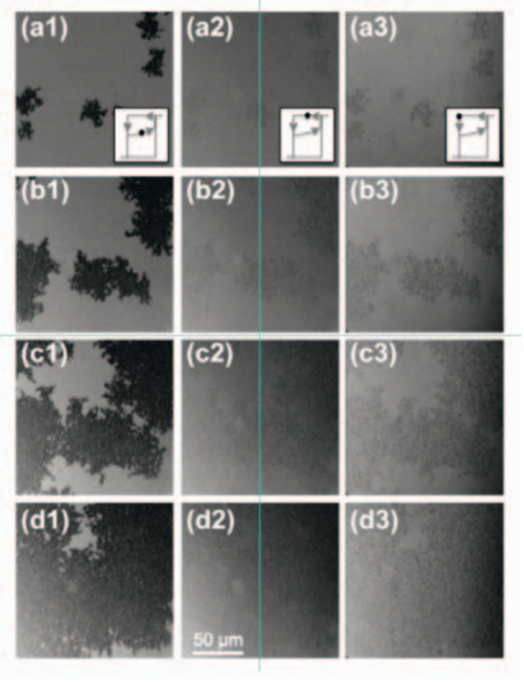


Figure 2

Sequence of Kerr-effect microscopy images taken on a $(Co/Pd)_8$-multilayer sample at different points of the field sequence during consecutive cycles. Columns 1, 2, and 3 correspond to the negative remanent state, the positive remanent state, and the initial negative reversal state, respectively. Rows (a) – (d) show pictures taken during four subsequent minor loop cycles. The schematic insets in (a1) – (a3) indicate at which point on the minor loop cycle the observation was made.

Conferences & Workshops

Even before the construction of the facilities, nanoGUNE started to play an active role in the promotion of nanoscience and nanotechnology through the organization of international conferences and workshops, and also through other similar events in the Basque Country. These events offer the possibility to work out the various challenges of our activity simultaneously, being international conferences a natural environment for excellent research, the front door to internationalization, and the best opportunity for young researchers to learn and interact with the world leaders in the field.

Various events have been organized in close collaboration with the Donostia International Physics Center (DIPC) and the University of the Basque Country (UPV/EHU), which has made possible to reach an international impact far beyond the expectations for a young research center like nanoGUNE.

Apart from purely scientific events, nanoGUNE has also promoted public conferences, with the aim of popularizing among the general public science and technology, in general, and nanoscience and nanotechnology, in particular. The AtomByAtom conference, co-organized by nanoGUNE and the DIPC, and the Passion for Knowledge event, organized by the DIPC in collaboration with nanoGUNE, are remarkable examples of our commitment to communicate science and technology to the general public.

Nano2006 Workshop
4-6 September 2006

http://dipc.ehu.es/nano2006/

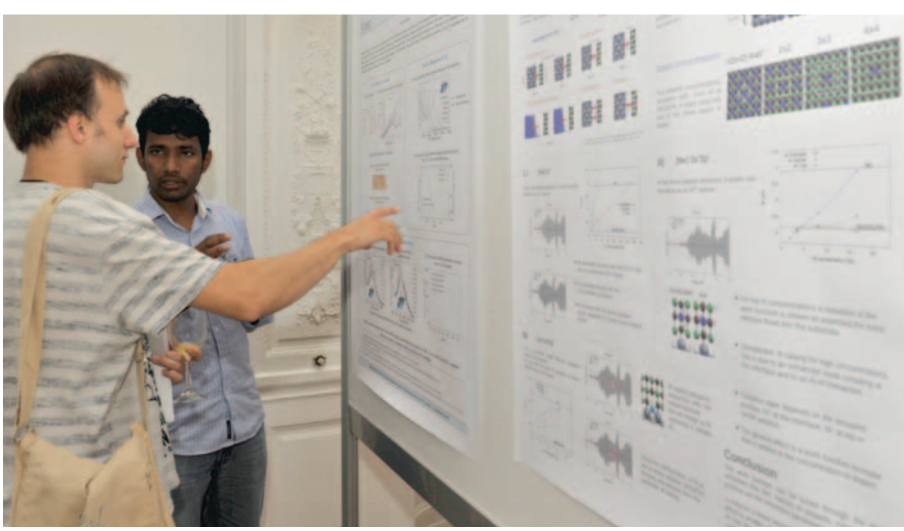
Coinciding with the launching of nanoGUNE on 1 September 2006, the aim of this multidisciplinary workshop was to assess the state of the art in the understanding of nanoscale physics, chemistry, engineering, biology, and medicine, and to access the knowledge and advice from leader scientists in these fields. It was also intended to discuss emerging applications with potentially significant impact for the materials, electronics, photonics, and life-science industries, and to debate about the current strategy and perspectives in Nanoscience and Nanotechnology. The workshop also served to introduce nanoGUNE to the scientific community.

The workshop was divided into 7 sessions, which were devoted to various hot topics in the area:

- Nanophotonics
- Nanostructures
- Management and Coordination
- Nanobiotechnology
- Electronic Structure
- Nanoelectronics
- Nanomagnetism

Nano2006 in figures

Chairman: José M. Pitarke (nanoGUNE)
Vicechairmen: Javier Aizpurua (DIPC)
Daniel Sánchez Portal (CFM)
Participants: 102
Invited Talks: 26
Oral Contributions: 9
Posters: 33



TNT2007, Trends in NanoTechnology
7-11 September 2007

http://www.tntconf.org/2007/index.php?conf=07

The TNT high-level scientific meeting series aims at presenting a broad range of current research in Nanoscience and Nanotechnology as well as related policies and initiatives.

TNT events have demonstrated to be particularly effective in transmitting information and establishing contacts among workers in the field. The TNT2007 edition, co-organized by the Phantons Foundation and nanoGUNE, took place in San Sebastian and kept the fundamental features of the previous editions, thus providing a unique opportunity for broad interaction.

The topics discussed in TNT2007 were:

- Atomic-scale effects in nano-CMOS electronics
- Carbon-nanotubes-based nanoelectronics and field emission
- Low-dimensional materials (nanowires, clusters, quantum dots, etc.)
- Nanobiotechnologies
- Nanochemistry
- Nanofabrication tools and nanoscale integration
- Nanomagnetism and spintronics
- Nanooptics and nanophotonics
- Nanostructured and nanoparticle-based materials
- Scanning Probe Microscopy
- Theory and modelling at the nanoscale

TNT2007 in figures

Organizers: Antonio Correia (Phantoms Foundation)
José M. Pitarke (nanoGUNE)

Participants: 418

Invited Talks: 4

Keynotes: 37

Oral Contributions: 14

Posters: 266

InterGUNE Workshop
2 March 2009

http://www.nanogune.eu/en/events/intergune/

NanoGUNE organized a so-called interGUNE workshop, in which researchers from the cooperative research centers microGUNE, biomaGUNE, and nanoGUNE presented to each other their research lines and technology platforms. The workshop program was divided into four sessions, three of them for the respective cooperative research centers to present their research activity and capabilities, and a fourth one to explore common interests.

InterGUNE in figures

Participants: 75
Oral Contributions: 14

AtomByAtom - Nano2009

28-30 September, 2009

http://atombyatom.nanogune.eu/

The AtomByAtom conference, co-organized by nanoGUNE and the DIPC, took the audacious step of bringing together beneath a single umbrella an international scientific conference (Nano2009) and a series of activities focusing on bridging the gap between science and the general public. At nanoGUNE, we feel responsible to the international scientific community and to our citizens for conveying knowledge and contributing to progress, culture, and freedom in society. Our aim is to provide meeting places for scientists and between science and society. We were successful with AtomByAtom, and we are proud of our efforts.

Chairmen

Pedro M. Echenique
José M. Pitarke

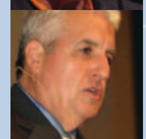
Technical Committee

Igor Campillo
(Secretary General)
Juan José Iruin
Unai Ugalde

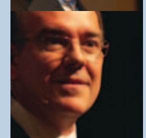
Plenary Sessions

AtomByAtom was opened to the general public via its plenary section, with the purpose of bringing together scientific rigor and entertainment to foster an immersion in science as a cultural activity. The AtomByAtom plenary section, involving an outstanding line-up of speakers featuring two Nobel laureates and renowned researchers, presented a program of conferences and activities open to the public that addressed an extensive range of topics in which nanotechnology is expected to have a powerful impact, such as electronics, health, or new materials.

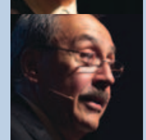
•• **Sir Harold Kroto**
1996 Nobel Prize in Chemistry
Florida State University (USA)
Science, society, and sustainability



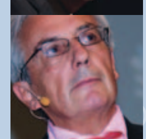
•• **Felix Goñi**
Biophysics Unit, Centro Mixto CSIC-UPV/EHU (Spain)
Lipidic nanoparticles: Fat is beautiful



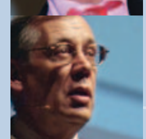
•• **José A. Maiz**
Intel Corporation (USA)
Nanoscience and nanotechnology: The promise, the reality, and the challenges



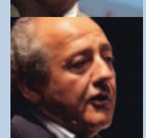
•• **Carlos Bustamante**
University of California, Berkeley (USA)
Grabbing the cat by the tail: DNA packaging motor



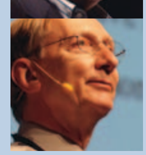
•• **Albert Fert**
2007 Nobel Prize in Physics
Université Paris-Sud, Unité Mixte de Physique CNRS/Thales (France)
Spintronics: Fundamentals, recent developments, and perspective



•• **Emilio Mendez**
Brookhaven National Laboratory (USA)
Nanotechnology and the energy challenge



•• **Juan Colmenero**
UPV/EHU, CSIC-UPV/EHU, DIPC (Spain)
Molecule by molecule: Molecular self-assembly and nanotechnology



•• **Sir John Pendry**
Imperial College, London (UK)
Transformation optics and nanotechnology

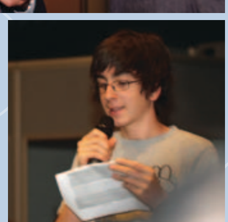
The attendance to the Plenary Sessions exceeded all expectations and represents the main indicator of success.

Monday 28 September	Tuesday 29 September	Wednesday 30 September
812 participants	948 participants	615 participants

Encounter with Nobel Laureaters

AtomByAtom was more than the plenary lectures. Nobel Laureates Heinrich Rohrer and Sir Harold Kroto participated in an interactive session with high-school students. This session was moderated by Pedro Miguel Echenique and took place at the KutxaGune of Science, the science museum in San Sebastian. 130 high-school students and 43 teachers from 43 schools all around the Basque Cuntry participated in the event, which permitted informal yet in depth dialogue on the vital experience of both scientists, the essential questions of nanoscience and nanotechnology, and their opinions and thoughts about the future.

Public attendance well overshot our expectations as we saw how the talks and activities were followed with tremendous interest and enthusiasm. That is why we at nanoGUNE and the DIPC are even more determined to continue concentrating on our undertaking of bringing science to society. All the plenary lectures and the encounter with Nobel Laureates are available at http://dipc.tv.



Nano2009 Workshop

In the framework of the AtomByAtom program, the **Nano2009** workshop reviewed the state of the art in the fields of nanomagnetism, nanooptics, self-assembly, nanobiotechnology, nanodevices, and theory and simulation at the nanoscale, giving access to the knowledge and advice from leader scientists in these fields. The workshop was intended to discuss emerging applications with potentially significant impact for the materials, electronics, photonics, and life-science industries, and debate about the current strategy and perspectives in Nanoscience and Nanotechnology. The workshop also served to introduce the newly created nanoGUNE research groups to the scientific community.

The workshop was structured into the following sessions:

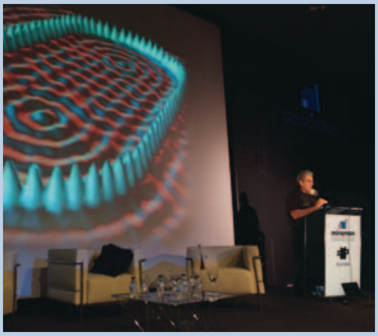
- Theory and Simmulation
- Nanooptics and Nanophotonics
- Self-Assembly
- Nanobiotechnology
- Nanodevices
- Nanomagnetism

Nano2009 in figures

Chairman: José M. Pitarke (nanoGUNE)
Participants: 105
Invited Talks: 15
Oral Contributions: 15
Posters: 46

The Kursaal Congress Center awarded nanoGUNE for the celebration of this Conference. This was the third edition of the Kursaal Prizes for the Promotion of Conferences, which awarded nine institutions. The award ceremony was chaired by the Major of the Regional Council of Gipuzkoa.








NanoICT School 2009

26-30 October 2009

http://www.phantomsnet.net/nanoICT/School09/

The EU funded nanoICT project establishes a broad array of specialized training activities to provide students with interdisciplinary competences in Nanotechnology and, more specifically, in "nano-scale ICT devices & systems" (Emerging Nanoelectronics). The aim of the project is to generate a new generation of high-skilled interdisciplinary scientists, which is of great importance for the sustainability of European excellence in this topic. The school was organized by the Phantoms Foundation in collaboration with the Donostia International Physics Center (DIPC), the Spanish Research Council (CSIC), and nanoGUNE.

The School covered the topics of nanophotonics and modelling, and included a Symposium where experts in these fields presented the latest developments in their research areas.

NanoICT School in figures

Organizers: Antonio Correia (Phantoms Foundation)
Igor Campillo (nanoGUNE)
Pedro M. Echenique (DIPC)
Daniel Sanchez-Portal (CSIC)

Participants in the nanphotonics sessions: 35

Participants in the modelling sessions: 26

Participants in the Symposium: 66

Workshop on Nanomaterials for Energy and Biotechnology
25-26 November 2009

http://www.nanogune.eu/en/events/nanomaterials-for-energy-and-biotechnology/

Celebrated at the nanoGUNE facilities, the "Nanomaterials for Energy and Biotechnology" workshop aimed at being a multidisciplinary event for the review of important research activities in the field of nanomaterials for applications related to energy and biotechnology. The workshop was composed of four complementary sessions: Nanomaterials for Energy, Nanomaterials for Biotechnology, Devices in Nanobiotechnology and Energy, and Characterization of Nanomaterials.

The workshop represented a joint initiative of the Israel Institute of Technology 'Technion' in Haifa, the Barcelona Nano Cluster Bellaterra in Barcelona, and nanoGUNE in San Sebastian. It offered a unique opportunity to explore common interests and to establish fruitful collaborations.

In figures

Participants: 24
Oral Contributions: 22

inanoGUNE Workshops

http://www.nanogune.eu/en/events/

The inanoGUNE project, granted by the Basque Government in the framework of the Etortek program, represents a key mechanism to coordinate and foster cooperation among agents of the scientific and technological community in the areas of nanoscience and nanotechnology in the Basque Country.

The partners of this inanoGUNE project are Tecnalia Coorporation (3 groups), IK4 Technological Alliance (3 groups), the University of the Basque Country (7 groups), the Donostia International Physics Center (2 groups), and nanoGUNE (3 groups).

Among the various activities of the project, various workshops and complementary training sessions were organized periodically, as follows:

- **25-26 May 2009**
  1st inanoGUNE workshop (65 participants). “Get to know” workshop. The partners presented their research activity and interests, in order to identify common interests and room for collaboration.

- **16 June 2009**
  “The art of presenting” training session, with the participation of Gonzalo Álvarez.

- **23 November 2009**
  “Launching new technology-based companies” training session, with the participation of BicBerrilan.

- **14-15 December 2009**
  2nd inanoGUNE workshop (70 participants). The workshop gave the opportunity to pre-doctoral and post-doctoral researches to present their research and to discuss with participants from other groups.

- **25 May 2010**
  3rd inanoGUNE workshop (83 participants). Basque companies were invited to participate, for them to explain their challenges, interests, and needs in the area of nanotechnology.

- **29-30 November 2010**
  4th inanoGUNE workshop (53 participants). Summary of the activities developed by the partners during the last two years. The program included the training session “Catching private investment”, with the participation of Iñaki Azpiazu (42 participants).


Transformation Optics
a new vision for electromagnetism & how it developed
The old optics
• ray approximation
• refraction at discrete interfaces
• limited material properties
the new vision
• beyond the ray approximation
• near field optics i.e. manipulate D and B as well as the rays
• sub wavelength optics
• exploit the potential of metamaterials
Imperial Colleg
London
atomBYatom

Ongoing Theses

2007

Synthesis, Functionalization, and Characterization of Silicon, Zinc, and Titanium Oxide Nanoparticles
Gemma Berriozabal
Started in April 2007

Nanoscale resolved free-carrier mapping in nanostructures by infrared near-fied microscopy
Johannes Stiegler
Started in December 2007

2008

Study of plasmonic antennas and false surface polaritons by near-field microscopy
Martin Schnell
Started in February 2008

Magnetization reversal in magnetic films, multilayers, and nanostructures
Olatz Idigoras
Started in October 2008

Fast magnetization dynamics near magnetic ordering tenperatures
Txema Porro
Started in October 2008

2009

Molecular and cellular toxicity of nanomaterials
Simon Poly
Started in March 2009

Organic spin tunnel devices
Marco Gobbi
Started in March 2009

Resistive switching in oxides
Raul Zazpe
Started in March 2009

nano-FTIR - broadband near-field spectroscopy
Florian Huth
Started in May 2009

Electrospining of biomolecules
Wiwat Nuansing
Started in May 2009

Plant virus drug delivery
Abid Ali Khan
Started in July 2009

Biomolecular spintronics
Thales de Oliveira
Started in August 2009

Nanobio hybrid materials with energy transfer properties
Roman Krutokhvostov
Started in November 2009

2010

Electronic transport in single molecules
Libe Arzubiaga
Started in January 2010

Carbon electrodes in energy storage
Pablo Rodal
Started in January 2010

Interface phenomena in hybrid materials built from biomolecules and nanostructures
Anthony Le Cigne
Started in June 2010

Multi-layers and nanostructures with competing electronic order states
Jon Ander Arregi
Started in October 2010

Development of novel infrared near-field probes based on antenna and waveguide structures
Paulo Sarriugarte
Started in October 2010

Spin injection, detection, and manipulation using lateral spin valves
Estitxu Villamor
Started in October 2010

Invited Talks

2007

Challenges and Opportunities in Nano Magnetism Research and Technology
03/09/07, **Andreas Berger**
Trends in Nanotechnology 2007, San Sebastian (Spain)

2008

Near-Field Infrared Nanoscopy and Nanospectroscopy
25/02/08, **Rainer Hillenbrand**
Annual German Physical Society Meeting 2008, Berlin (Germany)

Bioinspired Synthesis and Materials
01/03/08, **Alexander Bittner**
Schloss Ringberg Conference, Tegernsee (Germany)

Near-Field Infrared Nanoscopy and Nanospectroscopy
24/05/08, **Rainer Hillenbrand**
91st Canadian Chemistry Conference and Exhibition, Edmonton (Canada)

Nanooptics with Nanocrystals
10/07/08, **Igor Nabiev**
5th International Conference on Nanobiotechnology and Cellular Biology, Moscow (Russia)

Viruses as Scaffolds for Tubes and Wires
17/08/08, **Alexander Bittner**
236th American Chemical Society Meeting, Philadelphia (USA)

Biomolecular Tubes and Fibers
01/09/08, **Alexander Bittner**
Trends in Nanotechnology 2008, Oviedo (Spain)

Nanoscale Material and Conductivity Mapping by IR and THz Near-Field Microscopy
03/11/08, **Rainer Hillenbrand**
NanoSWEC, Bourdeaux (France)

Fabrication and Characterization of Magnetic Nano-Scale Materials
03/11/08, **Andreas Berger**
NanoSWEC, Bourdeaux (France)

Nanoscience in the Basque Country: The Big Challenge of the Small
14/11/08, **José M. Pitarke**
Second International Seminar of Nanoscience and Nanotechnology, La Habana (Cuba)

Magnetic Characterization of Granular Nano-Scale Materials
23/11/08, **Andreas Berger**
M-SNOWS 2008, Nancy (France)

2009

Nanofabrication with Peptide and Protein Tubes
09/03/09, **Alexander Bittner**
Nanospain 2009, Zaragoza (Spain)

Spintronics with Organic Semiconductors
13/04/09, **Luis Hueso**
MRS Spring Meeting, San Francisco (USA)

IR and THz Nanoscopy for Characterizing Electronic and Photonic Nanostructures
11/05/09, **Rainer Hillenbrand**
The International Conference on Nanophotonics 2009, Harbin (China)

Determination of the Intrinsic Switching Field Distribution in Granular Magnetic Materials
06/06/09, **Ondrej Hovorka**
IEEE ROMSC 2009, Lasi (Romania)

IR and THz Nanoscopy for Characterizing Electronic and Photonic Nanostructures
10/06/09, **Rainer Hillenbrand**
4th EOS Topical Meeting on Advanced Imaging Techniques, Jena (Germany)

IR and THz Nanoscopy by Elastic Light Scattering from an AFM Tip
15/06/09, **Rainer Hillenbrand**
2nd Multifrequency AFM Conference, Madrid (Spain)

Nano-Bio Hybrid Materials with Desired Energy Harvesting and Transfer Properties
23/06/09, **Igor Nabiev**
EC Workshop "Towards Zero-Power ICT (2zeroP)", Brussels (Belgium)

Nanoscale Optical Material and Device Characterization by Scattering-Type Near-Field Microscopy
06/07/09, **Rainer Hillenbrand**
5th Workshop on Numerical Methods for Optical Nano Structures, Zurich (Switzerland)

IR and THz Nanoscopy for Characterizing Electronic and Photonic Nanostructures
01/09/09, **Rainer Hillenbrand**
5th Handai Nanoscience and Nanotechnology International Symposium, Osaka (Japan)

Spintronics with Organic Semiconductors
07/09/09, **Luis Hueso**
Trends in Nanotechnology 2009, Barcelona (Spain)

New Horizons in Nano-Magnetism: Experiments, Theory, Simulations, and Applications
14/09/09, **Paolo Vavassori**
ICEAA 2009, Turin (Italy)

Organic Spintronic Nanostructures
10/10/09, **Luis Hueso**
Advances in Magnetic Nanostructures Workshop, Vall (Colorado)

Spintronics with Organic Semiconductors
26/10/09, **Luis Hueso**
NanoICT School 2009, San Sebastian (Spain)

On-Chip Manipulation at the Nano-Scale of Single Magnetic Particles Via Domain Walls Displacement in Magnetic Nanowires Conduits
27/10/09, **Paolo Vavassori**
MAGNET'09, Rome (Italy)

Resonance Energy Transfer From Semiconductor Quantum Dots Improves Biological Function of Bacteriorhodopsin Within the Bacteriorhodopsin-Quantum Dot Hybrid Material
02/11/09, **Igor Nabiev**
Nano South-West European Conference (NanoSWEC), Bourdeaux (France)

2010

IR and THz Nanoscopy for Characterizing Electronic and Photonic Nanostructures
14/02/10, **Rainer Hillenbrand**
2010 RBNI Winter School, Dead See (Israel)

Carbon-Based Spintronics
14/02/10, **Luis Hueso**
XI Escuela Nacional de Materiales Moleculares, Peñafiel (Spain)

Magnetic Nano-Structures for the Manipulation of Individual Nano-Scale Particles in Bio-Compatible Environments
15/03/10, **Paolo Vavassori**
APS March Meeting 2010, Portland (USA)

How to Coat Plant Viruses
23/03/10, **Alexander Bittner**
Nanospain 2010, Malaga (Spain)

Spin Tunneling and Transport in Organic Materials
30/05/10, **Luis Hueso**
ICNDR Conference, Osaka (Japan)

Infrared Plasmonics
12/06/10, **Rainer Hillenbrand**
Gordon Conference in Plasmonics, Waterville, Maine (USA)

Organic Spintronics
17/06/10, **Luis Hueso**
Nanomediterraneo II, Alicante (Spain)

Scattering-Type Near-Field Microscopy and Its Applications
21/06/10, **Rainer Hillenbrand**
Summer School on Plasmonics: Enhanced sensing on metal nanostructures, Jaca (Spain)

IR and THz Near-Field Nanoscopy for Characterizing Nanoscale Materials and Devices
28/06/10, **Rainer Hillenbrand**
3rd International Conference on Nanostructures Self-Assembly, Nanosea 2010, Cassis (France)

Nanotecnología
28/06/10, **José M. Pitarke**
Summer School "Investigación e Innovación Biosanitaria", San Sebastian (Spain)

Chemistry and Physics Behind Energy Transfer from Nanostructures to Bio-Supramolecular Photosensitive Complexes
16/07/10, **Igor Nabiev**
Workshop "Nanoscience: Chemistry and Physics Behind Supramolecular Science", organized by College de France and Fundación Botín, San Sebastian (Spain)

Infrared and Terahertz Nanoscopy
19/07/10, **Rainer Hillenbrand**
IEEE Photonic Society Summer Topical Meeting, Playa del Carmen (Mexico)

Transporte de Spin en Materiales Basados en Carbono
19/07/10, **Luis Hueso**
Curso "Nuevos retos y aplicaciones del magnetismo", Universidad Internacional Menéndez Pelayo, A Coruña (Spain)

IR and THz Near-Field Microscopy
29/08/10, **Rainer Hillenbrand**
The 11th International Conference on Near-Field Optics, Nanophotonics, and related techniques Beijing (China)

Vector Near-Field Nanoscopy of Mid-Ir Antennas
03/09/10, **Rainer Hillenbrand**
Frontiers of Plasmonics, Xian (China)

IR and THz Near-Field Nanoscopy for Mapping Local Chemical Composition, Free-Carrier Properties and Strain
13/09/10, **Rainer Hillenbrand**
E-MRS Fall Meeting, Warsaw (Poland)

Phase-Sensitive Mapping of Nanoscale Optical Vector Fields
13/09/10, **Rainer Hillenbrand**
Metamaterials 10, Karlsruhe (Germany)

The Asymptotic Behavior of The Kohn-Sham Potential of Density-Functional Theory at Metal Surfaces
27/09/10, **José M. Pitarke**
Passion for Electrons Workshop, San Sebastian (Spain)

Espintrónica con Semiconductores Orgánicos
12/11/10, **Luis Hueso**
CEMAG Annual Meeting, San Sebastian (Spain)

Outreach Activity

The strategic plan of nanoGUNE establishes outreach activities as one of the fundamental activities of the center. In this sense, nanoGUNE intends to play an active role in the spreading of scientific knowledge to industry and to society, thus contributing to the understanding of the social dimension of science and projecting the expected image of an intellectually and technologically advanced country.

Education

Master in Nanoscience (http://www.mscnano.eu/)

NanoGUNE collaborates with the Department of Materials Physics (University of the Basque Country UPV/EHU), the Center of Materials Physics CFM (CSIC-UPV/EHU), and the Donostia International Physics Center DIPC in the design, organization, and teaching of this Master Degree, which was recognized by the Spanish Ministry of Education as a highly-qualified master program (Mención de Calidad MCD2007-00052).

The objective of the master is to provide the students with (i) the basic concepts and the most commonly used working tools in the field of Nanoscience, including the use and interpretation of the results of the experimental techniques that are specific to nanotechnology research laboratories, (ii) topics related to the nanomaterials and their applications, and (iii) a general knowledge of the research activity at the international level in the field of nanoscience. In addition, students are exposed to the research work that is carried out, in the areas of nanoscience and nanotechnology, by various scientific and technological institutions in the Basque Country. After completing the master, students could choose to proceed with the research work that would allow them to obtain the PhD degree.

Taking nanotechnology to secondary schools

In collaboration with the Department of Education, Universities, and Research of the Basque Government (through the GARATU program), nanoGUNE offers a nanotechnology introductory course to high-school science and technology teachers. The objectives of the course are:

· Understand the key concepts of nanotechnology and their relation to the development of science and technology in the 20th and 21st centuries.

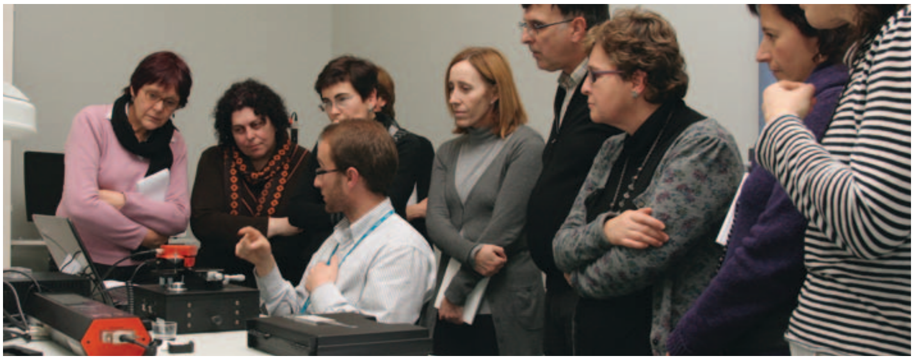
· Describe the theoretical framework and the fundamental technological tools of nanotechnology.

· Present the current research challenges in the field.

· Get insight on the everyday life of scientists and researchers.

· Remark the relevance of the interaction between research, education, companies, and society in general.

In the 2010 edition, 20 high-school teachers participated in the course with very satisfactory results.



Conferences

Apart from scientific conferences targeted to the research community, nanoGUNE has been organizing and collaborating in the organization of various events targeted to the general public, with the aim of promoting the interest and the understanding of the newest scientific developments.

AtomByAtom, 28-30 September 2009

The AtomByAtom conference, co-organized by nanoGUNE and the Donostia International Physics Center (DIPC), was celebrated in San Sebastian with the purpose of disseminating, in a clear and accessible manner, nanoscience and nanotechnology to the society. See detailed information on page 90.

Passion for Knowledge, 27 September – 1 October 2010

NanoGUNE collaborated actively in the organization of the Passion-for-Knowledge event that celebrated the 10th anniversary of the Donostia International Physics Center. Following the trends defined in the AtomByAtom conference, Passion-for-Knowledge included conferences open to the general public (featuring ten Nobel Laureates and other world-class lecturers), encounters between scientists and different communities (the bio-health community, high-school students, and high-school teachers), art exhibitions (nanoart XXI and FotCiencia), and an online video contest on short science documentaries (www.onzientzia.tv).

Passion for Knowledge in figures:
Registrations: 1652
Participants in the encounters: 448
Visitors of the exhibitions: 1000

Visits

ERDF meeting, 27 May 2010

The European Regional Development Fund (ERDF) aims at strengthening economic and social cohesion in the European Union, by correcting imbalances between its regions. NanoGUNE hosted the ERDF monitoring meeting for the Basque Country celebrated in San Sebastian in May 2010. The monitoring committee, which includes representatives from various Basque and Spanish institutions, was presided by Anatolio Alonso (ERDF Deputy Subdirector of the Spanish Ministry of Economy) and Koldo Hualde (Economy and Planning Director of the Basque Government).

FP7 KEEN-Regions project visit, 28-29 June 2010

The FP7 KEEN-Regions project aims at accelerating and fostering the nanotechnology development in three European regions [Veneto (Italy), Rhone Alps (France), and Basque Country (Spain)] through the establishment of consistent and cooperative networks of research centers, boosting the synergies among the research and business communities, and valorizing the complementarities among these regions.
This FP7 KEEN-Regions project is one of the Regions-of-Knowledge projects that are supported by the European Commission through its Seventh Framework Programme.

On 28-29 June 2010, a mutual-learning visit was celebrated at nanoGUNE were representatives from other regions were introduced to the technological offer in the Basque Country and had the opportunity to meet local companies to explore common interests. The program included visits to nanoGUNE, microGUNE, Polymat, Biomagune, and Cidetec, and a partnering event consisting of individual meetings between companies and technological centers from the three regions.

High-school visits

NanoGUNE runs a program of visits where high-school students come to the center in order to have a closer look at nanotechnology and our activity. Visits typically include a lecture about nanotechnology and its challenges, an open discussion with researchers of the center, and a guided visit to the laboratories. In 2010, eight visits were hosted at nanoGUNE.

Open-doors policy

NanoGUNE maintains an open-doors policy and is always ready to organize visits and presentations to various agents and/or people that are interested in getting to know the activity of the center. The following visits took place in the period 2009-2010:

- Arteleku: community of artists working in San Sebastian.
- First-Year Engineering Students from The University of the Basque Country and from Mondragon University.
- Third-Year Chemistry Students from The University of the Basque Country.
- Other research institutions in the region.

Popularization articles

2007

J. M. Pitarke and I. Campillo
El Noticiero de las Ideas **30**, 17 (2007)
Nanotecnologia: una vision que empieza a ser realidad

I. Campillo and J. M. Pitarke
Enciclopedia Durvan **36**, 152 (2007)
Nanotecnologia

J. M. Pitarke
CICNetwork **1**, 41 (2007)
Nanociencia y Nanotecnología

J. M. Pitarke and I. Campillo
Euskonews **413** (2007)
Nanoscience and Nanotecnology

2008

J. M. Pitarke
CICNetwork **4**, 1 (2008)
Cerrando la brecha abierta entre ciencia y sociedad

2009

J. M. Pitarke
Science & Technology **3**, 60 (2009)
Nanoscience in the Basque Country: The Big Challenge of the Small

J. M. Pitarke
Elhuyar Zientzia eta Teknika **256**, 54 (2009)
Nanozientzia eta Nanoteknologia, txikiaren erronka handia

I. Campillo and J. M. Pitarke
Science & Technology **5**, 1 (2009)
A public engagement

I. Campillo and J. M. Pitarke
Elhuyar Zientzia eta Teknologiaren Hiztegi Entziklopedikoa (2009)
Nanozientzia eta nanoteknologia

2010

E. Zarate and J. M. Pitarke
International Journal on Basque Studies, **55**, 269 (2010)
Atomoz Atomo

E. Zarate and J. M. Pitarke
Ekaia **23**, 29 (2010)
Nanoteknologia, txikiaren handitasuna

A. Bittner
CICNetwork **8**, 52 (2010)
Magnyfico

Popularization lectures

2009

Nanozientzia eta Nanoteknologia: Txikiaren Erronka Handia
07/05/09, **J. M. Pitarke**
Bidebarrieta Científica, Bilbao (Spain)

2010

Handienetik Txikienera: Quasar-a, Quark-a eta Nanoeskala
13/05/2010, **J. M. Pitarke**
Kutxa Lectures, Passion for Knowledge, San Sebastian (Spain)

In the media

In particular, nanoGUNE has collaborated with the media in various events related with the activity of the center, collaborating with journalist in communicating to the general public the latest advances in the field of nanoscience and nanotechnology.

In addition to more that 150 press releases (corresponding to the period 2007-2010), nanoGUNE has collaborated in the recording of two short documentaries about nanotechnology with SUT&BLAI, a Basque TV program targeted to teenagers, one of them concerning general concepts of nanotechnology and the other one related to the self-assembly approach to nanotechnology. The videos can be watched at:

· http://www.sutanblai.com/ata_edukia.php?id_edukia=722
· http://www.sutanblai.com/ata_edukia.php?id_edukia=806

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/en/seminars

2009

The European Research Council
Manolis Antonoyiannakis, European Research Council (ERC), London (UK)
29 January 2009

Optical pumping of active thin films and micro-cavity for one- and two-photon induced amplified emission
Samuele Gardin, University of Padova (Italy)
2 February 2009

Photonic properties of a variety of optoelectronic materials, focusing on silicon multinanolayers
Salvatore Minissale, University of Amsterdam (The Netherlands)
13 February 2009

Towards graphene nanoelectronics: Structural and electrical characterization
Ather Mahmod, Centre d'Elaboration de Materiaux ed d'estudes Estructurales (CEMES), Toulouse (France)
3 February 2009

Large-scale molecular dynamics simulations with applications to molecular biology
Frederik Heber, University of Bonn (Germany)
6 March 2009

Properties of cationic surfactant self assemblies /
The counterion effect on morphology of aggregates by Electron Microscopy
Sabine Manet, Université Paris-Sud, Orsay (France)
17 March 2009

Fabrication of small devices
Fèlix Casanova, University of California San Diego (USA)
12 May 2009

Electrical transport properties of metallic nanowires and nanoconstrictions created with FIB/SEM dual beam
José María de Teresa, Instituto de Nanotecnología de Aragón (Spain)
24 April 2009

New era in TEM nanocarbon research
Andrey Chuvilin, University of Ulm (Germany)
12 May 2009

Nonlinear ferromagnetic resonance in confined geometries
Robert Camley, University of Colorado (USA)
21 May 2009

Metamaterials: From planar circuit technology to volumetric
Mario Sorolla, Universidad Publica ed Navarra (Spain)
22 May 2009

Valence electron spectroscopy using energy-filtering TEM
Wilfried Sigle, Max-Planck Institute for Metals Research, Stuttgart (Germany)
1 June 2009

Surface-plasmon photonics
F. J. García-Vidal, Universidad Autónoma de Madrid (Spain)
2 June 2009

Luminescent nanocrystal quantum dots: building blocks for nano- and micro-devices
Yuri Rakovich, Trinity College, Dublin (Ireland)
26 June 2009

Formation of ordered III-V semiconductor nanostructures by different technological approaches
Pablo Alonso, Centro Nacional de Microelectrónica, Madrid (Spain)
30 June 2009

Spin torque phenomena in high-anisotropy nanostructures
Eric Fullerton, University of California San Diego (USA)
4 September 2009

Magnetic nanostructures
Rafael Morales, Universidad de Oviedo
9 September 2009

Ion scattering from 2D structures: Pursuing the monolayer resolution
Miguel Ángel Muñoz, Instituto de Ciencia de Materiales de Sevilla (Spain)
9 November 2009

Applications of nanocomposite metal-containing amorphous carbon films deposited by filter cathodic arc
José Luis Endrino, Instituto de Ciencia de Materiales de Madrid (Spain)
10 November 2009

Designing nanotools for biology and medicine
Romain Quidant, The Institute of Photonic Sciences (ICFO), Barcelona (Spain)
11 November 2009

2010

Tip-enhanced Raman scattering spectroscopy and Probing strain in nanowire by Raman spectroscopy
Jianing Chen, nanoGUNE
8 February 2010

Magnetic characterization of nano-scale granular magnetic materials
Ondrej Hovorka, nanoGUNE
15 February 2010

Molecular and cellular toxicity of nanomaterials
Simon Poly, nanoGUNE
22 February 2010

Electrospinning system for biomolecules
Wiwat Nuansing, nanoGUNE
1 March 2010

Diluted magnetic semiconductors. Above room temperature ferromagnetism in Si:Mn and TiO(2-x):Co
Alexander Granovsky, Moscow State University (Russia)
2 March 2010

Magnetoelectric effects in Fe/BaTiO3(001) interfaces for spintronics devices
Ricardo Bertacco, Politecnico di Milano (Italy)
3 March 2010

Quantum Rotational Motion in mesoscopic systems
Javier Tejada, University of Barcelona (Spain)
4 March 2010

Myths and truths about magnetism in diluted magentic semiconductors oxide
Federico Golmar, nanoGUNE
8 March 2010

The onset of biomineralization in Dps proteins studied by X-ray crystallography
Kornelius Zeth, Max Planck Institute for Developmental Biology, Tübingen (Germany)
18 March 2010

Improvement of resolution by scanning near-field cathodoluminescence microscopy and spectroscopy, nano-EBIC, and conductive atomic force microscopy
Michel Troyon, University of Reims (France)
22 March 2010

Electronic structure of graphene interacting with transition metals: substitutional defects in graphene/Ru(0001)
Daniel Sánchez-Portal, Center of Materials Physics (CFM), San Sebastian (Spain)
29 March 2010

TEM study of internally stressed Pt- and Ni-based superalloys
Elizaveta Nikulina, Max Planck Institute of Microstructures, Halle (Germany)
15 April 2010

Plant virus drug delivery
Abid Ali Khan, nanoGUNE
19 April 2010

Introductory Molecular Biology
Abid Ali Khan, nanoGUNE
23 April 2010

Magnetic molecules and hybrid materials for molecular spintronics
Eugenio Coronado, Universidad de Valencia (Spain)
26 April 2010

Friction reduction and particle manipulation on the nanoscale
Enrico Gnecco, University of Basel (Switzerland)
28 April 2010

IR mapping of photonic and electronic nanodevices
Pablo Alonso, nanoGUNE
3 May 2010

Static and dynamic properties of magnetic nanostructures
Pedro Landeros, Universidad Técnica Federico Santa María (Chile)
10 May 2010

An introduction to the European Theoretical Spectroscopy Facility (ETSF)
Anne Matsuura, Université Catholique de Louvain (Belgium)
11 May 2010

Carbon nano test-tubes: Interactions of nanotubes with molecules and nanoparticles
Andrei Khlobystov, University of Nottingham (UK)
17 May 2010

RRAM and resistive switching in metal / transition metal oxide interfaces
Pablo Levy, Comisión Nacional de Energía Atómica, (CNEA), Buenos Aires (Argentina)
21 May 2010

From terascale integration to nanobiosensing in vivo - a long way to nanomedicine
Gianfranco Cerofolini, University of Milano-Bicocca (Italy)
24 May 2010

Plasmon-resonance-enhanced absorption and circular dichroism in organic molecules and supramolecular biological complexes
Dimitry Melnikov, nanoGUNE
7 June 2010

Synthesis and characterization of multiferroic oxides: from ceramics to thin films
Diego Rubi, Commissariat a l'energie atomique (CEA), Saclay (France)
11 June 2010

From the Ising model to mesoscopic studies of multiferroics containing crystal defects
Roman Gröger, Academy of Sciences of the Czech Republic (Czech Republic)
14 June 2010

Liquid nanodispensing : Molecules deposition and manipulation of ultrasmall droplets
Thierry Ondarçuhu, Centre d'Elaboration de Materiaux ed d'estudes Estructurales (CEMES), Toulouse (France)
17 June 2010

Micro- and nanofluidics with TMV?
José María Alonso, nanoGUNE
21 June 2010

Magnetic circular dichroism in metal and semiconductor nanoparticles
Heme-Containing Proteins and their Complexes in Aqueous Solutions
Roman Krutokhvostov, nanoGUNE
5 July 2010

Reflection high-energy electron diffraction characterization of Co clusters electrodeposited on Au(100) electrode
Mauscheng Zei, National Central University (Taiwan)
20 July 2010

Unveiling physics in Biology by manipulation of single molecules
J. Ricardo Arias-González, IMDEA-Nanociencia, Madrid (Spain)
13 September 2010

Frustration and grace under pressure: three tales about novel oxides
John Mitchell. Argonne National Laboratory (USA)
15 September 2010

Potential application of nanotechnology to Parkinson disease treatment
Gurutz Linazasoro, Fundacion Inbiomed, San Sebastian (Spain)
20 September 2010

The fidelity of adaptative phototaxis
Idan Tuval, University of Cambridge (UK)
21 September 2010

The electronic properties of functionalized SWCNTs assessed by photoemission and X-ray absorption spectroscopy
Paola Ayala, University of Vienna (Austria)
22 September 2010

Phaseless optical nanoimaging in three-dimensions
Alexander Govyadinov, University of Pennsylvania (USA)
23 September 2010

Thin film carbon materials for nanotechnologies
Alexander Obraztsov, Moscow State University (Russia)
4 October 2010

Semiconductor nanoparticles: from simple synthetic approaches to optoelectronic applications
Silvia Masala, Centro Ricerche Portici, Napoli (Italy)
11 October 2010

Nano-reporters and nano-bullets: how nanotechnology advances enable to probe and target human cellular structures
Yuri Volkov, Trinity College, Dublin (Ireland)
11 October 2010

Spin transport in C60 molecules
Marco Gobbi, nanoGUNE
18 October 2010

Controlling spins with light
Theo Rasing, Radboud University, Nijmegen (The Netherlands)
25 October 2010

Graphene on metal surfaces - binding, structure, and growth
J. Wintterlin, Ludwig Maximilian Universitat (LMU), München (Germany)
2 November 2010

Polyaniline nanostructures for spin valves
Thales de Oliveira, nanoGUNE
15 November 2010

Magnetic characterization of single nanostructures
Hans Peter Oepen, University of Hamburg (Germany))
22 November 2010

Large-scale fist-principles calculations of solids, liquids, and nano-structures
Emilio Artacho, University of Cambridge (UK)
26 November 2010

Spintronics using molecular materials
Masashi Shiraishi, University of Osaka (Japan)
13 December 2010

Double Program: The Rashba effect in ferromagnetic metal layers and Magnetismat the molecule/metal interface
Pietro Gambardella, Institut Català de Nanotecnologia (ICN-CIN2), barcelona (Spain)
Aitor Mugarza, Institut Català de Nanotecnologia (ICN-CIN2), Barcelona (Spain)
21 December 2010

ISI Publications

	2007	2008	2009	2010	Total
ISI Publications	15	31	36	42	**124**
Average Impact Factor	4.9	3.7	5.7	4.0	**4.5**
Cites	9	67	175	403	**654**
h-index	2	4	8	12	**12**

2007

M. Beruete, M. Sorolla, M. Navarro-Cia,
F. Falcone, I. Campillo, and V. Lomakin
Optics Express **15**, 1114 (2007)
Extraordinary transmission and left-handed propagation in miniaturized stacks of doubly periodic subwavelength

M. Beruete, M. Navarro-Cia, I. Campillo,
F. Falcone, I. Arnedo, and M. Sorolla
Optical and Quantum Electronics **39**, 293 (2007)
Parametrical study of left-handed or right-handed propagation by stacking hole arrays

R. Gaudoin and J. M. Pitarke
Physical Review B **75**, 155105 (2007)
Quantum Monte Carlo modeling of the spherically averaged structure factor of a many-electron system

J. M. Pitarke, J. Inglesfield, and N. Giannakis
Physical Review B **72**, 165415 (2007)
Surface-plasmon polaritons in a lattice of metal cylinders

C. Pozo Gonzalo, J. A. Pomposo, D. Mecerreyes,
R. Marcilla, M. Salsamendi, M. Dobbelin, and
P. Carrasco
Chemistry of Materials **19**, 2147 (2007)
Influence of ionic liquids on the electrical conductivity and morphology of PEDOT: PSS films

J. A. Pomposo, H. Grande Tellería, M. Iñaki,
D. Mecerreyes, A. Genua, N. Kehagias,
C. Sotomayor, J. Alduncin, and V. Reboud
Nanotechnology **18**, 215301 (2007)
Functional patterns obtained by nanoimprinting lithography and subsequent growth of polymer brushes

M. Beruete, M. Navarro-Cia, M. Sorolla,
and I. Campillo
Optics Express **15**, 8134 (2007)
Polarized left-handed extraordinary optical transmission of subterahertz waves

L.A. Constantin and J. M. Pitarke
Physical Review B **75**, 245127 (2007)
Simple dynamic exchange-correlation kernel of a uniform electron gas

B. Diaconescu, K. Pohl, L. Vattuone, L. Savio, P. Hofmann, V. Silkin, J. M. Pitarke, E. V. Chulkov,
P. M. Echenique, D. Farias, and M. Rocca
Nature **448**, 57 (2007)
Low-energy acoustic plasmons at metal surfaces

R. Marcilla, R. Pacios Castro, C. Pozo Gonzalo, J. A. Pomposo, H. Grande Tellería, J. Aizpurua,
and D. Mecerreyes
Journal of Nanoscience and Nanotechnology **7**, 2938 (2007),
Combined electrochromic and plasmonic optical responses in conducting polymer/metal nanoparticle films

R. Gaudoin and J. M. Pitarke
Physical Review Letters **99**, 126406 (2007)
Hellman-Feynman operator sampling in Diffusion Monte Carlo calculations

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Land transfer for the nanoGUNE building
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5 years

Max Planck Institute for Biochemistry
01/02/2008
Cooperation and access to MPIB's nanophotonic laboratory
30/01/2009

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

Max Planck Institute for Solid State Research
10/10/2008
Equipment non-permanent loan
Unlimited

Technology Center Foundation Iñaki Goenaga
14/10/2008
Participation in different calls concerning training and specialization programs
Unlimited

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

BASF
01/12/2008
Sample provision agreement
1 year

University of the Basque Country (UPV/EHU)
16/03/2009
Cooperation and development of lecturers, researchers, and students
Unlimited

PoliMilano
31/03/2009
Exploit agreement of a joint-patent led by PoliMilano
5 years

ETP nanomedicine
17/06/2009
Services of the secretariat of the ETP nanomedicine
3 years

Progenika Biopharma S. A.
10/09/2009
Technology support for the development of novel diagnosis methods
31/12/2012

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

Instituto de Investigación BIODONOSTIA
10/12/2009
Collaboration in research projects among Biodonostia and nanoGUNE groups
Unlimited

BIOLAN
01/02/2010
Foster collaboration, exchange and integration among both work teams
Unlimited

PoliMilano
12/02/2010
Exploit agreement of a joint-patent led by nanoGUNE
5 years

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

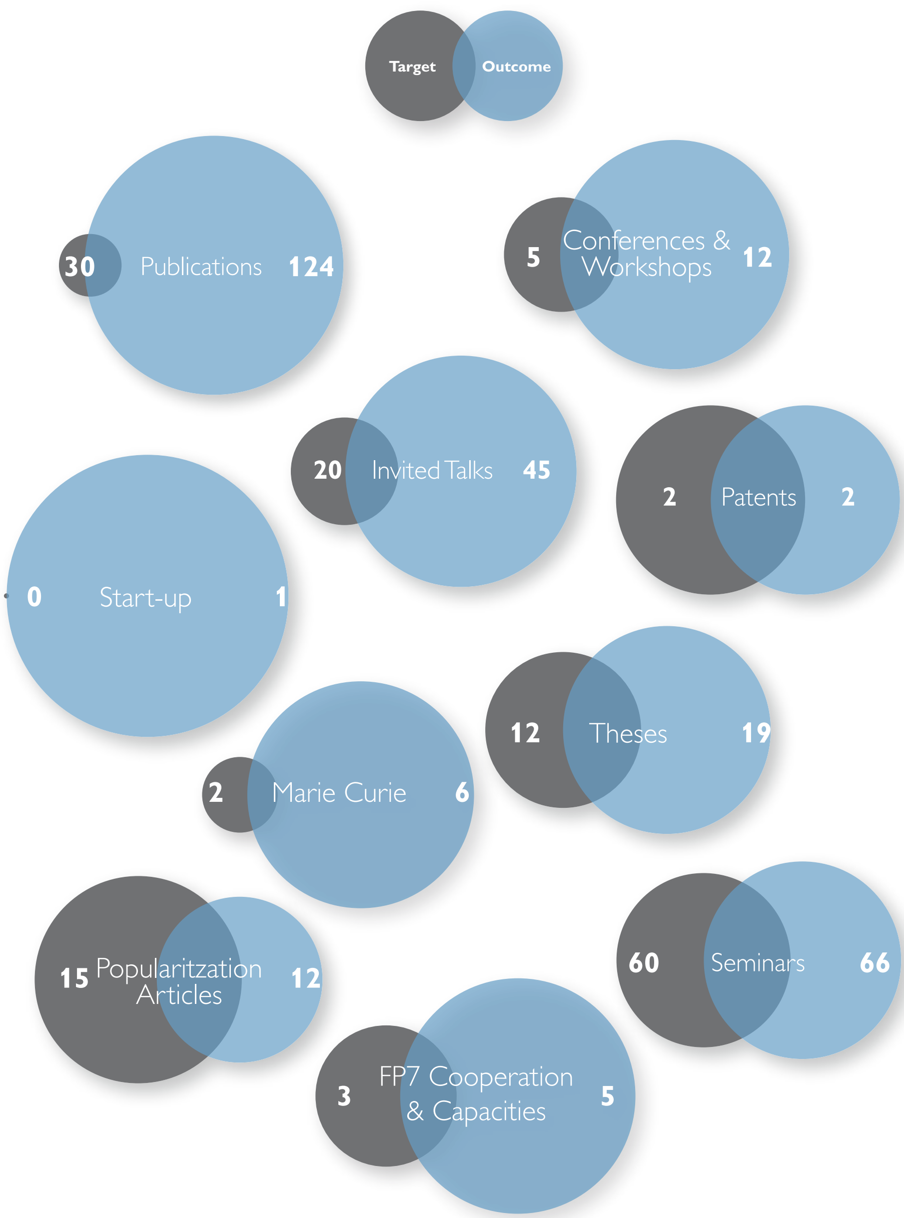
FEI Company
01/05/2010
Development of the Advanced Electron-Microscopy Laboratory and related research projects
01/04/2013

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

BicBerrilan
21/10/2010
Development of an incubator for nanotechnology-based new companies at nanoGUNE
Unlimited

Summary of Indicators

The following figure compares the *Outcome* of nanoGUNE's activity in the period 2007-2010 with the *Target* that was proposed for the same period of time in the Strategic Plan 2007-2010.



7

Funding

4.5 M€

European Funding

5

Cooperation & Capacities Projects

6

Marie Curie Actions

2

Starting Grants

Funding

Origin (M€)

	Awarded (2006-2010)	Allocated (2006-2010)			Allocated (2011-2016)
			% Executed	%Planned*	
Spanish Government	30	26	50%	43%	4
Basque Government - DIICT	24	16	31%	39%	8
Basque Government - DEUI	2**	1	2%		1
UPV/EHU	5	5	9%	8%	0
Europe	4,5	1	2%	3%	3,5
Regional Council of Gipuzkoa	2,5	2,5	5%	4%	0
Industry & Others	1	0,5	1%	3%	0,5
TOTAL	**69**	**52**	**100%**	**100%**	**17**

(*) In the framework of the 2007-2010 Strategic Plan

(**) Includes 1 M€ awarded by Ikerbasque (the Basque Foundation for Science) through the assignment to nanoGUNE of 7 Ikerbasque Research Professors

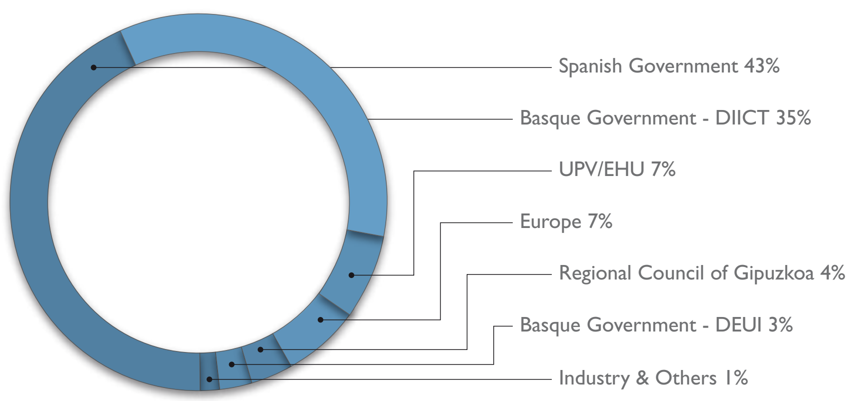
DIICT: Department of Industry, Innovation, Trade, and Tourism
DEUI: Department of Education, Universities, and Research

Destination (M€)

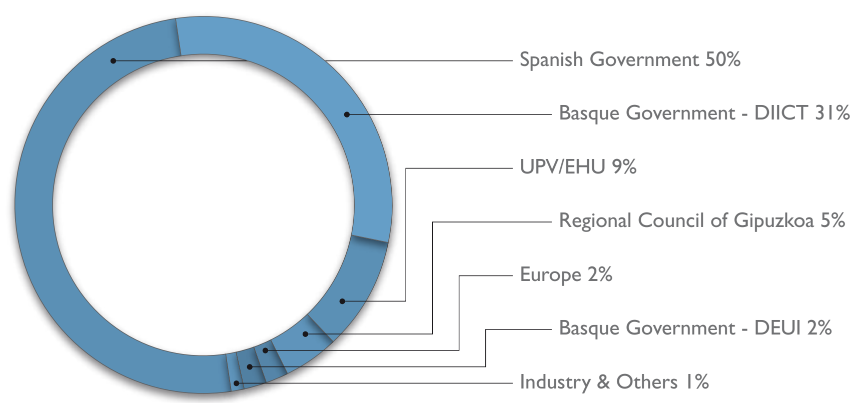
	Spent (2006-2010)		
		% Executed	%Planned*
Infrastructure	41	79%	81%
Research activities and operational costs	11	21%	19%
TOTAL	**52**	**100%**	**100%**

(*) In the framework of the 2007-2010 Strategic Plan

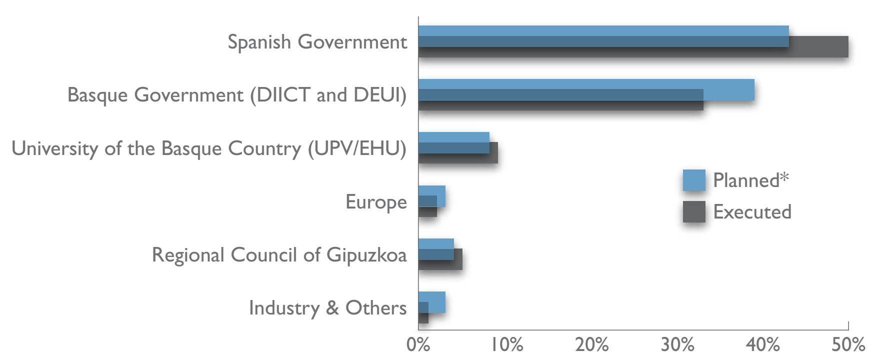
69 M€ Awarded (2006-2010)



52 M€ Allocated (2006-2010)



Planned vs. Executed

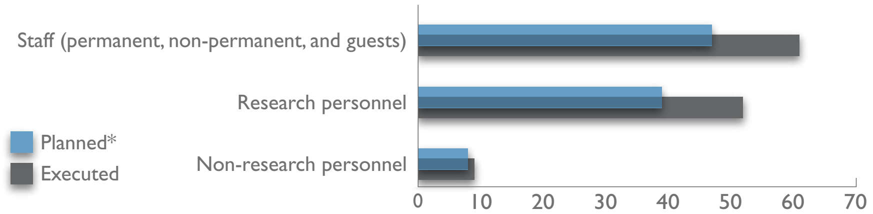


(*) In the framework of the 2007-2010 Strategic Plan

Personnel on 31 december 2010

	Planned	Executed
Staff (permanent, non-permanent, and guests)	47	61
Research personnel	39	52
Non-research personnel	8	9

Planned vs. Executed



(*) In the framework of the 2007-2010 Strategic Plan

Funding Institutions

Europar Batasuna
Unión Europea
Eskualde Garapenerako Europako Funtsa
FEDER
Fondo Europeo de Desarrollo Regional
Europa eskualdez eskualde eginez
Una manera de hacer Europa

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN

EUSKO JAURLARITZA
GOBIERNO VASCO

Gipuzkoako Foru Aldundia
Diputación Foral de Gipuzkoa

eman ta zabal zazu
Universidad del País Vasco
Euskal Herriko Unibertsitatea

ikerbasque
Basque Foundation for Science

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