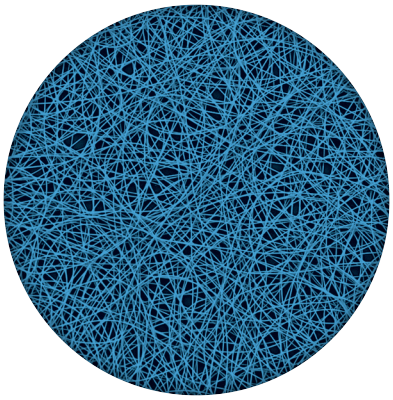
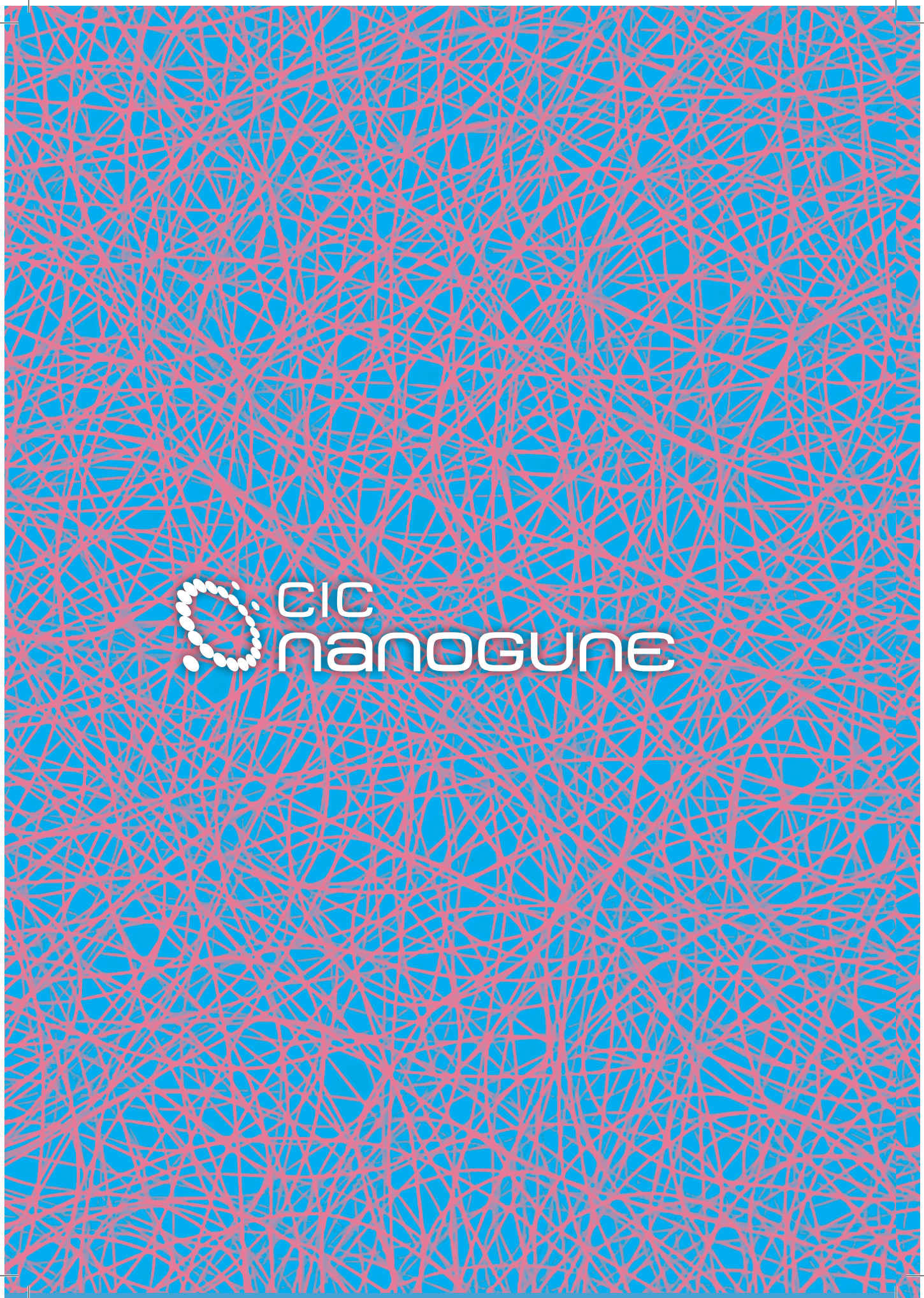


CIC nanoGUNE,
WHERE SMALL BECOMES...


CIC
nanoGUNE

...BIG

CIC nanoGUNE is a Center promoted by the Basque Government with the mission of addressing basic and applied world-class research in nanoscience and nanotechnology, fostering high-standard training and education of researchers in this field, and promoting cooperation among different agents in the Basque Science, Technology, and Innovation Network (Universities and Technological Centers) and between these agents and the industrial sector.


CIC
nanoGUNE
nanoscience cooperative research center

José M. Pitarke
Director

Nanotechnology is currently accepted as being one of the main driving forces behind economic growth in the 21st century, apart from being a key factor of a sustainability that cannot fail to mark the future development of humanity. The road ahead is long and uphill: one needs to understand new phenomena and master the manipulation of matter on a nanometer scale; one also needs to be capable of designing and creating materials, devices, and systems through controlling matter at that scale.

To investigate the small and to extract a technological performance that can be converted into new products and more efficient processes, and at the same time contribute to make our world more sustainable, is a huge challenge. This challenge is currently being taken on by the most advanced countries in the world and, in particular, by those that expect to occupy a prominent place in the future. There is no doubt that this represents a big challenge for a small country, the Basque Country, which is currently aiming at becoming an innovation reference in Europe.

NanoGUNE, promoted by the Basque Government, represents a necessary step for the promotion of a solid knowledge community with the vocation of transfering the results of reasearch to an industrial sector that needs to become increasingly more competitive in the current scenario of globalization. A world-class research team, state-of-the-art facilities, close collaboration with other research laboratories and with industry, and a commitment to our society define our way of understanding scientific research.

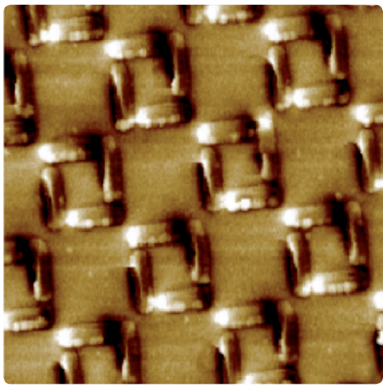
Being a small center in a small country, we will compete and collaborate with many other research laboratories around the world while finding the space that will allow us to offer something different. In doing so, we will be contributing to the creation of the necessary conditions for humanity to benefit from a wide range of nanotechnologies. This is the big challenge of the small.

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, a unique infrastructure was built, free of electromagnetic interference (EMI), with an ultralow level of vibration and acoustical noise, and the availability of ultra-clean rooms. The nanoGUNE building, located at the Campus of Ibaeta of the University of the Basque Country in San Sebastian, was inaugurated officially in January 2009. This is a building of 6,200 m² that includes 15 ultra-sensitive laboratories in the basement and a cleanroom of about 300 m² for nanofabrication.

RESEARCH GROUPS

- NANOMAGNETISM
- NANOOPTICS
- SELF-ASSEMBLY
- NANOBIOMECHANICS
- NANODEVICES
- ELECTRON MICROSCOPY
- THEORY
- NANOMATERIALS
- NANOIMAGING
- NANOENGINEERING

NANOMAGNETISM



Andreas Berger
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Paolo Vavassori
Ikerbasque Research Professor
Group Coleader
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The nanomagnetism group is led by Andreas Berger jointly with group coleader Paolo Vavassori. Focused on the fabrication and characterization of new nano-layered materials and other magnetic nanostructures, the research program for the nanomagnetism group has been divided into three main themes of research, as described below.

Theme 1: Magnetization reversal, dynamics, and related characterization methods

- Partially correlated magnetization reversal.
- Individual magnetization reversal events, their repeatability and statistics.
- Materials characterization and identification methods.
- Fast magnetization dynamics below and near the magnetic ordering temperature.

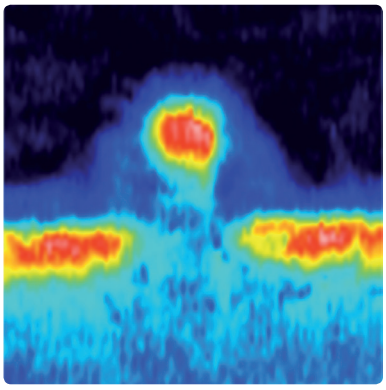
Theme 2: Fabrication and magnetic properties of multilayered materials

- Growth and characterization of granular materials.
- Multilayered materials with competing electronic and magnetic order states.
- Study of device relevant magnetic multilayers.

Theme 3: Fabrication, characterization, and application of magnetic nanostructures

- Electron and ion beam processing for nanostructure fabrication.
- Domain and domain wall structures in magnetic nanostructures.
- Utilization of magnetic domain walls for particle transport and field pulse generation.
- Magneto-optic scattering, diffraction, and ellipsometry.

NANOOPTICS



Rainer Hillenbrand
Ikerbasque Research Professor
Group Leader
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The nanooptics group is led by Rainer Hillenbrand. Focused on near-field optics, including (i) the development of new imaging and spectroscopy techniques that go beyond the diffraction limit and (ii) its application for the characterization of nanoscale materials and photonic nanostructures, the research program for the nanooptics group has been divided into three main themes of research, as described below.

Theme 1: Development of ultra-broadband near-field optical microscopy and spectroscopy

- Infrared nano-spectroscopy (nano-FTIR).
- Efficient near-field probes.
- Theory of near-field optical contrast mechanisms.
- Methods including subsurface imaging and near-field tomography.

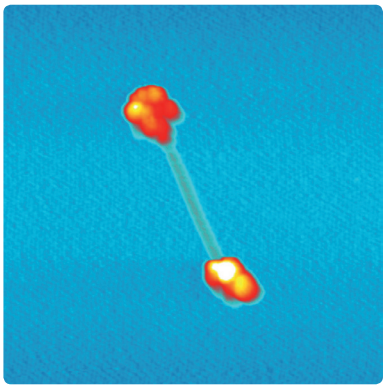
Theme 2: Near-field optical characterization of nanoscale materials

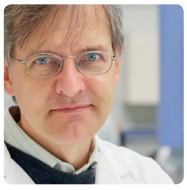
- Free-carrier profiling of semiconductor nanowires and in industrial semiconductor devices.
- Nanoscale chemical mapping and identification of polymers.
- Graphene.

Theme 3: Development and near-field characterization of photonic structures

- Fabrication and study of novel optical antenna structures.
- Surface waves in photonic waveguide structures and metamaterials.

SELF-ASSEMBLY





Alexander Bittner
Ikerbasque Research Professor
Group Leader
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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 for the self-assembly group has been divided into two main themes of research, as described below.

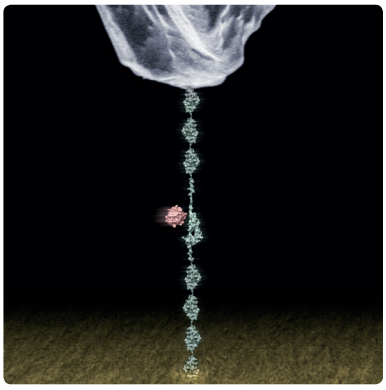
Theme 1: Plant viruses as scaffolds for the synthesis of nanoscale structures

- Virus / nanoparticle composites.
- Virus-based ferrofluids.
- TMV nanofluidics: Fluids confined in a 4 nm channel with chemically well-defined walls.
- Drug encapsulation.

Theme 2: Electrospinning of self-assembling material to wires

- Peptide wires/tubes: Steering the assembly of biomolecules by electrospinning.
- Electrospininng and one-dimensional assembly of proteins.
- Understanding and controlling electrospinning.
- Peptide fibers and neuropathology.

NANOBIOMECHANICS



Raul Perez-Jimenez
Ikerbasque Research Professor
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The Nanobiomechanics group is led by Dr. Raul Perez-Jimenez. It is focused on atomic-force microscopy to study the mechanical features of proteins, including (i) the use of advanced molecular-biology techniques and cutting-edge force spectrometers to investigate the role of mechanical forces in biology, (ii) a novel research line, mechanopharmacology, for the design and development of new compounds capable of altering the mechanics of proteins involved in human pathologies, and (iii) the study of the evolution of proteins.

Theme 1: Protein Mechanics

- The mechanical architecture of proteins.
- Mechanical forces in biochemical reactions.

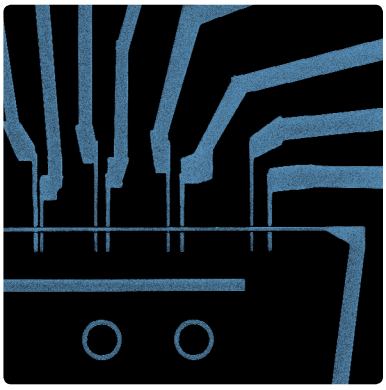
Theme 2: Mechanomedicine

- Mechanical forces in human pathologies, viral, and bacterial infections.
- Mechanopharmacology.

Theme 3: Protein Evolution

- Ancestral sequence resurrection: a travel back in time.
- Resurrected paleoenzymes in biotechnology.

NANODEVICES



Luis E. Hueso
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Félix Casanova
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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 the nanodevices group has been divided into three main themes of research, as described below.

Theme 1: Spin transport

- Organic magnetic tunnel junctions.
- Organic spin field-effect transistors.
- Graphene spintronics.
- Metallic lateral spin valves.

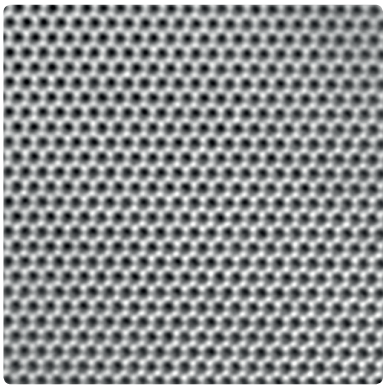
Theme 2: Multifunctional devices

- Resistive non-volatile memory devices.
- Organic/inorganic hybrid multifunctional devices.

Theme 3: Advanced nanofabrication

- Atomic Force Microscopy nanofabrication.
- Extreme electron-beam and focused ion-beam nanofabrication.

ELECTRON MICROSCOPY



Andrey Chuvilin
Ikerbasque Research Professor
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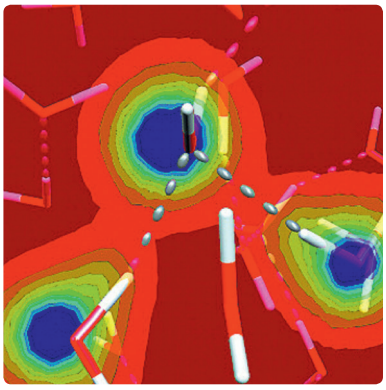
The advanced electron-microscopy laboratory, led by Andrey Chuvilin, represents a fundamental milestone in the infrastructure development of nanoGUNE and of the Basque Country. This new facility is open to other research and technological institutions and companies in the Basque Country, and puts nanoGUNE 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.

THEORY



Emilio Artacho
Ikerbasque Research Professor
Group Leader
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The theory group is led by Emilio Artacho. Its activity is focused on computational and theoretical condensed matter physics, using first-principles molecular dynamics based on density-functional theory and on linear-scaling density-functional theory for the study of complex solids, liquids, and nanostructures.

Theme 1: Nanoscale oxide heterostructures including multiferroics

- Origin and properties of two-dimensional electron gases in oxide interfaces.
- Nanoscale ferroelectrics.

Theme 2: Liquid water and water/solid interfaces

- Molecular-scale structure and properties of the liquid and its anomalies.
- How do such properties change when the liquid is confined to nanoscale.
- Interfaces between water and solids and macromolecules. Hydration.

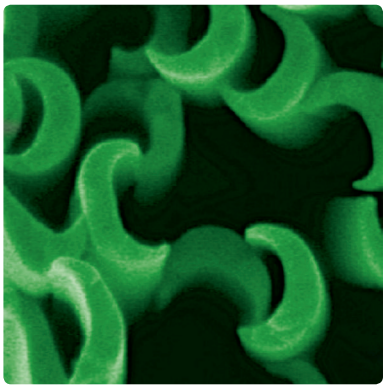
Theme 3: Non-adiabatic processes related to radiation damage of materials

- Electron energy uptake from ions shooting through matter.
- Non-adiabatic effects in radiation cascades.

Theme 4: Theoretical development and implementation

- Linear scaling density-functional theory.
- Time-dependent density-functional theory.
- Coupled electron-ion dynamics.

NANOMATERIALS



Mato Knez
Ikerbasque Research Professor
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The nanomaterials group is led by Dr. Mato Knez. The activity of the nanomaterials group is focused on the Synthesis and Functionalization of Materials. The research program has been divided into three main themes of research.

Theme 1: Thin-film coatings for functionalization of materials using Atomic Layer Deposition (ALD) Techniques

- Diffusion phenomena at interfaces.
- Corrosion protection and barrier layers.
- Optical and electronic properties of thin films.

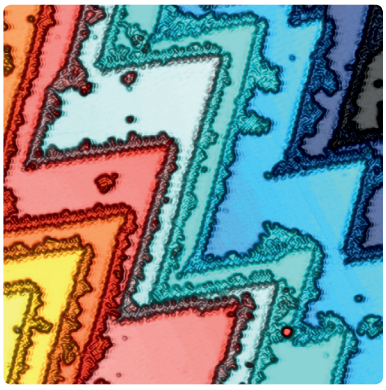
Theme 2: Hybrid inorganic-organic materials

- Top-down and bottom-up synthesis.
- Physical properties of inorganic-organic alloys.
- Porous catalytic materials.

Theme 3: Bio-inorganic nanomaterials

- Particle-cell interactions.
- Drug delivery.

NANOIMAGING



Nacho Pascual
Ikerbasque Research Professor
Group Leader
Ji.pascual@nanogune.eu

The probe microscopy group is led by Nacho Pascual. The activity of the group is focused on Scanning Tunneling Microscopy and related techniques applied to the characterization of nanostructures and nanomaterials, with strong focus on the physics of molecules.

Theme 1: Electronic structure of surfaces and quantum objects

- Quantum effects.
- Electron correlations.

Theme 2: Electronic transport through single molecules

- Electron excitations and dynamics.
- Light emission from molecular junctions.

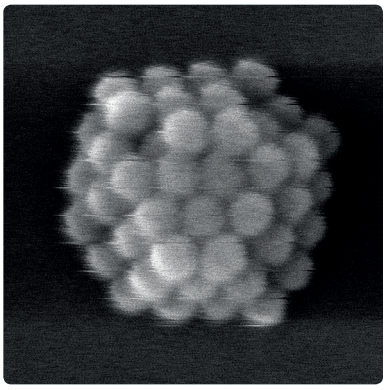
Theme 3: Molecular-based magnetism

- Local phenomenology of magnetic molecules on metal surfaces.
- Molecular radicals and metal-organic nanostructures.

Theme 4: Single-molecule force spectroscopy

- Atomic-forces measurement with sub-nanometer spatial resolution.
- Chemical interactions in the sub meV regime.

NANOENGINEERING



Andreas Seifert
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The nanoengineering group focuses on research at the interface between fundamental nanoscience and applied engineering, particularly in the area of photonic medical diagnostics, environmental issues, and food control. By introducing nanotechnology and photonic approaches, we bridge the gap between physical sciences and industrial as well as clinical applications to finally gain added value for novel biomedical methods, devices, and instrumentation. The acceleration of technology transfer is the driving motor for our research activities.

Theme 1: Early detection of Alzheimer's disease

- Early detection of Alzheimer's disease employing Raman and FTIR (Fourier transform mid-infrared) spectroscopy

Theme 2: Plasmonic detection of biomarkers

- Highly sensitive liquid biopsy based on plasmonic sensing
- Applications for food control and measurement of environmental conditions

Theme 3: Photonic monitoring of physiology

- Methods and devices for continuous non-invasive monitoring of physiological parameters of the human body

Theme 4: Photonic monitoring of vital signs

- Methods and devices for continuous long-term monitoring of vital signs

Theme 5: Plasmonic supercrystals

- Optimization of the fabrication of plasmonic supercrystals to further push the limit of detection in Surface-Enhanced Spectroscopy as SERS and plasmonic methods as SPR or LPR

START-UP COMPANIES

GRAPHENEA

A high-quality graphene producer

www.graphenea.com

SIMUNE

Atomistic simulations

www.simune.com

CTECH-NANO

Innovation with ALD solutions

www.ctechnano.com

EVOLGENE

Enzymes from the past for the future

www.evolgene.com

PROSPERO BIOSCIENCES

New applications within the mass-spectrometry industry

www.prospero-biosciences.com

FACILITIES

The nanoGUNE building includes avant-garde architectural and engineering solutions that guarantee the operational conditions required by nanostructure characterization and fabrication instruments. State-of-the-art equipment is gradually being incorporated as required by the research activities being performed by the research groups.

HOSTING NEW COMPANIES: nanoHabia

As part of our commitment with entrepreneurship, nanoGUNE has opened nanoHabia, a nanoincubator in collaboration with Bic Gipuzkoa Berrilan, an entrepreneurship institution in Gipuzkoa. The idea behind this facility is to host and help nanotechnology-based starting companies to give their first steps to get into the market.

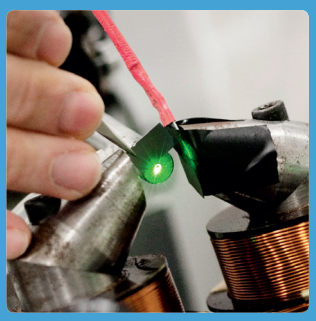
Graphenea, funded jointly by private investors and nanoGUNE, was the first company installed at nanoHabia. Graphenea was created with the mission of producing and commercializing high-quality graphene wafers to be used at laboratories and companies worldwide.

CLEANROOM

With an area of nearly 300 m², and classes ranging from ISO 5 (class100) to ISO 7 (class 10000), the cleanroom is divided in work zones areas related with different techniques in the nanofabrication process: Electron-lithography Room, Photo Bay, Etching Bay, and Deposition Bay. Each of the areas includes the newest equipments and solutions.

- E-beam Lithography.
- Photolithography.
- Reactive and Ion-Beam Etcher.
- E-beam and thermal evaporators. Sputter deposition tools.
- Atomic Layer Deposition.
- Surface and process characterization techniques: ellipsometer, profilometer, SEM, optical microscopy.

MAGNETO-OPTIC CHARACTERIZATION

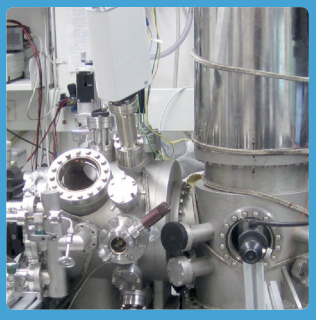


- Magneto-Optical Kerr Effect Magnetometers and Ellipsometers.
- Magneto-Optical Kerr Effect Spectrometer.
- Magneto-Optical Kerr Effect Diffractometer.
- Optical Microscope with Polarization Analysis.

NANOMATERIALS

- Atomic Layer Deposition.
- High-Performance Liquid Chromatographer & Mass Spectrometer.
- Fourier-Transform Infrared Spectrometer.
- Dual-mode UV-Vis Spectrophotometer.

LOW-TEMPERATURE PROBE MICROSCOPY



- Ultra-Low-Temperature (1 K) Ultra-High-Vacuum Scanning Tunneling and Atomic Force Microscope (STM-AFM) with 3 T axial magnetic field.
- Ultra-High-Vacuum STM-AFM with Light Emission Spectroscopy Setup.
- Low-Temperature Atomic-Force and Magnetic-Force Microscope with Confocal Microscopy add-on under 3D strong Magnetic Fields.

SYNTHESIS

- Electrospinning.
- Dynamic Light Scattering.
- Infrared Spectrometer.
- Ellipsometer.

NANOBIOMECHANICS

- Force spectrometry.
- Confocal microscopy.
- Protein engineering.
- Microcalorimetry.
- Cell culture.

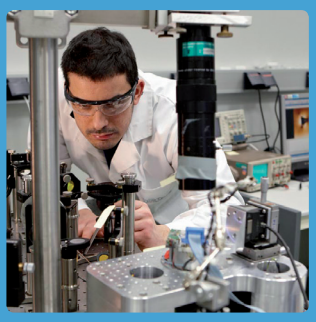
CHARACTERIZATION

- Confocal Laser Microscope.
- Laser Flow Cytometer.
- Magnetic Circular Dichroism Spectrometer.

DEPOSITION

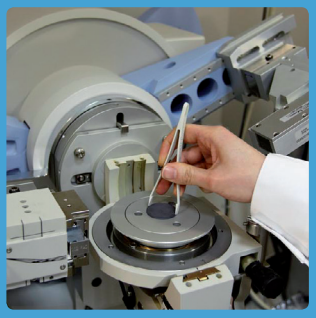
- Ultra-High-Vacuum Sputter Deposition.
- Dual-Chamber Organic/Metallic Ultra-High-Vacuum Evaporator.

NANOOPTICS



- Scattering-type Scanning Near-Field Optical Microscope.
- Supercontinuum, Infra-Red, and THz Lasers.
- Raman Microscope.

PHYSICAL CHARACTERIZATION

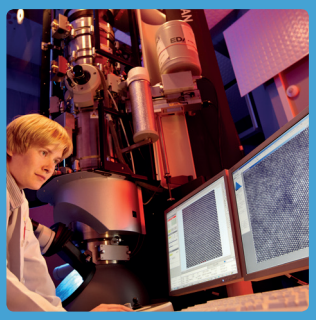


- High-Sensitivity Magnetometer (SQUID).
- Physical Properties Measurement System (PPMS).
- X-Ray Diffractometer.
- Variable-Temperature Probe Station.

MICROSCOPY

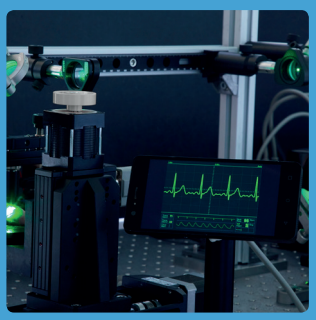
- Atomic-Force Microscopes.
- Magnetic-Force Microscopes.
- Magneto-Optical Kerr Effect Microscope.
- Infrared Microscope.

ELECTRON MICROSCOPY



- Spherical-aberration-corrected high-resolution transmission electron microscope.
- Environmental Scanning Electron Microscope.
- Dual-Beam Focused Ion Beam.
- Sample preparation line.

NANOENGINEERING



- High-power industrial picosecond laser.
- Microscopy platform for materials research.
- UV-NIR spectrometry.
- 3D optical profiler.
- Surface-plasmon-resonance platform.

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PARTNERS

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