E nano newsletter

No. 15

April 2009
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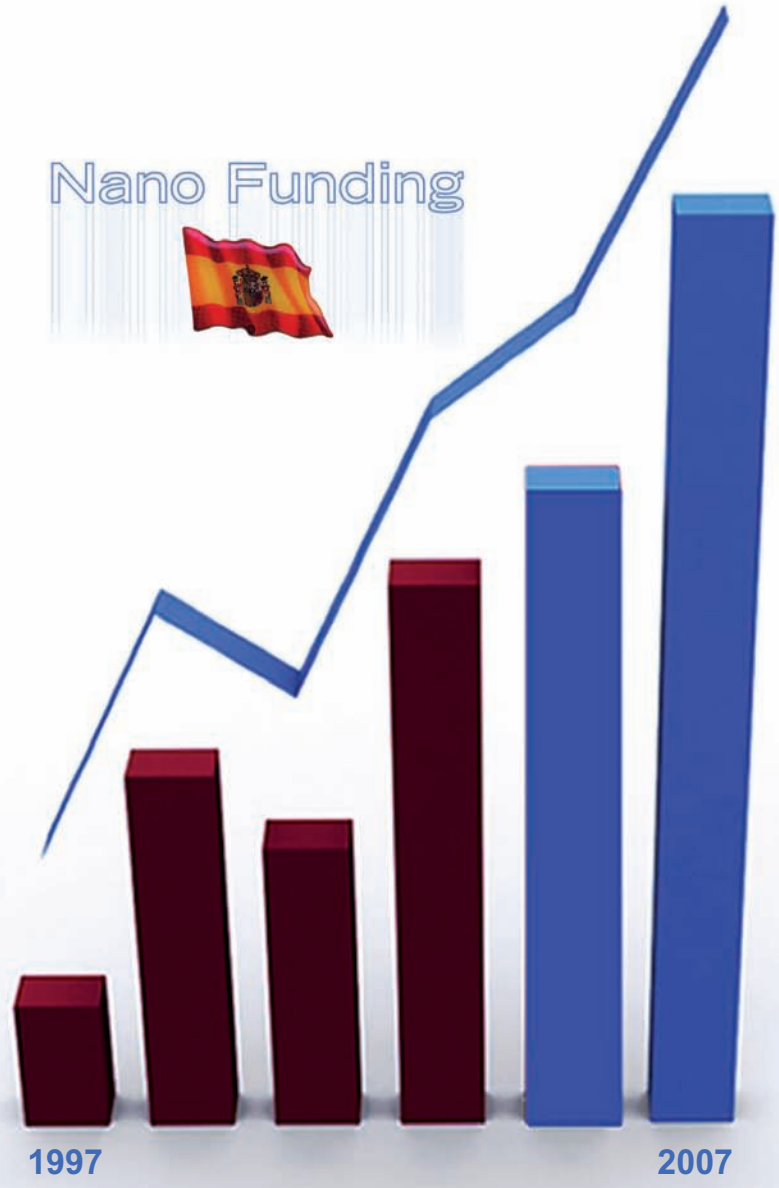
## NANOMAGMA: NANOstructured active MAGneto-plasmonic MAterials

## The implementation of the Action Plan for Nanosciences and Nanotechnologies in Spain (2005-2007)

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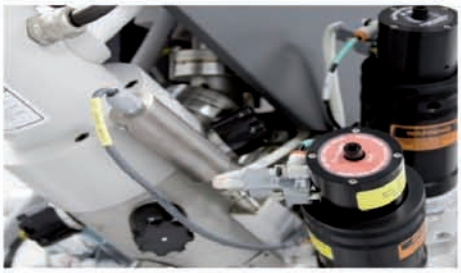
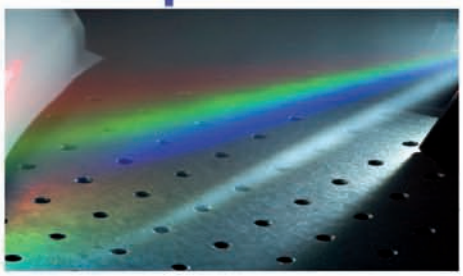
## Nanomagnetism

## Nanodevices



## Nanooptics



## Nanobiotechnology

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# Dear Readers,

In this issue, we publish a review article prepared by Dr. Antonio Garcia-Martin (IMM-CNM-CSIC, Spain) on the current status of "magneto-plasmonics and applications" and a list of the partners involved in the related EU funded Project NANOMAGMA (NANOstructured active MAGneto-plasmonic MAterials), detailing their activities and core competences.
The purpose of this project is the study, development and application of a novel concept of nanostructured materials formed by the combination of components with plasmonic and magneto-optic (MO) activity. This smart combination will produce "magneto-plasmonic" nanomaterials tailored on the nanoscale.

The second article, prepared by Prof. Pedro A. Serena (ICMM-CSIC & Spanish Ministry for Science and Innovation-MICINN, Spain) presents "the implementation of the Action Plan for Nanoscience and Nanotechnology in Spain" (2005-2007). Worldwide governments realized the important role deserved to Nanotechnology and during the last decade budgets allocated to R&D in Nanotechnology have continuously increased. Following this global trend, Spanish scientists and institutions have gone from having a rather conservative attitude to promoting a number of different initiatives aiming at increasing the contribution of Spain to the development of Nanoscience and Nanotechnology. The efforts of Spanish researchers along with the influence of European Union have driven the interest of the Public Administration to this scientific-technological field. Therefore several Ministries launched several activities to promote Nanoscience and Nanotechnology. A summary of these activities and related funding is provided in this newsletter issue.

We invite readers to send us their scientific contributions either as articles, reviews or publication highlights.

We would like to thank all the authors who contributed to this issue as well as the European Commission for the financial support (project NANOMAGMA, Ref: FP7-214107-2).

**Dr. Antonio Correia**
E nano newsletter Editor
Phantoms Foundation

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## EDITORIAL INFORMATION

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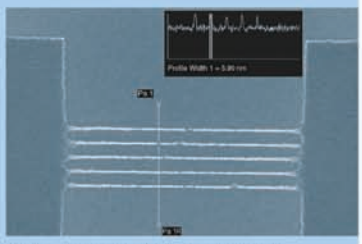

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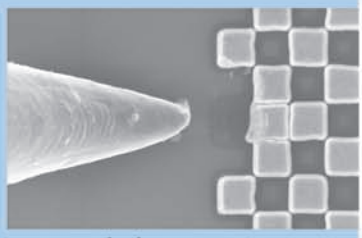

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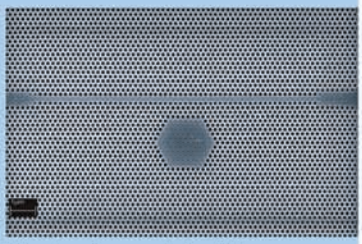

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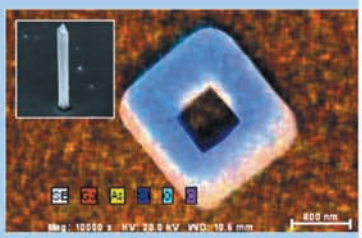

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# NANOMAGMA: NANOstructured active MAGneto-plasmonic MAterials

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## 1.- Introduction

During the last decade nano-optics has develop itself as a very active field within the broader nanotechnology community **[1]**. Much of it has to do with surface plasmon based subwavelength optics and applications **[2]**, based in submicrometric films, that comes from the need to develop optical components in the nanoscale and to overcome the restriction imposed by the diffraction limit. Also, isolated metallic particles supporting localized plasmons have attracted a great deal of interest due to their ability to concentrate the electromagnetic field in subwavelength (some tens of nanometers) volumes. Plasmonics is the name that receive the research activity on the optical properties and correlated properties that these two type of materials exhibit due to surface plasmon excitations.

Plasmonic properties in films are due to the generation of Propagating Surface Plasmon Resonances (PSPR). It has already given rise to some novel devices whose possible applications are on telecommunications **[3]**, fluorescence **[4]**, sensors **[5]**, energy harvesting **[6]**, optical trapping **[7]** or medical therapy **[8]**. Nevertheless, the practical implementation of plasmonic devices is still limited because of coupling/decoupling as well as guiding losses and requires some improvement in their optometric specifications to have a significant impact in telecom applications. Perhaps the most widespread application of this plasmonic effect is not yet in the telecommunication branch but rather in sensing/biosening, the well known Surface Plasmon Resonance sensor (SPRs). This is due to the fact that optical sensing transduction can be an alternative to conventional analytical techniques as they can avoid expensive, complex and time-consuming procedures for detection. With current instruments the detection of mass changes at the sensor surface in the picogram range is possible. Among these optical biosensors those based on SPRs have achieved a limit of detection of 1-5 pg•mm$^{-2}$ of biomolecules adsorbed at the sensor surface **[9]**. These limits of detection are still not enough for the direct detection of low concentration of low weight molecules, as for example some pathogens, the detection of Single Nucleotide Polymorphisms (SNPs) variations in DNA strands, or direct protein-protein detection at femtomolar level. Recently, several SPR configurations have been described to improve these limits of detection as, for example, the phase sensitive SPR based on a Mach-Zehnder configuration **[10]**, the differential ellipsometric SPR **[11]**, the optical heterodyne SPR **[12]** or the SPR based on gold nanoclusters **[13]**.

The basic principle of the SPRs lies in the dependence of the plasmon excitation to the refractive index of the material surrounding the metal and is based on the measurement of the variation of the optical response (in conditions of plasmon excitation) upon adhesion of the target to the sensing layer. The very small width of the plasmon resonance permits that very small changes of the dielectric refractive index induce a noticeable variation of the optical response (see **figure 1**). This has been used to test the sensing properties of thin films composed of shape-controlled colloidal $TiO_2$ nanocrystals deposited on proper Au/glass substrates, for the detection of alcohol vapours by means of the SPR technique **[14]**. The same principle can be exploited for the monitoring of DNA-DNA interactions for biomedical application after chemical linkage of thiol-modified DNA strands on Au films both in a traditional and imaging SPR configuration **[15]**. Au nanoparticles have been used for same purposes: the optical properties of three-dimensional aggregates of Au nanoparticles in solution or deposited onto suitable surfaces have been analyzed to detect hybridization processes of specific DNA sequences as possible alternatives to fluorescent labeling methods **[16]**. Recently, the multiphase process of interaction between a cell lytic agent (melittin) and a lipid membrane has been unveiled and described using SPR approach, with emphasis on the biosensing related capabilities **[17]**.

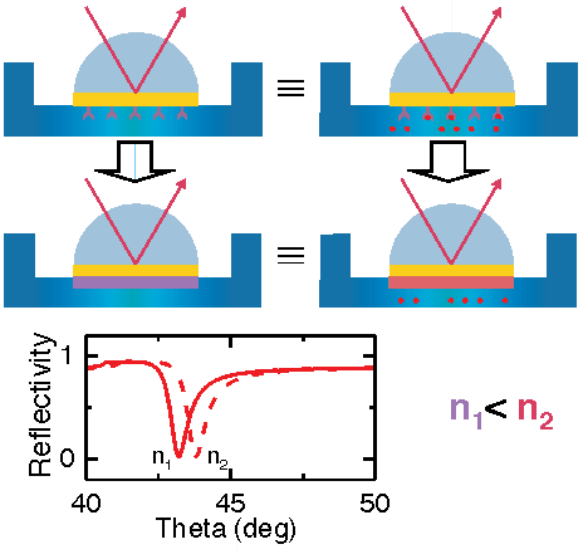
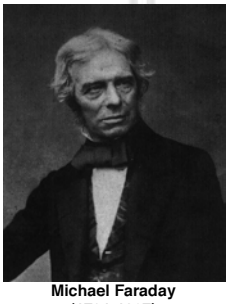


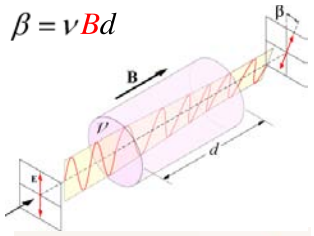

***Figure 1***. *SPR schematic description in the Kretschmann configuration for plasmon excitation. The receptors can be seen as a layer of index $n_1$ that upon recognition changes into $n_2$, causing a shift in the reflectivity curve.*

As another approach, metallic nanostructures (exhibiting Localized Surface Plasmon Resonances, LSPR) are currently being used for chemo/bio sensing **[18]**. Each single nanostructure has a certain advantage. For instance, nano-disks involve localized surface-plasmon excitation, possess well pronounced and narrow absorption/scattering and high field-enhancement factors. Near-field optical studies show that nanoparticle chains made of noble metals are useful for micro-scale photonic devices enabling a directed signal transmission on a subwavelength scale.

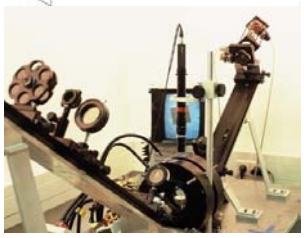


Michael Faraday
(1791-1867)

$$\beta = vBd$$




John Kerr
(1824-1907)



*Michael Faraday and John Kerr with their respective set-ups for measuring the polar MO effect.*

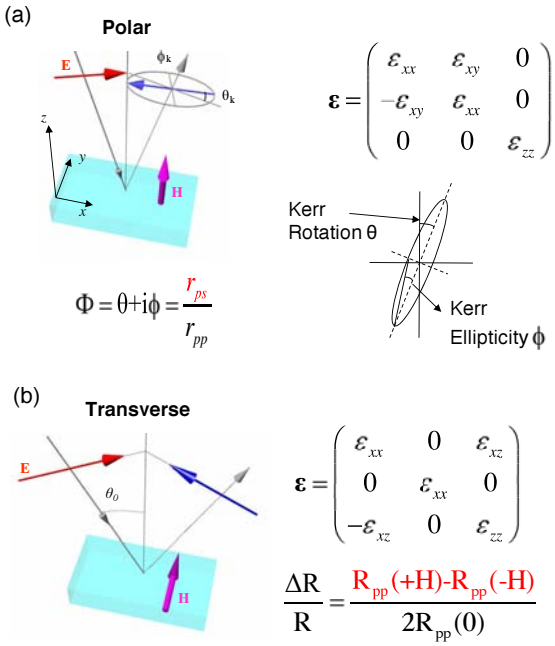
These near-field interaction properties are under current extensive investigation for different nanometric structures and their arrangements, and they play an important role in the efficiency of a real sensor operation.

In order to find new applications other than purely optical interconnections, as well as to increase the performance of the SPRs, it is necessary to add active functionalities to these SP-based devices, an area known as active plasmonics. The development of active plasmonics requires the use of materials or strategies in which the surface plasmon properties can be controlled by an external agent. To date, the feasibility of realization of active plasmonic devices, although still with limited applications, has been demonstrated by considering different control agents: temperature **[19, 20]**, electric field **[21]**, electromagnetic waves **[22, 23]** or magnetic fields **[24, 25]**.

Our approach is based in the choice of magneto-optically, MO, active materials that besides having already proven great capabilities in modifying the propagation of surface plasmon waves it has been shown to experiment an enhancement of their MO response upon plasmon excitation in surface plasmonic crystals **[26]**. The resulting system will have thus a magnetic-field to control the properties of the plasmon (via the MO effect) and simultaneously the excitation of the plasmon, either propagating or localized, alters the magneto-optical response due to the localization of the electromagnetic field in the vicinity of the metallic entity.

The magneto-optical effect was discovered in the year 1845 by Michael Faraday when he discovered that the polarization plane of a beam of light was modified after going through a dielectric in the presence of a magnetic field applied in the same direction of the beam, and perpendicular to the sample plane. Some thirty years after, John Kerr discovered the same effect but when the light was reflected now from a plate of an electromagnet made of a ferromagnetic material. The effect, however, depends on the orientation of the magnetic field respective to the sample plane and the incidence plane.

Two MO effects will be considered in this work, both in reflection configuration. In the polar Kerr configuration the magnetization is perpendicular to the surface of the sample (**figure 2(a)**), and the variation of the polarization state (rotation, $\theta$ and ellipticity, $\phi$) when a linearly polarized light beam at normal incidence is reflected is measured. In this configuration one is sensitive to the "sample-plane" (xy) elements of the dielectric tensor. The complex Kerr rotation ($\Phi = \theta + i\phi$) equals $r_{ps}/r_{pp}$, where $r_{ps}$ reflects the polarization conversion upon reflection induced by the MO properties and $r_{pp}$ is the "purely" optical complex reflection. In the other configuration, the transverse Kerr effect (**figure 2(b)**), the sample magnetization lies in the sample plane and perpendicular to the plane of incidence of the light, and the relevant magnitude is the change in reflectivity of p-polarized light when the magnetization is reversed, $\Delta$ R/R. In this case, the measurement is sensitive to the "incidence-plane" (xz) elements of the dielectric tensor.




$$\varepsilon = \begin{pmatrix} \varepsilon_{xx} & \varepsilon_{xy} & 0 \\ -\varepsilon_{xy} & \varepsilon_{xx} & 0 \\ 0 & 0 & \varepsilon_{zz} \end{pmatrix}$$

$$\Phi = \theta + i\phi = \frac{r_{ps}}{r_{pp}}$$

$$\varepsilon = \begin{pmatrix} \varepsilon_{xx} & 0 & \varepsilon_{xz} \\ 0 & \varepsilon_{xx} & 0 \\ -\varepsilon_{xz} & 0 & \varepsilon_{zz} \end{pmatrix}$$

$$\frac{\Delta R}{R} = \frac{R_{pp}(+H) - R_{pp}(-H)}{2R_{pp}(0)}$$

***Figure 2.*** *Scheme of the geometry and the relevant magnitudes for the two magneto-optical effects considered in this work: (a) polar Kerr configuration; (b) transverse Kerr configuration.*

## 2.- Novel concept

The application of the idea of the magneto-plasmonic effect would be immediate using a ferromagnetic metal, since due to the ferromagnetic character it would be MO active whereas due to the metallic character it would present a plasmon excitation. This has been performed in ferromagnetic wires **[26]**, namely an ordered array of nickel wires, where it has been shown that the excitation

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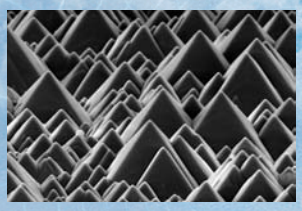
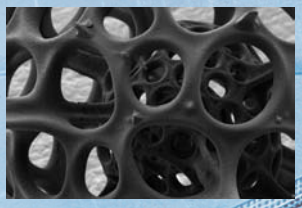
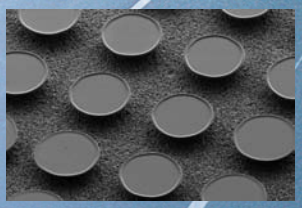
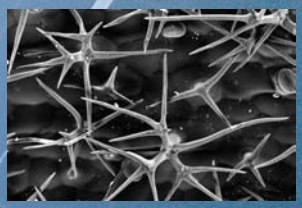




*By courtesy of AMD*





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of a plasmon running along the wire gives rise to an enhancement of the magneto-optical response. Nevertheless, the spectral extension where the enhancement takes place limits its use in some applications, it would be desirable to be as close as possible to the spectral behavior of noble metals.

While noble metals have no magneto-optical activity and ferromagnetic materials suffer from strong plasmon damping, metallic heterostructures made of noble metals and ferromagnetic materials may sustain surface plasmons and have at the same time magneto-optical activity. The nanoscale here is crucial since the base is the interaction between the magneto-optically active material and the electromagnetic field of the plasmon, whose extension is precisely on the nm scale. The ferromagnetic material broadens the plasmon resonance of the structure, but it introduces a magneto-optical activity in the system, absent in pure noble metal layers. This way, to the control of light transmission and guiding with subwavelength elements and sensing applications that plasmonic materials make possible, we propose that in magneto-plasmonic materials the action of an external magnetic field will allow controlling externally these guiding properties and enhancing the sensitivity of plasmonic sensors by magnetic field modulation enabled by the MO activity endorsed by the ferromagnetic counterpart. The novel magneto-plasmonic materials offer the unique ability to control their properties in more than one way, since the magneto-optical activity will be affected by the alteration of the plasmonic characteristics and the optical response will depend on the magnetic ones. Therefore, they will be applicable in a broad spectrum of research and industrial areas. In particular, we believe that they could become key elements in future tunable nano-optical devices and in biosensors with enhanced sensitivity. The latter puts an additional advantage over conventional materials, since the optical response can be actively tuned by means of a magnetic field, having already used in the form of continuous layers to develop new high sensitivity biosensors **[27]** (see **figure 3 page 9**).

### 3.- Nanomagma's mission

As we have already mentioned, it has been put forward that structures exhibiting LSPR may possess a mayor advantage with respect to continuous structures: the strong localization of the electromagnetic field associated to these resonances which leads to a higher sensitivity and might lead to a noticeable enhancement in the MO properties **[28]**. This fact could be exploited to make such a system become a promising candidate for the development of high spatial specificity magneto-plasmonic sensing devices the materials will have a niche for enhanced and innovative applications (in the areas of photonics and sensors).

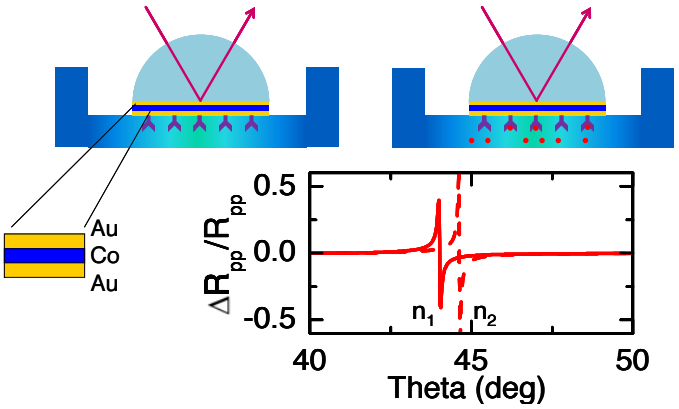


***Figure 3.*** *Transverse MO Kerr effect curve before and after a recognition process. The higher sensitivity comes from the higher slope when compared with conventional sensors.*

Therefore we will design novel active (thus "smart") materials tailored in the nanoscale, in particular we will develop two kind of systems: one in which the propagating plasmons are present (i.e. continuous material with corrugations or topographical features of nanometer dimensions), the other magneto-plasmonic nanoparticles (i.e. isolated nanostructures that will exhibit localized plasmons) in different geometries using different means to obtain them, either physical or chemical or a combination of both.
The interplay between the plasmon excitation and the magneto-optical effect takes place necessarily in the near field, due to the evanescent nature of the plasmon, and thus the magneto-plasmonic response (so then the performance of any device based on it) might be very sensitive to features in the nanoscale. Therefore it is very important to carry out a comprehensive characterization, covering structural, magnetic and magneto-plasmonic both in the near and far fields to be able to deeply understand the far-to-near field correlations. In this context, near-field optical experiments will be performed on the samples with or without an external magnetic field **[29]**, and will be correlated to theoretical and numerical modelling **[30]**. In view of the design of efficient biosensors, the possibility of controlling and enhancing the signal of individual fluorophores by magneto-plasmonic structures will be examined, since the dynamics of the fluorophores is strongly dependent on the coupling with surface plasmons **[31]**.

All this will be supported with state-of-the art numerical simulations able to face the complex optical phenomena taking place at the nanoscale involving metals and resonances, and simultaneously capable of taking into account the complexity introduced by the magneto-optical effect **[32, 33]**.

In the end one of the main goals is to deeply understand the interactions of the magnetic properties with the plasmonic and optical ones, linked to electric charge oscilla-

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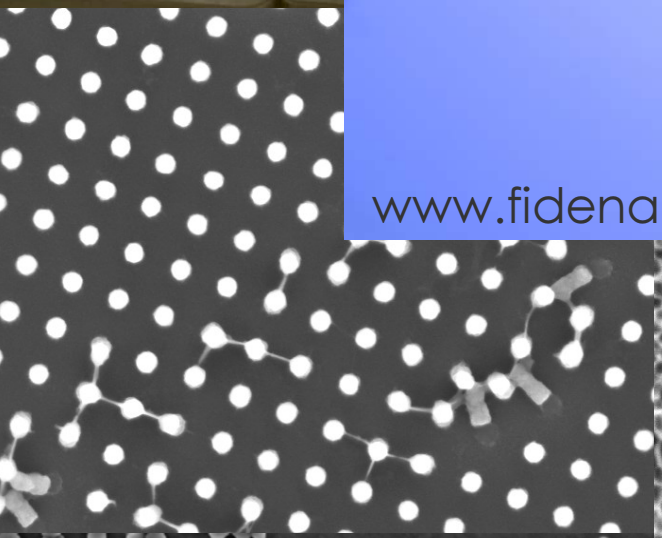

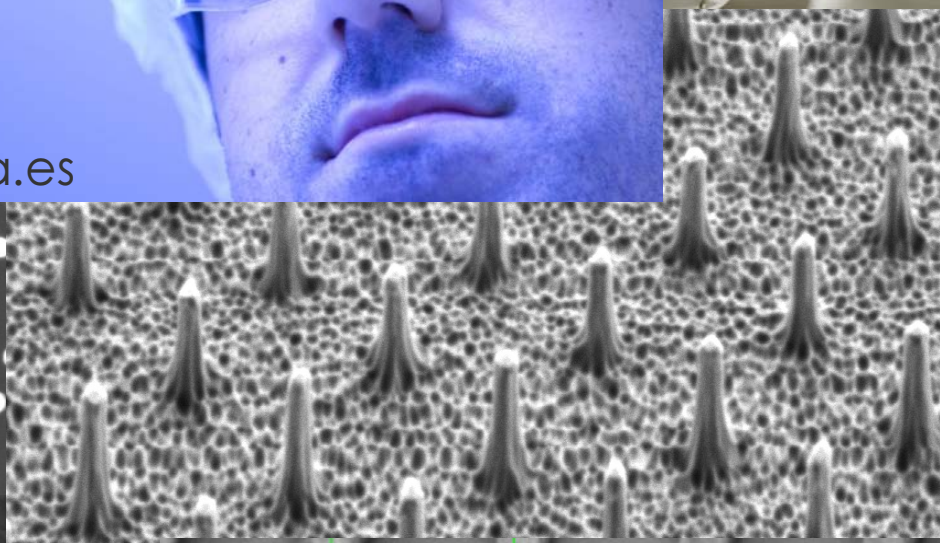

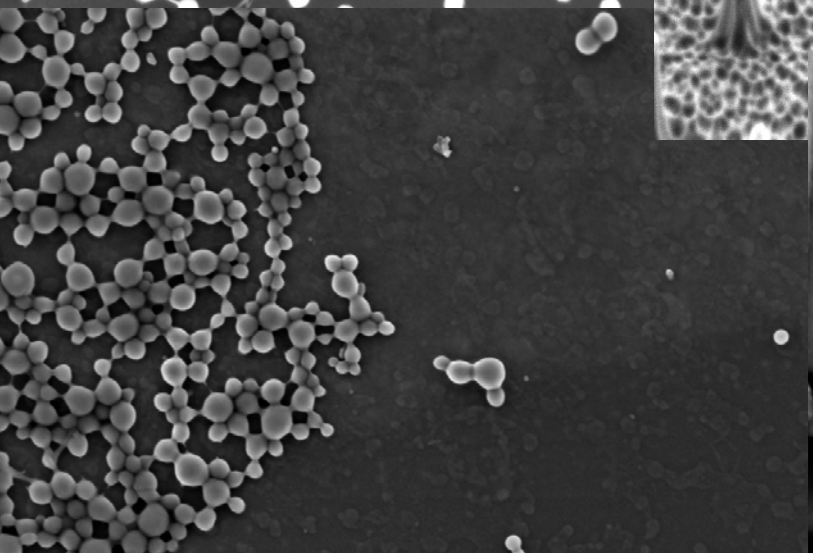

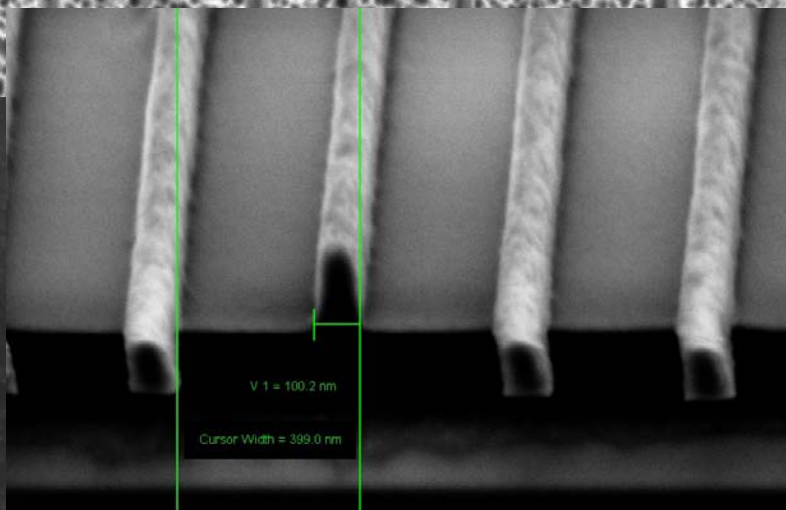

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tions. But we will also propose devices for applications that can benefit of such coupling. We will focus on the gas and bio-sensing applications where the nanostructuration and the benefits of the MO elements will be of primal importance. Additionally we will perform prospective tasks for silicon-oriented uses. This part includes the identification of relevant applications of magneto-plasmonic materials for microelectronics and information technology. Depending on the materials properties several application routes will be proposed in either opto-electronic, spintronic, or spin-photonic domains.
In short, the S&T objectives can be regarded as four, in which we will consider both bottom-up and top-down approaches to obtain the desired magneto-plasmonic materials:

(a) Development of nanomaterials that combine plasmons and magnetic properties (films, nanoparticles, core-shell and other heterostructures).
(b) Investigate the correlation between the optical, magnetic, magneto-optical and magneto-plasmonic properties.
(c) Carry out theoretical calculations of the optical response considering the magneto-optical contribution.
(d) Perform proof of concepts based in the magneto-plasmonic activity and testing for specific applications in the field of chemical sensors and biosensors. Identification of applications for microelectronics and information technology.

To that end, we have gathered a multidisciplinary consortium of ten members from five EU countries, involving two Universities, six research institutions, one SME and one foundation.

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## NANOMAGMA: Info and Partners

NANOstructured active MAGneto-plasmonic MAterials (nanomagma) is one of the new EU Projects funded within the NMP programme (**http://cordis.europa.eu/nmp/**). Below are detailed a list of the partners involved.

**Short facts:**
**EC contribution:** 2.963.156 Euros
**Contract number:** FP7-214107-2
**No. of partners:** 10
**Coordinator:** IMM / CSIC (Spain) / Antonio Garcia-Martin
**Start date:** November 01, 2008
**Duration:** 36 months
**WEB site:** **http://www.nanomagma.org**

**P1.** Consejo Superior de Investigaciones Científicas (CSIC) - Spain (coordinator)
**P2.** Universidad Autónoma de Madrid (UAM) - Spain
**P3.** Centre National de la Recherche Scientifique (CNRS) - France
**P4.** Consorzio Interuniversitario Nazionale per la Scienza e Tecnologia dei Materiali (INSTM) - Italy
**P5.** Consiglio Nazionale delle Ricerche (CNR) - Italy
**P6.** International Centre of Biodynamics (ICB) - Romania
**P7.** University of Hamburg (UH) - Germany
**P8.** Biotecgen srl (BTG) - Italy

**P9.** Commissariat à l'Energie Atomique (CEA) - France
**P10.** Phantoms Foundation (PH) - Spain

**P1**
**Research group / Company:**
Instituto de Microelectrónica de Madrid - Consejo Superior de Investigaciones Científicas
**Contact Person & E-mail:**
Antonio Garcia-Martin (**antonio@imm.cnm.csic.es**)
**Nano Activities:**
Magnetic Nanostructures, Magneto-optics, plasmonics and Magneto-plasmonics, nanophotonics
**nanoMagma Activities**
Materials development, nano-lithography, optical and magneto-optical spectrometry (experiment and theory), plasmonics
**Core Competences:**
Coordination, magneto-plasmonic structures tailored in the nanoscale (modelling and fabrication), plasmonic and magneto-optical charaterization, electromagnetic modelling
**Equipment:**
Physical vapour deposition techniques (Magnetron UHV sputtering), UV and high resolution electron beam lithography + etching facilities, Workstations, Philips MRD X-ray diffractometer, SEM (Hitachi S-800, LEO 1455) and AFM and MFM (Nanotec), Polar and Transverse Kerr loopers, Magneto Optical Torque set-up for anisotropy characterization Polar Kerr looper and spectrometer. Magnetic field up to 1.6T, Transverse Kerr looper (Magnetic field up to 1.5T) and spectrometer, Magnetoplasmon characterization using Kretschmann configuration, Spectral Ellipsometer (Woollam M-2000FI), SNOM (Nanonics 4000)
**WEB site:**
**http://www.imm-cnm.csic.es/magnetoplasmonics**

**P2**
**Research group / Company:**
MOLE Group, Universidad Autónoma de Madrid
**Contact Person & E-mail:**
Juan José Sáenz (**juanjo.saenz@uam.es**)
**Nano Activities:**
(Theory and Modelling) optical forces, optics of random media, fluorescence, scanning force microscopy
**nanoMagma Activities:**
(Theory and Modelling) magneto-optical nanoparticles, active gratings, near-field optics, single-molecule fluorescence
**Core Competences:**
Theory and Modelling of light scattering from nanostructured magneto-optical devices
**Equipment:** Workstations
**WEB site:**
**http://www.uam.es/gruposinv/MoLE/**

**P3**
**Research group / Company:**
CNRS - ESPCI ParisTech
**Contact Person & E-mail:**
Remi Carminati (**remi.carminati@espci.fr**)
**Nano Activities:**
Near-field optics, plasmonics, scanning near-field optical microscopy, fluorescence, nanoscale heat transfer, optics of random media
**nanoMagma Activities:**
Near-field optics (experiment and theory), plasmonics, single-molecule fluorescence
**Core Competences:**
Scanning probe micoscopy, electromagnetic Modelling
**Equipment:**
SNOM, AFM, SEM, Workstations
**WEB site:**
**http://www.lpem.espci.fr**
**http://www.institut-langevin.espci.fr**

**P4**
**Research group / Company:**
Consorzio Interuniversitario Nazionale per la Scienza e Technologia dei Materiali. Research Unit of Florence
**Contact Person & E-mail:**
Andrea Caneschi (**andrea.caneschi@unifi.it**)
**Nano Activities:**
Synthesis, nanostructural, magnetic and magneto-optical studies
**nanoMagma Activities:**
Synthesis of nanoparticles with different nanostructures. Nanostructural, optical, magnetic, magneto-optic and magnetoplasmonic characterizations
**Core Competences:**
Synthesis of magnetic nanoparticles, noble metal nanoparticles and nanoheterostructures. Magnetic, photomagnetic and magneto-optical studies. Research on the dynamic and reversal process of nanostructures.
Nanostructural and morphological characterizations of nanostructures
**Equipment:**
Laboratory of synthesis, (2) SQUID and vibration sample magnetometers, susceptometers, Low and room temperature magneto-optical set-ups, Atomic Force and Scanning Tunneling microscopes, X-ray diffractometers, X and W band ferromagnetic resonance devices
**WEB site:**
**http://www.instm.it**

**P5**
**Research group / Company:**
Istituto per la MIcroelettronica e Microsistemi (National research Council) – IMM CNR unit of Lecce
**Contact Person & E-mail:**
Roberto Rella (**roberto.rella@le.imm.cnr.it**)
**Nano Activities:**
Chemical sensors and biosensors devices
**nanoMagma Activities:**
Optical trasdaction tests in controlled atmosphere for chemical sensors and biosensors tests in liquid phase
**Core Competences:**
Realisation of solid state gas sensing and biosensing devices and analysis of the sensing performance by using optical and electrical transduction methodology
**Equipment:**
Laboratory test benches for optical and electrical calibra-

tion of gas sensors and biosensors in controlled environmental, clean room facilities for devices realisation, morphological and structural characterization of the sensing and biosensing layers
**WEB site:**
**http://www.imm.cnr.it**

**P6**
**Research group / Company:**
International Centre of Biodynamics
**Contact Person & E-mail:**
Eugen Gheorghiu (**egheorghiu@biodyn.ro**)
**Nano Activities:**
Thin film deposition of metals (PVD) and polymers (spin coating)
**NanoMagma Activities:**
Development of biosensing assays using combined SMPR and impedance assays with integrated Flow Injection Analysis, FIA
**Core Competences:**
• development and characterization of sensing platforms (bio-affinity and cellular sensors)
• non-invasive analysis (measurement techniques and related instrumentation) using combined:
  • optical: SPR, TIRFM
  • electrochemical assays (including electrical impedance spectroscopy, EIS)
• modelling:
  • impedance/dielectric behavior of biointerfaces and (interconnected)cells/particles with (non)spheroidal shapes
  • kinetic equations related to affinity processes and the related contribution to SPR or EIS data
• data analysis
**Equipment:**
Biacore 3000, impedance analyzers: Agilent 4294a and Solartron 1260, as well as home made devices, PVD 75, TIRFM on Zeiss AxioObserver Z1 with Andor camera
**WEB site:**
**http://www.biodyn.ro**

**P7**
**Research group / Company:**
University of Hamburg, Institute of Applied Physics
**Contact Person & E-mail:**
Kornelius Nielsch (**knielsch@physnet.uni-hamburg.de**) & Josep Montero (**montero@ub.edu**)
**Nano Activities:**
Magnetic Nanostructures and Thermoelectric Materials
**nanoMagma Activities:**
Development of large-scale periodic arrays of magneto-plasmonic objects
**Core Competences:**
Interference Lithography, Al2O3-Membranes, Atomic Layer Deposition, Magnetic Characterisation
**Equipment:**
2 Laser interference setup, 4 ALD reactors, 2 SQUID-Magnetometer and Nano-MOKE, Setup for Ferromagnetic Resonance Measurements
**WEB site:**
**http://www.physnet.uni-hamburg.de/institute/IAP/Group_K/multifunctional_nanostructures.htm**

**P8**
**Research group / Company:**
Biotecgen srl
**Contact Person & E-mail:**
Maurizio Chiesa (**m.chiesa@biotecgen.it**)
**Nanomagma activities:**
Development of surface chemistry for biomolecules immobilisation to be applied in the development of biosensors using the new SMPR biosensing material
**Core competences:**
Extended experience both in research and product development, especially regarding laser scanner and fluorescent probes-based technologies, oligonucleotide custom arrays with selected sub-set of genes and analysis of post-translational modifications (phosphorylation, nitrosylation, poly-(ADP ribosylation)
**WEB site:**
**http://www.biotecgen.it/default.aspx**

**P9**
**Research group / Company:**
CEA-LETI
**Contact Person & E-mail:**
Ségolène Olivier (**segolene.olivier@cea.fr**)
**Nano Activities:**
Photonics and plasmonics (design and nanofabrication in clean room), optical data storage (design, fabrication and characterization)
**nanoMagma Activities:**
Electromagnetic simulations, definition of process flows for integrated devices
**Core Competences:**
Electromagnetic simulations, photonics, data storage
**Equipment:** simulation softwares, clean room facilities for 200 nm wafers, optical characterization set-ups
**WEB site:**
**http://www-leti.cea.fr**

**P10**
**Research group / Company:**
Phantoms Foundation
**Contact Person & E-mail:**
Antonio Correia (**antonio@phantomsnet.net**)
**Core Competences:**
Nanotechnology Team with high experience and skills in project management and scientific conference organisation
**nanoMagma Activities:**
Project management and scientific results dissemination
**WEB site:**
**http://www.phantomsnet.net**

# Advertisement

**ADVERTISING RATES**

E nano newsletter

**Don't miss the opportunity to advertise in E-NANO Newsletter!**

Launched in 2005, E-NANO Newsletter is published four times a year and distributed among 1500 research labs in Europe. This newsletter brings readers the latest news, research articles and resources from the Nanotechnology world.

**Option 1**: Featured Company
**Option 2**: Featured Company Plus
**Option 3**: Highlighted Company
**Option 4**: Company banner (WEB site)
**Option 5**: E-Nano Newsletter - 1 page advert
**Option 6**: E-Nano Newsletter - 1/2 page advert
**Option 7:** E-Nano Newsletter - 1/4 page advert

**Option 1:** Featured Company
Your Company Logo Banner on the PHANTOMS Foundation homepage website during one year: 1000 Euros. This option also includes:
A quarter web page description of the company (products, contact details, news, pressreleases, etc.): **http://www.phantomsnet.net/Foundation/advertising.php?project=1**
A half page (horizontal or vertical) full colour advert in four printed issues of the E-Nano Newsletter.
6 advertisements in the phantoms Foundation mailing lists (around 4000 subscribers worldwide) during one year (every 2 months).

**Option 2:** Featured Company Plus
This option is similar to option 1 but includes 4 one page full colour adverts in the E-Nano Newsletter (4 printed issues): 1500 Euros.

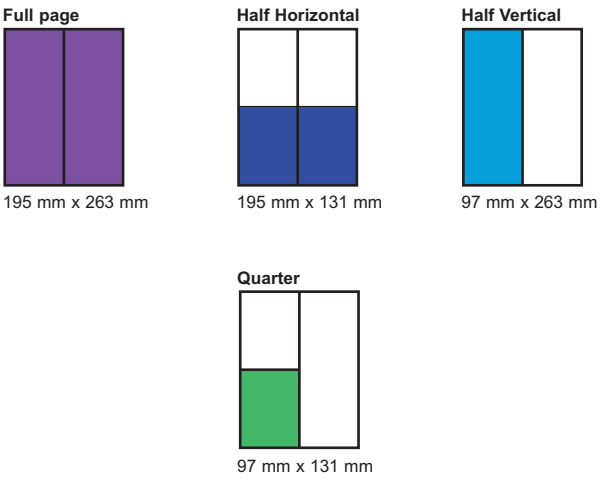
**Option 3:** Highlighted Company
This option completes options 1 & 2 with a spotlight banner of your company on the PHANTOMS Foundation homepage website and one related advertising section (Newsletters, conferences, etc.) during three months: + 250 Euros.

**Option 4:** Company banner (WEB site)
Your Company Logo Banner on the PHANTOMS Foundation homepage website during one year: 600 Euros.
This option includes a quarter web page description of the company (products, contact details, news, press releases, etc.).

**Option 5:** E-Nano Newsletter - 1 page advert full colour*
Your Company advert in the E-Nano Newsletter:
1 page ad / 4 issues: 700 Euros
1 page ad / 2 issues: 500 Euros
1 page ad / 1 issue: 400 Euros

**Option 6:** E-Nano Newsletter - 1/2 page advert full colour*
Your Company advert in the E-Nano Newsletter:
1/2 page ad / 4 issues: 600 Euros
1/2 page ad / 2 issues: 400 Euros
1/2 page ad / 1 issue: 300 Euros

**Option 7**: E-Nano Newsletter - 1/4 page advert full colour*
Your Company advert in the E-Nano Newsletter:
1/4 page ad / 4 issues: 500 Euros
1/4 page ad / 2 issues: 300 Euros
1/4 page ad / 1 issue: 200 Euros




*Adverts in Black and White: 15% discount

**More information**
·Adverts in Black and White: 15% discount
·Specified positions (including inside front page, inside back cover and back page), please add 15% to the advertisement rates.
·Ads must be supplied by advertisers.
·Rates do not include VAT (16%).
For more details on advertising, please contact us by E-mail (**antonio@phantomsnet.net**) or fax (+34 91 4973471)


Phantoms Foundation
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28049 Madrid, Spain
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**Current E-NANO Newsletter Ads**

## NANO Conferences http://www.phantomsnet.net/Resources/cc.php

**(June 2009)**

**ICMAT2009 (Symposium G-Plasmonics and Applications).**
June 28-July 03, 2009. (Singapore)
http://www.mrs.org.sg/icmat2009/symposia/sym-g/default.htm
*NanoPhotonics & Nano-Optoelectronics, Plasmonics*

**Piezoresponse Force Microscopy and Nanoscale Phenomena in Polar Materials.**
June 23-27, 2009. Aveiro (Portugal)
http://pfm4.web.ua.pt/
*NEMS & MEMS, Nanotechnologies*

**4th International Conference on Surface Plasmon Photonics (SPP4).**
June 21-26, 2009. Amsterdam (The Netherlands)
http://www.spp4.org/
*NanoPhotonics & Nano-Optoelectronics, Plasmonics*

**Nanophotonics Down Under 2009.**
June 21-24, 2009. Melbourne Convention Center, Melbourne (Australia)
http://www.smonp2009.com/
*NanoPhotonics & Nano-Optoelectronics, Plasmonics*

**XI International Scanning Probe Microscopy Conference.**
June 17-19, 2009. Madrid (Spain)
http://www.imm.cnm.csic.es/spm/ispm/scope.html
*SPM*

## NANO Conferences http://www.phantomsnet.net/Resources/cc.php

**XXIV Congress of the Spanish Microscopy Society.**
June 16-18, 2009. Segovia (Spain)
**http://biocomp.cnb.csic.es/iberm2009/index.html**
*Nanotechnologies, SPM*

**NanoBio-Europe 2009.**
June 16-18, 2009. Grenoble (France)
**http://www.nanobio-europe.com/**
*NanoBiotechnology, NanoMedicine*

**NanoMaterials 2009.**
June 16-18, 2009. Maritim Bonn Hotel - Bonn (Germany)
**http://www.cemmnt.co.uk/events.php/cemmnt-event:-nanomaterials-2009**
*NanoMaterials*

**20th International Conference on Noise and Fluctuations (ICNF 2009).**
June 14-19, 2009. Pisa (Italy)
**http://www.icnf2009.org/**
*Theory & Modeling*

**Nanomedicine 2009 - 2nd European Summer School in Nanomedicine.**
12-16 June, 2009. Lisbon (Portugal)
**http://www.ff.ul.pt/nanoschool2009/**
*NanoMedicine*

**EMC Europe 2009: materials in EMC applications.**
June 11-12, 2009. Athens (Greece)
**http://emceurope2009.iccs.gr/**
*NanoMaterials, Theory & Modeling, Nanotechnologies*

**28th annual international courses in nano, semiconductor, and device technology.**
June 8-12, 2009. Cambridge (United Kingdom)
**http://www.cei.se/**
*NEMS & MEMS, NanoLithography, Nanotechnologies*

**S2K 2009.**
June 3-4, 2009. City Hall, Cardiff (Wales)
**http://www.cemmnt.co.uk/events.php/cemmnt-event:-s2k-2009**
*Nanoelectronics, Nanotechnologies*

**EuroNanoForum 2009.**
2-5 June, 2009. Prague (Czech Republic)
**http://www.euronanoforum2009.eu/**
*Nanotechnologies*

### (July 2009)

**9th IEEE Conference on Nanotechnology (Nano2009).**
July 26-30, 2009. Genova (Italy)
**http://www.medinfo.dist.unige.it/ieeenano2009/**
*Molecular Electronics, NanoTubes, NanoFabrication*

**International Workshop on Nanomagnetism and Superconductivity.**
July 05-09, 2009. Coma-Ruga, Tarragona (Spain)
**http://www.ub.edu/gmag/comaruga/**
*NanoMagnetism*

## NANO Vacancies - http://www.phantomsnet.net/Resources/jobs.php

**PhD Position (Institut Curie, France):** *"High speed atomic force microscopy (HS-AFM) of membrane proteins"*

Our team based at the 'Institut Curie' with a high expertise in the field of high-resolution AFM imaging of membrane proteins is now looking for motivated PhD students candidates which want contribute to our HSAFM projects. Candidates with physics, nano-science and bio-physics background would fit best the profile.
**The deadline for submitting applications is June 06, 2009**

For further information about the position, please contact: Simon Scheuring (**simon.scheuring@curie.fr**)

**PhD Studentship (University of Strathclyde, United Kingdom):** *"Hydrogen storage in nanoporous materials"*

Hydrogen powered fuel cells are a solution to polluting internal combustion engines, but hydrogen is notoriously difficult to store onboard vehicles. Molecular theory and simulation, including density functional theory and Monte-Carlo simulation techniques that take account of quantum fluctuations, will be used to design optimal nanoporous adsorbents for the storage of hydrogen over a wide range of conditions. (Supervisors: Dr Sweatman and Dr Fletcher).
**The deadline for submitting applications is June 07, 2009**

For further information about the position, please contact: Dr. Martin Sweatman (**martin.sweatman@strath.ac.uk**)

**PhD Studentship (University of Strathclyde, United Kingdom):** *"Flame synthesis of nanoparticles"*

There are serious concerns about the impact of combustion generated nanoparticles on human health. This project will investigate nanoparticle formation in flames, by performing advanced laser diagnostic techniques including laser induced fluorescence and cavity ring down spectroscopy, with a view to understanding particulate production processes and thereby reducing particulate emissions. The project involves collaboration with partners at the Universities of Cambridge and Lille. Supervisors: Dr Burns and Dr Norden (Chemistry).
**The deadline for submitting applications is June 07, 2009**

For further information about the position, please contact: Dr. Martin Sweatman (**martin.sweatman@strath.ac.uk**)

**Marie Curie Researcher (Tyndall National Institute, Ireland):** *"Integration of Plasmonic Structures with VCSELs and LEDs"*

Tyndall National Institute invites applications for the position of Process Engineer to develop nano-composite materials for the next generation SiC high temperature devices. High temperature resistant lead-free solders or metal alloys will be considered for either flip-chip interconnections or thermal interfacing.
**The deadline for submitting applications is June 07, 2009**

For further information about the position, please contact: Brian Corbett (**brian.corbett@tyndall.ie**)

**PhD Position (Tyndall National Institute, Ireland):** *"Development and Optimisation of Novel on-chip Nanowire-based Electrodes for Electrochemical-bas"*

The nanotechnology group at Tyndall National Institute focuses on development of methods for synthesis, fabrication, assembly and (opto-) electrical interfacing of nanoscale materials, structures and devices in order to exploit their unique properties within emerging ICT application areas. Tremendous potential for development of new technologies exists through convergence of traditionally disparate disciplines at the nanoscale, e.g., chemical, physical and life sciences and also microelectronic engineering. Special emphasis is placed within the group on development of novel interdisci plinary methods for materials processing, device fabrication and integration. The research is supported by a suite of equipment and laboratory facilities within the group that are amongst the best in Europe.
**The deadline for submitting applications is June 20, 2009**

For further information about the position, please contact: Alan O'Riordan (**alan.oriordan@tyndall.ie**)

**Research Group Leader positions - SENIOR & JUNIOR LEVEL (Principal Investigator Senior level, All) (INL, Portugal)**: *"Nanomedecine - Nanotechnology applied to food industry, food safety and environment control - Nanomanipulation and Nanoelectronics"*

INL is recruiting in the following research areas:

## NANO Vacancies - http://www.phantomsnet.net/Resources/jobs.php

- Nanomedecine: drug delivery systems, molecular diagnosis systems, cell therapy and tissue engineering.
- Nanotechnology applied to food industry, food safety and environment control.
- Nanomanipulation: molecular devices, using biomolecules as building blocks for nanodevices.
- Nanoelectronics: Nanofluidics, CNTs, molecular electronics, spintronics, nanophotonics, NEMS, and other nanotechnologies used to build nanodevices and system platforms to support the previous research topics.

**The deadline for submitting applications is June 27, 2009**

More information: **http://www.iinlrecruitment.com/work-employment-opening.php?id=21**

**PhD studentship (University of Quebec, Canada):** *"Synthesis and characterization of novel nanoparticle catalysts"*

Applications are invited for a PhD position at Institut national de la recherche Scientifique (INRS), University of Quebec, Canada on the synthesis of nanoparticles and their applications in catalysis. The student will be under the supervision of Prof. Dongling Ma (Nanomaterials chemist) and Prof. Federico Rosei (Canada Research Chair in Nanostructured Materials) . The successful candidate should have experience in the synthesis of nanoparticles in solution using a wet chemistry approach. The candidate should have a Bachelor/Master degree in Chemistry. Good English is required.The successful candidate should be highly motivated. The abilities to work in a team setting with PDFs on the similar projects as well as to work independently are important. Please send your CV (including the names and contact information of two referees) to Dongling Ma (ma@emt.inrs.ca). We thank all those who apply. Only those selected for further consideration will be contacted.

**The deadline for submitting applications is June 29, 2009**

For further information about the position, please contact: Dongling Ma (**ma@emt.inrs.ca**)

**PostDoctoral Position (CEA, France):** *"Carbon nanotube-based flexible and high frequency electronic devices"*

The Molecular Electronics Laboratory has an open position for a postdoctoral fellowship. The contract is for 18 months and can start immediately.
The Molecular Electronics Laboratory (LEM) is a multidisciplinary group of ~15 research scientists. It belongs to the Condensed Matter Physics (SPEC) department of the IRAMIS Institute (Institut Rayonnement Matière de Saclay), one of the Institutes for fundamental research of the CEA in Saclay (Paris area).

**The deadline for submitting applications is June 30, 2009**

For further information about the position, please contact: Vincent Derycke (**vincent.derycke@cea.fr**)

**Open positions for heads of research areas, principal investigators, associate researchers and technical staff (Andalusian Initiative for Advanced Therapies, Spain**): *"Nanodiagnostic, Therapeutic Nanosystems or Nanobiotechnology"*

The Andalusian Initiative for Advanced Therapies invites you to participate in the Andalusian Research Programme for Nanomedicine.

**The deadline for submitting applications is June 30, 2009**

More information: **http://www.juntadeandalucia.es/terapiasavanzadas/solicitudes/new**

**PhD Position (ICMM-CSIC, Spain):** *"Statistical properties of Light Emission and Transport in Photonic Materials: Theory and Numerical Simulation"*

The work will be carried out within the framework of the Spanish Consolider "Nanolight" Project. The understanding of the electromagnetic response of disordered and complex photonic materials (Photonic crystals and glasses, biological tissues, colloidal suspensions, emulsions, cosmic dust, atmospheric particles, metamaterials,...) is fundamentally relevant for a large variety of basic and applied problems and has motivated extensive theoretical and experimental efforts over a century. In the last years, the extraordinary advances in material science, chemistry and biochemistry, optical instrumentation, theory and modeling have opened new possibilities in the manipulation of light at the microscopic level giving rise to the appearance of the new and exciting area of nanophotonics.

**The deadline for submitting applications is July 15, 2009**

For further information about the position, please contact: **Luis Froufe** (**luis.froufe@icmm.csic.es**)

## NANO Vacancies - http://www.phantomsnet.net/Resources/jobs.php

**PostDoctoral Position (Institute for Physics and Chemistry of Materials in Strasbourg (IPCMS), France):** *"Molecular opto-spintronics"*

A post-doctoral position is available for a motivated scientist with a track record in spin electronics, molecular electronics and optical spectroscopy techniques.
Research will take place at the Institute for Physics and Chemistry of Materials in Strasbourg IPCMS, (http://www-ipcms.u-strasbg.fr) where a new facility for nanofabrication is being established. This laboratory is funded by a "Chaire d'excellence" fellowship from the French Ministry.
**The deadline for submitting applications is July 18, 2009**

For further information about the position, please contact: Bernard Doudin (**bdoudin@ipcms.u-strasbg.fr**)

**PostDoctoral Position (CNB-CSIC, Spain):** *"Single Molecule techniques and their application to DNA break repair"*

Our group, holder of one of the European Research Council Starting Grants, has one Postdoctoral Open Position with an EU contract for two years to study the action of molecular machines involved in DNA repair at the single-molecule level. We use and develop Magnetic, Optical Tweezers, and Atomic Force Microscopy to unravel the mechanisms of action of nanomachines involved in Homologous Recombination and DNA-End joining pathways to repair DNA damage in bacteria. To do that, our group develops projects in collaboration with Dr. Dillingham group at University of Bristol.
**The deadline for submitting applications is July 28, 2009**

For further information about the position, please contact: Fernando Moreno Herrero (**fernando.moreno.icn@uab.es**)

**PhD studentship (Universität Stuttgart, Germany):** *"Putting magnetism into carbon nanoelectronics"*

Applications are invited for a PhD position at Institut national de la recherche Scientifique (INRS), University of Quebec, Canada on the synthesis of nanoparticles and their applications in catalysis. The student will be under the supervision of Prof. Dongling Ma (Nanomaterials chemist) and Prof. Federico Rosei (Canada Research Chair in Nanostructured Materials) . The successful candidate should have experience in the synthesis of nanoparticles in solution using a wet chemistry approach. The candidate should have a Bachelor/Master degree in Chemistry. Good English is required.The successful candidate should be highly motivated. The abilities to work in a team setting with PDFs on the similar projects as well as to work independently are important. Please send your CV (including the names and contact information of two referees) to Dongling Ma (ma@emt.inrs.ca). We thank all those who apply. Only those selected for further consideration will be contacted.
**The deadline for submitting applications is July 30, 2009**

For further information about the position, please contact: Lapo Bogani (**lapo.bogani@pi1.physik.uni-stuttgart.de**)

**PostDoctoral Position (Centro Nacional de Microelectronica (CNM), Spain):** *"Digital logic microcircuits based on Silicon Carbide devices"*

The main objective of this research work is the design, the fabrication and the characterization of full SiC-based logics. 2 different approaches can be investigated depending on the candidate background. The first one is to focus on the development of logic circuits (NAND, NOR …) based on SiC MOSFETs by designing masks (Cadence, Spice, Sentaurus…) and using the available clean room technologies. Full electrical characterization equipment is available (DC, RF, Temperature ...). Then, the design of more complex logic full driver circuits based on CMOS will be addressed. If any time left, the driver will be implanted in biomedical sensors already existing at CNM. The second approach is completely different and will be based on graphene grown on SiC, technology already controlled at CNM. The candidate will have to validate first the technology to fabricate top gate FET transistors and then the concept of logic based on graphene on SiC.
**The deadline for submitting applications is July 31, 2009**

For further information about the position, please contact: Philippe Godignon (**philippe.godignon@cnm.es**)

**PhD Position (CEA-LETI, France):** *"Single charge device integration"*

LETI plays a major role in the field of microelectronics research especially regarding thin film technology. These technologies are at the same time close to be on the market and are characterized by their original transport properties originating from electrostatics, confinement, strain... One emerging topic for these thin films devices is single electron transistors.
**The deadline for submitting applications is September 01, 2009**

For further information about the position, please contact: Maud Vinet (**maud.vinet@cea.fr**)

# NANO News - http://www.phantomsnet.net/Resources/news.php

## (May 2009)

**Drexel Nanotechnology Research Paves the Way to Ever Smaller Electronic Devices [14-05-2009]**
http://www.materials.drexel.edu/News/Item/?i=3565
Professor Christopher Li in Drexel University's Department of Materials Science and Engineering and colleagues are one step closer to making personal electronic devices even smaller. Their pioneering research demonstrates that it is possible to manipulate a carbon nanotube for the future miniaturization of electronic devices.
*Keywords: Nanotubes / Nanoelectronics*

**Controllable double quantum dots and Klein tunneling in nanotubes [14-05-2009]**
http://www.physorg.com/news161521344.html
Researchers from the Kavli Institute of NanoScience in Delft are the first to have successfully captured a single electron in a highly tunable carbon nanotube double quantum dot. This was made possible by a new approach for producing ultraclean nanotubes.
*Keywords: Nanotubes*

**Freescale Taking Nanocrystal Flash to Production [12-05-2009]**
http://www.semiconductor.net/article/CA6657517.html?nid=3572&rid=8143013
At the International Memory Workshop being held this week in Monterey, Calif., Freescale Semiconductor Inc. (Austin, Texas) will detail progress in its nanocrystal (NC) flash development program. After five years of work on the technology, the company is ready to move NC flash to the product stage.
*Keywords: Nanoelectronics*

**Large graphene samples could boost carbon electronics [07-05-2009]**
http://www.utexas.edu/news/2009/05/07/faster_computers_graphene/
The creation of large-area graphene using copper may enable the manufacture of new graphene-based devices that meet the scaling requirements of the semiconductor industry, leading to faster computers and electronics, according to a team of scientists and engineers at The University of Texas at Austin.
*Keywords: Graphene / Nanomaterials / Nanoelectronics*

**Gallium assists quest for superior nanowires [07-05-2009]**
http://nanotechweb.org/cws/article/lab/39002
Scientists have found the way of synthesizing silicon nanowires by using gallium as a catalyst. Avoiding gold as a catalyst in the VLS process is believed to result in nanowires with superior electronic and optoelectronic properties.
*Keywords: Nanowires / Nanoelectronics*

**Printable NEMS platform drives down cost of sensors [05-05-2009]**
http://nanotechweb.org/cws/article/tech/38964
In a recent study, published in Nanotechnology, scientists in Sweden have investigated a totally new printable approach to manufacturing nanoelectromechanical systems (NEMS). The devices are based on nanometre-sized, high aspect ratio, tuneable grating structures (interdigitated pairs of walls).
*Keywords: NEMS & MEMS / Nanosensors & Nanodevices*

**MIT teams finding many uses for graphene, the newest form of carbon [04-05-2009]**
http://web.mit.edu/newsoffice/2009/graphene-feature-0504.html
The nanoscopic material called graphene turns out to have a variety of unique, and potentially very useful, characteristics - ones several MIT researchers are actively trying to better understand and turn into real-world applications.
*Keywords: Graphene*

**IMEC reports method to integrate plasmon-based nanophotonic circuitry with state-of-the-art ICs [04-05-2009]**
http://www2.imec.be/imec_com/plasmon-based-nanophotonic.php
IMEC reports a method to integrate high-speed CMOS electronics and nanophotonic circuitry based on plasmonic effects. Metal-based nanophotonics (plasmonics) can squeeze light into nanoscale structures that are much smaller than conventional optic components.
*Keywords: Nanophotonics / Plasmonics / Nanoelectronics*

# NANO News - http://www.phantomsnet.net/Resources/news.php

## (April 2009)

**Wafer-scale processes single out CNTs [16-04-2009]**
http://nanotechweb.org/cws/article/tech/38669
Researchers at the Jet Propulsion Laboratory (JPL), California Institute of Technology, US, have combined top-down nanofabrication approaches with bottom-up tube synthesis techniques to form controlled structures comprising of just single tubes.
*Keywords: Nanoelectronics / Nanotubes / Nanofabrication*

**Carbon nanotubes catalyst research could lead to cleaner fuels [16-04-2009]**
http://www.nanowerk.com/news/newsid=10145.php
Among their many other interesting properties, carbon nanotubes have been found to act as catalysts for some important chemical reactions, including some that could be used to make cleaner fuels.
*Keywords: Nanotubes / Energy*

**Important breakthrough towards silicon-based all-optical integrated circuits [14-04-2009]**
http://www2.imec.be/imec_com/important-breakthrough-towards-silicon-based-all-optical-integrated-circuits.php?year=2009&month=04
The April issue Nature Photonics publishes the first experimental proof of all-optical ultra-fast communication signal processing with silicon-based devices for transmission speeds above 100Gbit/s.
*Keywords: Nanoelectronics / Nanophotonics & Nano-Optoelectronics*

**Graphene Holds Promise to Revolutionize Microelectronics [14-04-2009]**
http://www.azonano.com/news.asp?newsID=10912
Andre Geim developed the first two-dimensional crystals made of carbon atoms. These graphenes not only promise to revolutionize semiconductor, sensor, and display technology, but also lead us to expect breakthroughs in basic research in quantum physics.
*Keywords: Graphene*

**IBM to Team Up with CEA to Develop Semiconductors and Nanoelectronics [13-04-2009]**
http://www.azom.com/news.asp?newsID=16420
CEA/Leti and IBM announced that they will collaborate on research in semiconductor and nanoelectronics technology.
*Keywords: Nanoelectronics / Nanotechnology Business*

**Carbon nanotubes clean up their act [08-04-2009]**
http://nanotechweb.org/cws/article/tech/38603
Researchers at Delft University of Technology in the Netherlands have developed a new technology for making ultra-clean carbon nanotube devices.
*Keywords: Nanoelectronics / Nanotubes / Nanofabrication*

**Report on the implementation of the Action Plan for Nanosciences and Nanotechnologies for 2005-2007 in Spain [06-04-2009]**
http://www.nanospain.org/files/news/Spain_First-Implementation-Plan_final.pdf
The promotion of nanosciences and nanotechnologies in Spain has fundamentally been developed on the basis of two instruments: the Strategic Action for Nanoscience and Nanotechnology (SANSNC) and the Ingenio 2010 initiative.
*Keywords: Scientific Policy / Nanotechnologies*

**The Phantoms Foundation coordinates the first Spain Pavilion at NSTI Nanotech 2009 (Houston, U.S.A.), world's largest and most anticipated annual nanotechnology conference and expo [03-04-2009]**
http://www.phantomsnet.net/files/NSTI_nanotech2009_press_release-April09.pdf
The twelfth edition of this conference and exhibition is more international in scope than ever, expecting over 5,000 attendees and 250 exhibitors.
*Keywords: Nanotechnology Business / Nanotechnologies*

# The implementation of the Action Plan for Nanosciences and Nanotechnologies in Spain (2005-2007)

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This report details the most important initiatives that were carried out in Spain during the period 2005-2008 as part of the different activities that followed the recommendations described in the Implementation Plan of Nanotechnologies launched by the European Commission (EC). This study is based on a report of the European Office (EO) of the Spanish Science and Innovation Ministry (MICINN) for the EC. The original report is available for download at the EO-MICINN site (**http://www.oemicinn.es/area5/area12**).

## 1. Public and private funding figures

### 1.1 Background: R&D National Plan 2004-2008 and Ingenio 2010 Initiative

Several Ministries carried out many activities intended to promote nanoscience and nanotechnology during the 2005-2007 period. All these activities were carried out under the framework of the Spanish National Plan for Scientific Research, Technological Development and Innovation (PNIDI) 2004-2007. The PNIDI was approved by the Council of Ministers in their meeting of November 7, 2003, and the most important information about it can be found at:
**http://www.micinn.es/ciencia/jsp/plantilla.jsp?area=plan_idi&id=2**.

For the first time in the history of national R&D plans, the 2004-2007 R&D Plan contained a cross-programme action, the Strategic Action for Nanoscience and Nanotechnology, or SANSNT. A full description of this action can be found, along with that of the other Strategic Actions, in the document at **http://www.micinn.es/ciencia/plan_idi/files/Plan_Nacional_Vol_II.pdf**.

The two fundamental objectives of the SANSNT were:
(i) To acquire scientific infrastructure, and
(ii) To implement demonstrative scientific and technical projects.

The priority scientific lines encompassed within the SANSNT were:
1.- Fundamental phenomena.
2.- Biotechnology, biomedicine and agro food.
3.- Energy and the environment.
4.- Magnetic information storage, magnetoelectronics.
5.- Nanoelectronics and molecular electronics, optoelectronics and photonics, semi-conductor nanostructures.
6.- Nanometric devices and machines, nanomanipulation, nanocharacterisation.
7.- Nanocomposites.

The new Government that came into power following the general elections in 2004 announced a National Reform Programme for Spain (NRP 2005), built around seven thematic pillars. (More information about the Programme can be found on this website: **http://www.lamoncloa.es/PROGRAMAS/OEP/PublicacionesEInformes/PNR/default.htm**).

The Ingenio 2010 initiative (**http://www.ingenio2010.es** or **http://ingenio2010.fecyt.es**) comprises the fourth pillar of the NRP, and constitutes the instrument designed to ensure convergence with the European Union in R&D, by increasing the levels of resources provided and putting strategic actions into practice. The Ingenio 2010 initiative has received the support of the European Union and also the OECD as an instrument to bring about modernisation in Spain.

The CONSOLIDER and CENIT programmes are of particular importance within the strategic strands relating to the implementation of nanosciences and nanotechnologies falling within Ingenio 2010. The first is a strategic line designed to achieve excellence in research by increasing the level of cooperation between researchers and by creating large research groups. The CENIT Programme, meanwhile, aims to boost R&D collaboration between companies, universities, institutions and public centres dedicated to research, as well as science and technology parks and technology centres, thus increasing public-private cooperation in R&D.

For this reason, the promotion of nanosciences and nanotechnologies in Spain has fundamentally been developed on the basis of two instruments: the Strategic Action for Nanoscience and Nanotechnology (SANSNT) and the Ingenio 2010 initiative. It should be noted that currently there is not strong coordination between the General State Administration and the governments of the autonomous communities in Spain, as consequence, it is currently impossible to be able to gauge the exact amount of resources devoted to the promotion of NS&NT. This also means that an estimate of the financial resources invested by the various autonomous governments could not be made for this report. Similarly, we do not know the level of resources dedicated to R&D in the 'nano' sphere by the private sector, apart from those sums arising from the participation of private companies in the CENIT consortia.

### 1.2 R&D Projects funded from Ministry of Education and Science within the Strategic Action on Nanoscience and Nanotechnology (SANSNT)

At this point, it must also be mentioned that it is very difficult to give a global figure for all the economic resources spent on activities related to nanoscience and nanotechnology. This is because activities clearly linked to both thematic areas have also been financed from different National Programmes connected to the research in the fields of physics, chemistry, materials, information technologies, biotechnology, etc. and being managed by

the Directorate General for Research (DGI) and the Directorate General for Technological Policy (DGPT). Since it is very difficult to separate 'nano' and 'non-nano' projects funded by these Programmes we limit ourselves to the analysis of those activities carried out by both, DGI and DGPT, within the SANSNT.

At the time of writing, updated figures were not available for 2007, and so data have been provided for the 2004-2006 period. The **table 1** shows funding for the whole range of projects and complementary activities funded by the DGI and DGPT within the Ministry of Education and Science (MEC) from 2004 to 2006.

| MEC: Strategic Action on NS&NT | | | | | | |
|---|---|---|---|---|---|---|
| | Requested Funding | | | Approved Funding | | |
| YEAR | Number of actuations | Public subsidy (k€) | Refundable advances (k€) | Number of actuations | Public subsidy (k€) | Refundable advances (k€) |
| 2004 | 211 | 85.000,00 | 0,00 | 37 | 12.000,00 | 0,00 |
| 2005 | 25 | 4.919,03 | 31.855,57 | 180 | 820,55 | 7.453,38 |
| 2006 | 70 | 9.722,29 | 85.542,10 | 33 | 2.675,97 | 10.044,07 |
| **Total** | **306** | **99.641,32** | **117.397,67** | **250** | **15.496,52** | **17.497,45** |
| The data corresponding to year 2007 are not available | | | | | | |
| Source: Sistema integral de seguimiento y evaluación del Plan Nacional de I+D+i (**http://sise.fecyt.es**) | | | | | | |

***Table 1**: Funding for the whole range of projects and complementary activities funded by the DGI and DGPT within the Ministry of Education and Science (MEC) from 2004 to 2006*

Funding for the SANSNT in the 2004-2006 period rose to €15.5 million in direct subsidies and €17.5 million in refundable advances.

Among all the activities carried out, one that must be highlighted because of its scientific and budgetary impact was the call for proposals for R&D projects by the Ministry of Education and Science's Directorate General for Research (now located in the Ministry of Science and Innovation). A total of 564 individual projects or sub-projects of coordinated projects presented applications to this call for proposals. Of these, it was only possible to fund 93 (a success rate of 16.5%). The amount of subsidies granted to fund projects stood at a total of €11.982,850. The breakdown of the projects approved can be found at the following website:

**http://www.micinn.es/ciencia/nanociencia/files/NANOCIENCIA-WEBMEC.pdf**

The **table 2** shows the projects approved within each line of priority research within the SANSNT.

| Number of approved sub-projects per priority research line | |
|---|---|
| **RESEARCH LINE** | **Number of Approved Projects** |
| 1. Fundamental phenomena | 6 |
| 2. Biotechnology, biomedicine and agro-food | 32 |
| 3. Energy and environment | 18 |
| 4. Magnetic information storage, magnetooelectronics | 3 |
| 5. Nanoelectronics and molecular electronics, optoelectronics and photonics, semiconductor nanostructures | 17 |
| 6. Nanometric devices and machines, nanomanipulation, nanocharacterisation | 10 |
| 7. Nanocomposed materials | 7 |
| **TOTAL** | **93** |

***Table 2:** Projects approved within each line of priority research within the SANSNT*

### 1.3 Industry projects supported from the Centre for the Development of Industrial Technology (CDTI)

The Centre for the Development of Industrial Technology (CDTI) is a Spanish public organisation, currently dependent on the Ministry of Science and Innovation, whose objective is to help Spanish companies to increase the technological profile of said companies. CDTI assesses and funds technological development, innovation and modernization projects developed by Spanish companies. CDTI classifies these technological projects in three categories: Concerted Industrial Research projects, Technological Development projects and Technological Innovation projects. CDTI also manages the CENIT Programme and supports the generation and development of new technology base firms, through the Neotec Initiative. Both activities are included within the Ingenio2010 Initiative (see next subsection).

The **table 3 (page 24)** shows the total number and funding figures corresponding to those nanotechnology-related industry projects with financial support from CDTI (through Concerted Industrial Research projects, Technological Development projects and Technological Innovation projects). We have excluded the CENIT and NEOTEC Programme.

### 1.4 R&D Projects within the Strategic Action on Nanoscience and Nanotechnology (SANSNT) founded from the PROFIT Programme Ministry of Industry

'Nanoscience and Nanotechnology' were included as a Strategic Action of both the 2004-2007 National Plan for R&D&I and the funding set aside within this Plan for the industrial sector (PROFIT Programme), with the aim of promoting the development of industrial projects (carried out by companies) with nanotechnology-focused objectives.

During the 2004-2007 period, around 40 projects were funded as a result of this Strategic Action, receiving a total of €2 million in subsidies and €8.5 million in associated investments. Results are summarized in **table 4 (page 24)**.

| CDTI: Summary of Nanotechnology related projects funded within the period 2004-2007 (excluding CENIT and NEOTEC projects) | | |
|---|---|---|
| **NUMBER** | **TOTAL COST (k€)** | **CDTI Funding (k€)** |
| 42 | 42.383,71 | 24.414,52 |

***Table 3:*** *Total number and funding figures corresponding to those nanotechnology-related industry projects with financial support from CDTI (through Concerted Industrial Research projects, Technological Development projects and Technological Innovation projects)*

| Ministry of Industry: PROFIT Programme - Strategic Action on NS&NT | | |
|---|---|---|
| **NUMBER of funded projects** | **Public subsidy (k€)** | **Associated investments (Refundable advances) (k€)** |
| 40 | 2.000,00 | 8.500,00 |

***Table 4:*** *Projects funded as a result os the Strategic Action, during the 2004-2007 period*

All the projects were headed by industrial companies, although universities and technological centres were involved in the development of many of them either on a collaborative basis, or were subcontracted by the company carrying out the project.

### 1.5 Ingenio 2010 Initiative

#### 1.5.1 Ingenio 2010 Initiative: CONSOLIDER Programme

The Ingenio 2010 has been involved with several of the calls for proposals within the CONSOLIDER and CENIT programmes. There have been two calls for proposals within the Consolider Programme, which have already been finalized (years 2006 and 2007). The results of both these calls for proposals can be found at the following websites:

**http://www.micinn.es/ciencia/consolider/files/2006-prog-seleccionados-convocatoria.pdf**
**http://www.micinn.es/ciencia/consolider/files/2007-prog-seleccionados-convocatoria.pdf**

The successful applicant projects with a clear 'nano' component, are shown in **table 5**.

#### 1.5.2 Ingenio 2010 Initiative: CENIT Programmes

The **table 6 (page 25)** shows the nanoscience and nanotechnology projects, approved within the CENIT Programme throughout 2006 and 2007. Each project has sub-projects or specific tasks working on developments within the 'nano' field. However, it is very difficult to determine with accuracy the percentage of funding dedicated to NS and NT within each project. It must also be pointed out that these projects are 50% funded by the participating companies.

| INGENIO 2010 & NSNT: CONSOLIDER Programme | | | |
|---|---|---|---|
| **YEAR** | **Title (Coordinator)** | **Acronym** | **Funding (k€)** |
| 2006 | Nanotechnology in Biomedicine (M.R. Ibarra) | NANOBIOMED | 4.500 |
| 2006 | Creation of a new R&D centre for the coordination and management of nanoscience research in the Basque Country (P.M. Echenique) | CIC NANOGUNE | 4.500 |
| 2007 | Molecular Nanoscience (E. Coronado) | NANOMOL | 5.750 |
| 2007 | Materiales avanzados, nanotecnologías para dispositivos y sistemas eléctricos, electrónicos y magnetoelectrónicos innovadores (X. Obradors) | NANOSELECT | 5.000 |
| 2007 | Light control on the nanoscale (N. Van Hulst) | Nanolight.es | 6.685 |
| **TOTAL FUNDING** | | | **26.435** |

***Table 5:*** *INGENIO 2010 & NSNT: CONSOLIDER Programme*

### 1.6 CIBER Programme

Biomedical Research Centres Network (CIBER), are entities that are gathered to develop an ambitious project on a pathology or group of pathologies. These groups will work inside a network, so results can be compared and a comparative research effort is achieved. The Instituto de Salud Carlos III will coordinate these Networks, and will issue yearly proposals on strategy and coordination for the future networks. Once this call has been made, the interested groups present their proposal for participating into such networks.

For the period 2007-2009, the Centro de Investigación Biomédica en Red (Networking Biomedical Research Center) in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), has been funded with 1.398.000 K€ by the Instituto de Salud Carlos III.

It brings together some of the main Spanish research groups in the subject, including both universities and hospitals or other technological centers. Its purpose is to conduct translational research and to transfer it to industry.

Additional information about this centre can be found at: **http://www.ciber-bbn.es**

| INGENIO 2010 & NSNT: CENIT Programme | | | | |
|---|---|---|---|---|
| YEAR | Coordinator | Acronym | TOTAL COST (k€) | Public Funding (k€) |
| 2006 | Oncnosis Pharma AIE | ONCNOSIS | 24.820,00 | 12.410,00 |
| 2006 | Genius Pharma AIE | Genius Pharma | 34.194,00 | 17.097,00 |
| 2006 | Acciona Infraestructuras SA | PROMETEO | 27.722,00 | 13.861,00 |
| 2006 | Pharmamar | NANOFARMA | 29.218,00 | 14.609,00 |
| 2006 | Grupo Antolín SA | REVELACIÓN | 24.698,00 | 12.349,00 |
| 2007 | Tolsa SA | DOMINO | 28.454,00 | 14.227,00 |
| 2007 | GreenCell SA | I+DEA | 27.814,00 | 13.907,00 |
| 2007 | Celata Emparanza y Galdos SA | DEIMOS | 27.518,00 | 13.759,00 |
| 2007 | Gas Natural SDG SA | SPHERA | 31.068,00 | 15.534,00 |
| **TOTAL** | | | **255.506,00** | **127.535,00** |

***Table 6:*** *Projects associated, to a greater or lesser degree, with nanoscience and nanotechnology, and that were approved within the CENIT Programme throughout 2006 and 2007*

**NAN2004-09267-C03**
Title: *"Development of nanoporous materials for environmental catalysis"*

**NAN2004-09306-C05**
Title: *"Technology for the development of new sensors and electrodes based on carbon nanotubes"*

**NAN2004-09333-C05**
Title: *"Graphite nanofibers as electro-catalysts for fuel cells"*

**NAN2004-09348-C04**
Title: *"Applications of Optical Tweezers for molecular biophysics"*

**NAN2004-09380-C04**
Title: *"Synthesis of nanomaterials and their interaction with different gases for their applications for sensing devices"*

## 2. Some examples of funded projects and "success stories"

### 2.1 Strategic Action on Nanoscience and Nanotechnology

#### 2.1.1 R&D Projects within the Strategic Action on Nanoscience and Nanotechnology

The Strategic Action on Nanoscience and Nanotechnology projects have been reviewed at the end of 2007, by international experts (forming an ad-hoc international review panel). The following list presents those projects (code project and title) that were considered as "outstanding" by the above mentioned review panel.

**NAN2004-08881-C02**
Title: *"Chemical activity, synthesis, and chirality of self-assembled monolayers"*

**NAN2004-09094-C03**
Title: *"Nanodevices for Spin Manipulation"*

**NAN2004-09125-C07**
Title: *"Bio-functionalised Magnetic glyco-nanoparticles for medical applications"*

**NAN2004-09183-C10**
Title: *"Force spectroscopy and fluorescence of single biomolecules"*

**NAN2004-09230-C04**
Title: *"Design of polymeric nanoparticles as synthetic vectors for gen therapy"*

#### 2.1.2 Other activities within the Strategic Action on Nanoscience and Nanotechnology: Networking

The Strategic Action for Nanoscience and Nanotechnology has funded various initiatives while also carrying out R&D projects. One of the most relevant features was the funding of the NanoSpain Network throughout , 2006 and 2007, a body comprising more than 270 research groups (**http://www.nanospain.org**). This network, which is one of the most important in the country, is coordinated by the CSIC (Spanish National Research Council) and the Phantoms Foundation, a private non-profit body leading several national and European projects. NanoSpain has collaborated in organizing annual meetings with an international conference format, attracting a high level of participation. These events (lead organizer, Phantoms Foundation, http://www.nanospainconf.org) have served as a meeting point for members of the scientific community working in nanoscience and nanotechnology as well as an international showcase for the Spanish scientific community. The biggest contribution of the NanoSpain Network in 2007 was, without a doubt, the preparation of the report called *"Nanoscience and Nanotechnology in Spain: analysis of the current situation and outlook for the future"*, which was financed by the former Ministry of Education and Science and edited by the Phantoms Foundation. This Ministry also helped to co-finance the conferences entitled "Trends in Nanotechnology", which were held in Spain in 2005 (Oviedo) and 2007 (San Sebastián), and organised by various institutions, including Phantoms Foundation, CSIC and Universidad Autónoma de Madrid.

### 2.2 Ingenio 2010 Initiative

#### 2.2.1 Ingenio 2010 Initiative: CONSOLIDER Programme

The following projects have received financial support from the CONSOLIDER Programme. The next table summarizes their objectives.

**NANOBIOMED:** The project combines joint expertise of relevant scientists from different research areas (Physics, Chemistry, Biochemistry, Pharmacy, and Medicine) in an attempt to solve borderline problems by using nanotechnology in the field of biomedicine. The objectives of the Team are focused on the applications of nanoparticles in two important areas: Nanotherapy and Nanodiagnosis.

**NANOGUNE:** This project is aimed to contribute to the impulse of a new Interdisciplinary Center for R&D (CIC nanoGUNE Consolider), as a new organizational unit, in the framework of the NANOBASK2015 initiative, a specific strategy designed by the Department of Industry, Trade, and Tourism of the Basque Government for the business development of nanoscience in the Autonomous Community of the Basque Country.

**NANOMOL:** The aim is to provide a suitable framework to develop a competitive and high quality research in Molecular nanoscience. Specifically the activities are: design, synthesis and characterization of molecules, supramolecules and nanoparticles with electronic, magnetic and biological functionalities. To explore their use, in molecular electronics (as OLEDs and solar cells), in chemistry (as molecular sensors) and in medicine (as contrast agents in magnetic resonance imaging, or as biosensors in anti-tumoral therapies by hyperthermia).

**NANOSELECT:** The aim of the project is to generate knowledge, products and devices that enable to develop emerging technologies that have a great capacity to generate new developments and industrial products in two strategic fields with a great economic potential:
1.- Electrical energy (superconducting power systems),
2.- Electronics and Information Sciences (Magnetoelectronics, Nanomagnetism).
The worldwide strategic relevance of these emerging technologies is very high and Europe should aim for a position of leadership.

**NANOLIGHT.ES:** This is a blue-sky project aimed to develop nanoscale light technology for applications in sensing, nanoimaging, optical circuitry and data storage, the key components of future information technology, and to consolidate a Spanish consortium acting as an international reference in this field. The experimental part comprises nanophotonics, plasmonics, nanofabrication, near field microscopy, single molecule detection, photonic crystals and nonlinear optics, and thus covers the most important current approaches to nanoscale light technology.

#### 2.2.2 Ingenio 2010 Initiative: CENIT and NEOTEC Programme

Among the different projects funded throughout the CENIT Programme, the **DOMINO** and **NANOFARMA** projects are those with the closest connection to nanotechnology R&D.

**DOMINO Consortium** (**http://www.cenitdomino.com**) aims at the development of new nanostructured materials, designed for the fabrication of new products with better performace for applications in different industrial sectors: automotive industries, packing, textiles, electricity & electronics, aeronautical, wind, environment, ceramics, glass, construction and coverings.

**NANOFARMA** (**http://www.cenitnanofarma.es**) is a Consortium made up by seven Spanish companies. Its goal is the joint research and development of nanotechnological systems applied to the pharmaceutical industry. The consortium is carrying out a large scale project "Systems for addressed drug delivery", an avant-grade and multidisciplinary large scale project, the aim of which is to innovate and develop new nanotechnological platforms in the field of Drug Delivery Systems (DDS). The major goal of the project is to development new DDS with feasibility for both oral and intravenous administration, which selectively transmit the drug to the target organs, tissues and cells. The scientific goals are:
(i) Grouping together Spanish research centres and companies of proved scientific excellence with proprietary and competitive drug delivery and nanomedical technologies, as well as SME dedicated to these fields.
(ii) Establishing a collaboration network to take advantage of existing synergies to the benefit level of the participants in the Nanofarma project within the field of drug delivery research.
(iii) Providing the Spanish pharmaceutical industry with the driving forces to acquire the high competitiveness required by the pharmaceutical sector and based on innovations in drug delivery systems, so as to achieve safer and more efficient pharmaceutical products with a at lower cost.

### 2.3 Other activities carried out by public Agencies and Foundations

#### 2.3.1 CSIC NANO AXIS

The CSIC is the largest public research Agency in Spain. CSIC plays an active role in the scientific policy of all the country's autonomous regions, and covers all fields of knowledge, from basic research through to advanced technological development. Within the CSIC Strategic Actuation Plan, new transversal structures (axis) have been defined aiming at the connection of different research areas.

Among these axis, the NANO Axis is formed by more than 100 research groups and presents several objectives: (i) the improvement of the interaction between the CSIC's groups involved in research in NS&NT; (ii) to promote high impact research in nanotechnology and, particularly, in those areas of interest for emerging and conventional Spanish industries, (iii) to improve the infrastructure devoted to nanoscale manufacture and characterisation; (iv) to promote the transfer of nanotechnology-related knowledge to the productive sector; (v) to promote the training of scientists and technologists in NS&NT; (vi) to raise to society's awareness of the activities and progress in na-

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## 6 Technician positions

Six Positions for young technicians to work in our clean room and Characterization Laboratories. Selected candidates will have the possibility of career development in an international organization and specific training in selected Nanotechnology Centers in the Iberian Peninsula, while INL´s laboratory infrastructure is not completed.

## 3 Postdoctoral Positions

**Super Resolution Microscopy based on QDs and other Multiparametric Nanoparticles** (in collaboration with Dr T Jovin, Max Planck Institute for Biophysical Chemistry. Göttingen, Germany).

**Study of Nanoparticles clusters through ultrasensitive microscopy techniques** (in collaboration with Dr O. Gang, Center for Functional Materials - Brookhaven National Laboratory. New York, USA).

**Low-field and solid-state NMR applied to food quality control** (in collaboration with Dr N. C. Nielsen, iNano University of Aarhus and Aalborg, Denmark).

For more information about the INL project and main steps of INL's recruitment process, please visit: **www.iinlrecruitment.com**

INL INTERNATIONAL IBERIAN NANOTECHNOLOGY LABORATORY

**www.iinlrecruitment.com**

notechnology in order to improve scientific culture and to achieve the goal of creating a new and sustainable knowledge-based society.

More info at
http://www.csic.es/documentos/ejesTematicos/EjeNanoEN.pdf.

**2.3.2 Activities of the Spanish Science and Technology Foundation (FECYT) for the promotion of NS&NT**

The Spanish Science and Technology Foundation (FECYT) (http://www.fecyt.es) is a dependent organisation on Ministry of Science and Innovation (MICINN). FECYT is conceived as a tool of the national system of knowledge generation and technological transfer. The Foundation operates as a non-profit private association and with functional autonomy, with the goal of rendering a continuous and flexible service to the Spanish system of science-technology-enterprise. Likewise, it contributes to identify opportunities and needs and proposes ways of actions to agents of the scientific research and technological innovation system. It strategic aims are: (i) to promote activities of excellent technological research and development; (ii) to favour collaboration between national and international agents of science and technology system; and (iii) to promote the social spreading of the scientific culture, as a tool of competitively and improvement of the life quality of citizens.

FECYT designed and launched a Nanotechnology Pilot Plan in order to improve the interaction between private and public agents. Several meetings (using Think Tank format) took place, giving rise to two publications:
1.- *"Estudios de las actividades y necesidades en el área de las Nanociencias/Nanotecnologías"* (co-edited with the Phantoms Foundation and prepared in collaboration with the NanoSpain Network).
2.- *"Spain Nanotechnology Think Tank 2005"*.
These publications are accessible on-line at http://www.fecyt.es (*"Publications"* section and *"Guides and Manuals"* subsection). More recently, FECYT has published a book devoted to the dissemination of Nanotechnology to Middle and High School students. It will be translated into Portuguese and freely distributed in Spanish and Latin-American Schools.

FECYT has been supporting the organisation of the national scientific photography contest FOTCIENCIA (http://www.fotciencia.fecyt.es) and international SPM image competitions as SPMAGE07 (http://www.icmm.csic.es/spmage07/index.php), both closely related with NS&NT activities.

**3. Funding figures for any projects dedicated to environmental, health, safety, ethical, legal and social aspects of nanotechnologies, or other national initiatives in these areas**

The **table 7 (page 29)** summarizes the funding from different programmes of those projects dealing with environmental, health, safety, ethical, legal and social aspects of nanotechnologies. Notice that we have excluded from this table those projects related to nanomaterials, photonics, nanomanipulation, etc, non directly related to the above-mentioned topics of interest.

We should also mention as a relevant activity within the 2005-2007 period, the preparation and publication of the report on technologic convergence entitled "Convergencia NBIC 2005. El Desafío de la Convergencia de la Nuevas Tecnologías (Nano-Bio-Info-Cogno)" authored by E. Fontela et al and funded by the Escuela de Organización Industrial (Industry Organisation School) depending on the former Ministry of Industry and Trade. Different organisations have been involved in the study of the convergence of technologies.

The most important initiative is the Converging Technologies Initiative (**http://nbic.org.es**), from the *University Autónoma of Barcelona* (UAB), with the collaboration of CSIC and Foundation OPTI. It emerges with the aim to ignite and develop projects and activities with other Science and Technology centres within the European Union and Latin America in the fields of Converging Technologies.

**4. Information on the development of relevant infrastructures**

The General State Administration (GSA) has promoted the creation of various research institutes focusing on research in nanoscience and nanotechnology, and the transfer of the results of such research to the industrial sector. The GSA participates directly in some of these centres as members on the governing boards of these new structures. In other cases, GSA participation is indirect, through funding from the Ingenio 2010 - Consolider programme, or by means of the CSIC State Agency, which falls under the remit of several ministries. The **table 8 (page 30)** sets out the current initiatives in Spain (with GSA intervention) stemming from the establishment of relevant scientific infrastructures.

| Nanotechnologies Implementation Plan 2005-2007 | | | | |
|---|---|---|---|---|
| | **NS&NT Strategic Action (MEC)** | **INGENIO 2010 Consolider** | **INGENIO 2010 CENIT** | **Total** |
| **Environment** | 4.251 | 0 | 57.061 | 61.312 |
| **Health** | 2.211 | 4.500 | 44.116 | 50.827 |
| **Safety** | 0 | 0 | 0 | 0 |
| **Ethical, legal and social aspects** | 0 | 0 | 0 | 0 |

***Table 7:*** *Funding from different programmes of those projects dealing with environmental, health, safety, ethical, legal and social aspects of nanotechnologies*

**5. Information on relevant national policies, in particular relevant innovation policies**

**5.1 Foresight Studies of the applications of nanotechnologies by Spanish industry**

The Observatory for Industrial Technology Foresight (OPTI) (**http://www.opti.org**) is a foundation, which under the auspices of the Ministry of Industry, Tourism and Trade, generates intelligent information on the evolution and future of science and technology on a medium to long term basis. The OPTI Foundation was born in 1997 with the following objectives: (i) to generate a base of information and knowledge on trends and predictions on the future with regards to the impact and influence of technology on industry, employment and competitiveness, and (ii) to provide useful information enabling decision makers within governments and enterprises to develop appropriate strategies to overcome technological challenges in the coming future. OPTI Foundation has published around fifty foresight studies to date in the technology field. During 2007 OPTI Foundation (together with INASMET-TECNALIA Technology Center) carried out a foresight study entitled *"Aplicaciones Industriales de las Nanotecnologías en España en el Horizonte 2020"*. This study was released at the beginning of 2008.

**5.2 Promotion of Spanish "nano" companies abroad**

The Spanish Institute for Foreign Trade (ICEX) ("Instituto Español de Comercio Exterior") depending of the Spanish Ministry of Industry, Tourism and Trade is the Spanish Government agency serving Spanish companies to promote their exports and facilitate their international expansion. The Plan for the Internationalization of the Spanish Technology, designed by the Ministry of Industry for the period 2005-2007 with a budget of 100 Millions €, and leaded by ICEX, focuses on the International Promotion of Spanish High Technology Industrial Sectors. Within this programme, The Phantoms Foundation, non-profit Association that coordinates the Spanish Nanotechnology Network "NanoSpain", and ICEX, have agreed a Programme of activities, with the objective of presenting the Spanish offer in NanoScience and Nanotechnology as a whole and to facilitate relations and cooperation between Research Centres, Industry and Spanish nanotech-companies in the global markets. ICEX total financial compromise for "nano" activities 2006-2008 (see **table 9, page 31**) is around 150.000€.

**5.3 Standardisation activities in the field of Nanotechnologies in Spain**

AENOR, the Spanish Association for Standardisation and Certification (**http://www.aenor.es**) established in 2006 the National Technical Committee for standardisation on Nanotechnologies in order to ensure the Spanish participation and contri-

## Research

| Institute / Center | WEB | Short description |
|---|---|---|
| Laboratorio Ibérico Internacional de Nanotecnologia | http://www.iinl.org | Common project between Spain and Portugal (funded from several Ministries). |
| IMDEA-Nanociencia | http://www.imdea.org | IMDEA NANOSCIENCE is a Foundation created by a joint institutional initiative of the regional Government of the Community of Madrid and the Ministry of Education and Science of the Government of Spain, to manage the Madrid Institute of Advanced Research in Nanoscience. |
| Centre d'Investigacions en Nanociència i Nanotecnologia (CIN2) | http://www.cin2.es | The "Centre d'Investigacions en Nanociència i Nanotecnologia" (CIN2) is a mixed Research Institute that has as partners the "Consejo Superior de Investigaciones Científicas" (CSIC) and the "Institut Català de Nanotecnologia" (ICN). |
| Instituto de Nanociencia y Nanotecnología de Asturias | (not available) | Join Initiative of the Principado de Asturias, Universidad de Oviedo and CSIC. |
| Instituto Universitario de Investigación de Nanociencia de Aragón (INA) | http://ina.unizar.es | CONSOLIDER Project: “Nanotecnología en Biomedicina” |
| CIC-nanoGUNE | http://www.nanogune.eu | NanoGUNE has been awarded as the first Consolider Center by the Spanish Education and Science Council. |

***Table 8:*** *Current initiatives in Spain (with GSA intervention) stemming from the establishment of relevant scientific infrastructures*

## Advertisement

| NS&NT ICEX activities (2006-2007-2008) - Coordinated by the Phantoms Foundation |
|---|
| Design and diffusion of promotional materials Highlighting the achievements of Spanish Nanotechnology and Nano–Science. **http://us.spainbusiness.com/chicago/technology/index.htm** |
| Promotion of the NanoSpain 2007 Conference (Sevilla, 2007) |
| Promotion of the International Conference "Trends in Nanotechnology" (TNT 2007) (San Sebastian, September 2007). |
| Promotion, support and sponsorship of the First Spanish Pavilion at Nanotech Japan (Tokyo, February 2008) that grouped 12 Spanish companies and research Centres. (More info at **http://www.phantomsnet.net/files/E_NANO_Newsletter_IssueSI.pdf**). |
| Sponsorship of the NanoSpain 2008 Conference (Braga, April 2008) |
| Promotion and sponsorship of the International Conference NanobioEurope 2008 (Barcelona, June 2008) |
| Promotion and sponsorship of the international Conference "Trends in Nanotechnology" (TNT 2008) (Oviedo, September 08) |
| Prospection of COMS International Trade Show (Mexico August – September 2008) |

***Table 9:*** *ICEX total financial compromise for "nano" activities 2006-2007-2008*

bution to the respective European and International ones, the European Committee for Standardisation (CEN), its sister organization CENELEC and the International Organization for Standardization (ISO, **http://isotc.iso.org**) as well as for the International Electrotechnical Commission (IEC, **http://www.iec.ch**).

During these past two years of life, the technical standardisation committee, AEN/GET 15 "Nanotecnologías", has carried out an intensive search for all interested stakeholders and now includes among its members representatives from the research community, as well as from producers and users of nanotechnology-based products, universities, sector technology platforms and public authorities (i.e. the chairmanship of the AEN/GET 15 is held by the Spanish Metrology Centre, CEM).

The technical committee is structured mirroring ISO/TC 229 in working groups that cover the following topics: Terminology and nomenclature, Measurement and characterization, Health, safety and environmental issues and Material specification, as well as Electrotechnical applications of nanotechnologies.

The current work program for establishing new standardisation documents includes over 20 drafts in different development stages which cover issues from terminology and definitions of nanoparticles, to measurement methods, toxicity testing, characterization of nanotubes, etc.

Spain is thus contributing to European and international standardisation with the active participation of its experts. In the field of European standardization it is especially relevant the response from the CEN/TC 352 (**http://www.cen.eu**) to the European Commission's mandate M/409 for the elaboration of a programme of standards to take into account the specific properties of na-notechnology and nanomaterials, which has been recently developed and shall define the guidelines for the deve-lopment of European standards in support of the European Union policies.

### 5.4 Nanometrology activities in Spain

Few specific projects on nanometrology have been running in the last years in Spain although measurement and characterization constitutes the most important part of many other nanotechnology projects. The Spanish Metrology Centre, CEM (**http://www.cem.es**) has initiated and funded some projects directly applicable to the nano field, in collaboration with Spanish companies, as for instance the so called SARTSI, System for detecting and eliminating non linearities in laser measurement interferometric systems, intended to calibrate piezoelectric actuators and nano-positioning systems with sub-nanometre uncertainty.

At present CEM is starting a new project in this field: the development of a metrological AFM for the calibration of samples and standards in the nanometric and sub-nanometric fields. Such a system, again realized in collaboration with Spanish partners, will combine SPM techniques with high resolution interferometry by using stabilized laser sources.

CEM is also participating in international comparisons organized by EURAMET (the European Association of National Metrology Institutes): Calibration of quartz line scales (K7.2006), Characterization of flatness by Fizeau interferometry with nanometric uncertainty (P672) or Interferometric calibration of micro-displacement actuators with sub-nanometric resolution and uncertainty (P866).

New EMRP (European Metrology Research Programme) Projects co-funded by the European Union and EURAMET partners constitute the most recent and specific way for Metrology to contribute to the development of the nanoscience. Projects like Traceable calibration of nanoparticles (JRP1.1), New routes for traceability in nanometrology (JRP1.4) or Interactions Tip-Sample in SPMs (JRP1.2) show clearly the efforts realized by National Institutes of Metrology to help to build a nanometrology infrastructure, crucial for improving the

accuracy and traceability of measurements in the nanoscale.

### 5.5 Technological Platforms and industrial networks

**GENESIS PLATFORM**
(**http://www.genesisred.net/index.htm**)
The objective of the Technological Platform for the Integration of Nanotechnology and Intelligent Systems is to promote the strategic positioning of Spain in these areas. GENESIS is a member of the ENIAC Stakeholders Forum. GENESIS is promoted by GAIA (Association of Electronic and Information Technologies Industries), the CNM – National Centre for Microelectronics (CSIC) and the CIDETEC – Centre for Technological Research into Electrochemistry. In addition, it receives the support and collaboration of the Ministry of Industry, Tourism and Trade, the Ministry of Education and Science, and the CDTI – Centre for the Development of Industrial Technology.

**NANOMED** (**http://www.nanomedspain.net/index.html**)
The Spanish Nanomedicine Platform is an initiative that aims to bring together the main Spanish players in the fields of research, industry and the government in order to push forward the development of a joint strategy in the highly multidisciplinary area of nanomedicine. Spanish industries operating within the biomedical and biotechnological sectors play a key role in this Platform, being supported very actively by a wide range of technological centres, research organisations, universities and hospitals, as well as by the Spanish Government.

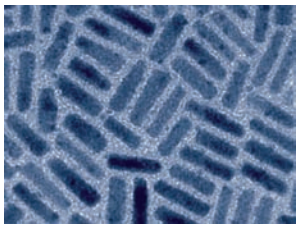
**RENAC** (**http://www.nano-renac.com**)
RENAC is the network for the application of nanotechnologies in construction and habitat materials and products. RENAC is made up of eight Technology Institutes and several prestigious research groups from universities from the Valencia region (Jaime I University, University of Valencia, Technical University of Valencia and University of Alicante). The reasons that lead to the creation of RENAC are: (i) understanding the huge industrial opportunities of the implementation of nanotechnological scientific developments to new and traditional construction and habitat products; (ii) awareness of their enormous scientific and technological complexity; (iii) awareness of the large investment required for scientific equipment and HR to work in the area; and (iv) awareness of the great international technological "competition" that is arising.

### 5.6 Training in Nanotechnology

This issue is an actual challenge due to its intrinsic multidisciplinary character. However, nanotechnology has been included in the curricula of almost 20 several Spanish Universities (public and private). This is a really important offer that does not fit to the decaying number of science and technology students in Spain. Therefore, some of such courses will disappear or merge in the short term.

# imdea nanociencia

MOLECULAR NANOSCIENCE



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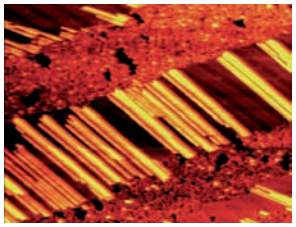

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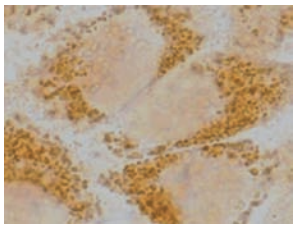
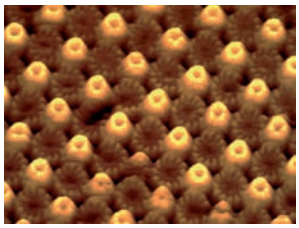
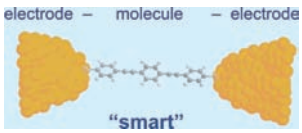


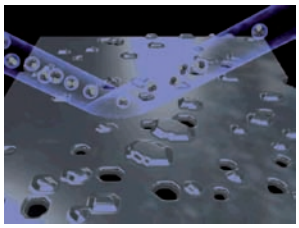
NANOBIOSYSTEMS: BIOMACHINES AND MANIPULATION OF MACROMOLECULES



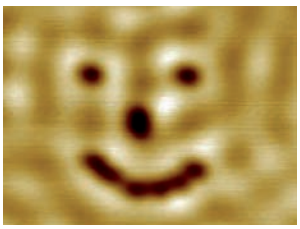
NANOELECTRONICS AND SUPERCONDUCTIVITY




SEMICONDUCTING NANOSTRUCTURES AND NANOPHOTONICS

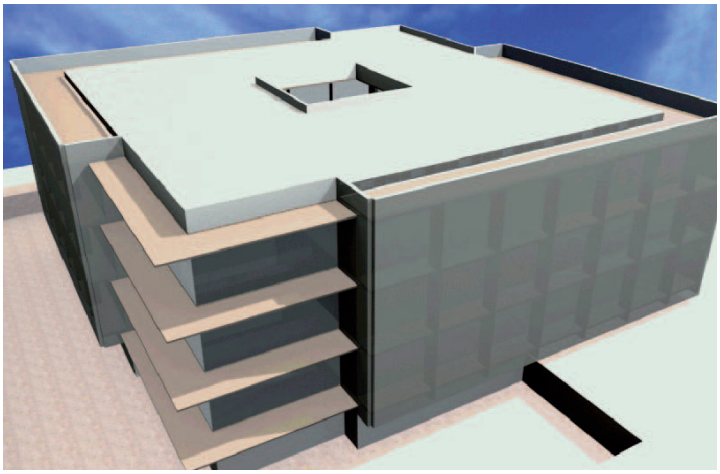


HORIZONTAL PROGRAM ON NANOFABRICATION AND ADVANCED INSTRUMENTATION



IMDEA-Nanociencia is a private Foundation created by joint initiative of the regional Government of Madrid and the Ministry of Education of the Government of Spain in February 2007 to manage a new research Institute in Nanoscience and Nanotechnology (IMDEA-Nanociencia), which is located in the campus of the Universidad Autónoma de Madrid, 12 km away from Madrid downtown with an excellent communication by public transportation with the Madrid-Barajas airport (25-30 min) and Madrid downtown (15-20 min).

The Institute offers attractive opportunities to develop a career in science at various levels from Ph.D. students to senior staff positions.



## Contact

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Campus de Cantoblanco · Madrid · 28049 · Spain
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For further details see www.nanociencia.imdea.org

The final landscape containing all the Master and PhD courses will be more realistic after the full implementation of the Bolonia scheme in the Spanish Universities at the end of 2009.

**5.7 The future: NS&NT as a key element of the Spanish R&D National Plan 2008-2011**

The structure of the Sixth National Plan (**http://www.plan-nacionalidi.es**) for scientific research, development and technological innovation for the 2008-2011 period is divided into four areas linked to instrumental programmes working towards concrete and specific objectives: (i) the knowledge and skills generation area; (ii) the promotion of cooperation in R&D area; (iii) the development and technological innovation area, and (iv) the strategic actions (SA) area.

Within the set of Strategic Actions, the new R&D National Plan includes the new Strategic Action for Nanoscience and Nanotechnology, New Materials and New Industrial Processes, designed for the overall enhancement of Spanish industry competitiveness through the implementation of deep changes in several industrial sectors by generating new knowledge and applications based on te convergence of new technologies, where nanotechnology plays a central role. This SA includes seven thematic lines:

1.- Nanotechnologies applied in materials and new materials within the field of health.
2.- Nanotechnologies for information and telecommunications.
3.- Nanotechnologies with respect to industry and the environment.
4.- Knowledge-based intelligent materials with individually-tailored properties and high performance materials and coatings.
5.- Advances in technology and processing of materials
6.- Development and validation of new industrial models and strategies. New technologies for design and manufacturing processes. Network-based production.
7.- Exploitation of convergent technologies.

The Strategic Action encompasses the development of activities within the six Instrumental Strands of Action of the National Plan (Human Resources, Projects, Institutional Strengthening, Infrastructures, Knowledge Use, and Articulation and Internationalisation of the System).

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Several authors
**Edited by Phantoms Foundation (2008)**

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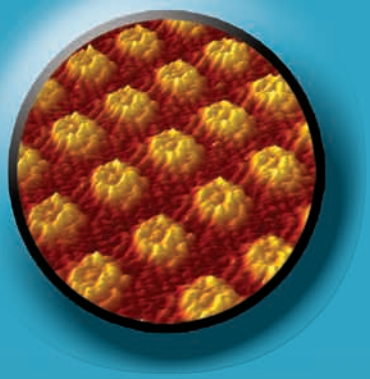
# SURFACE ANALYSIS

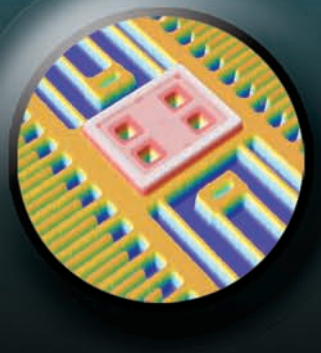


## AFM / STM

*Materials, polymers, biology, electrochemistry...*

## SNOM Microscopy

*Reflection, transmission, Apertureless...*
*SECM, Deep Trench, nanopipette probes...*



## 3D Optical Profilometry

*New confocal technology...*
*Interferometry (PSI/VSI)...*

## And also...

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