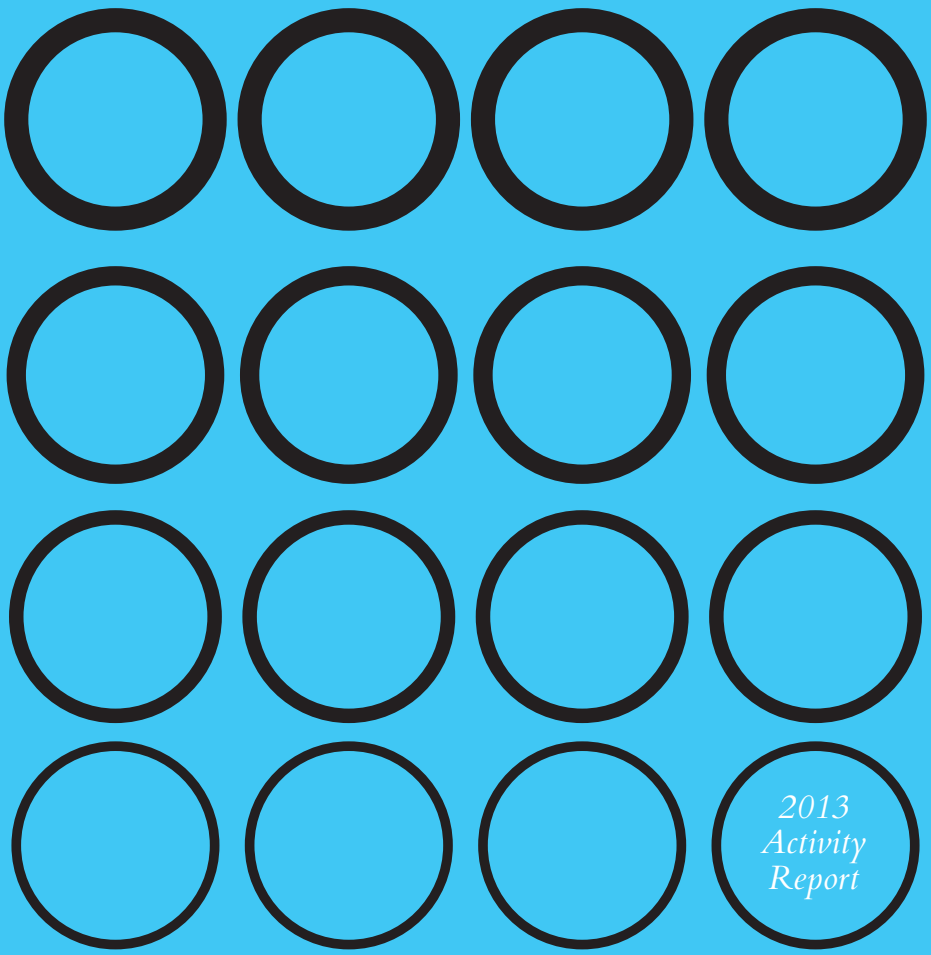
BCMATERIALS

BASQUE CENTER FOR MATERIALS, APPLICATIONS & NANOSTRUCTURES

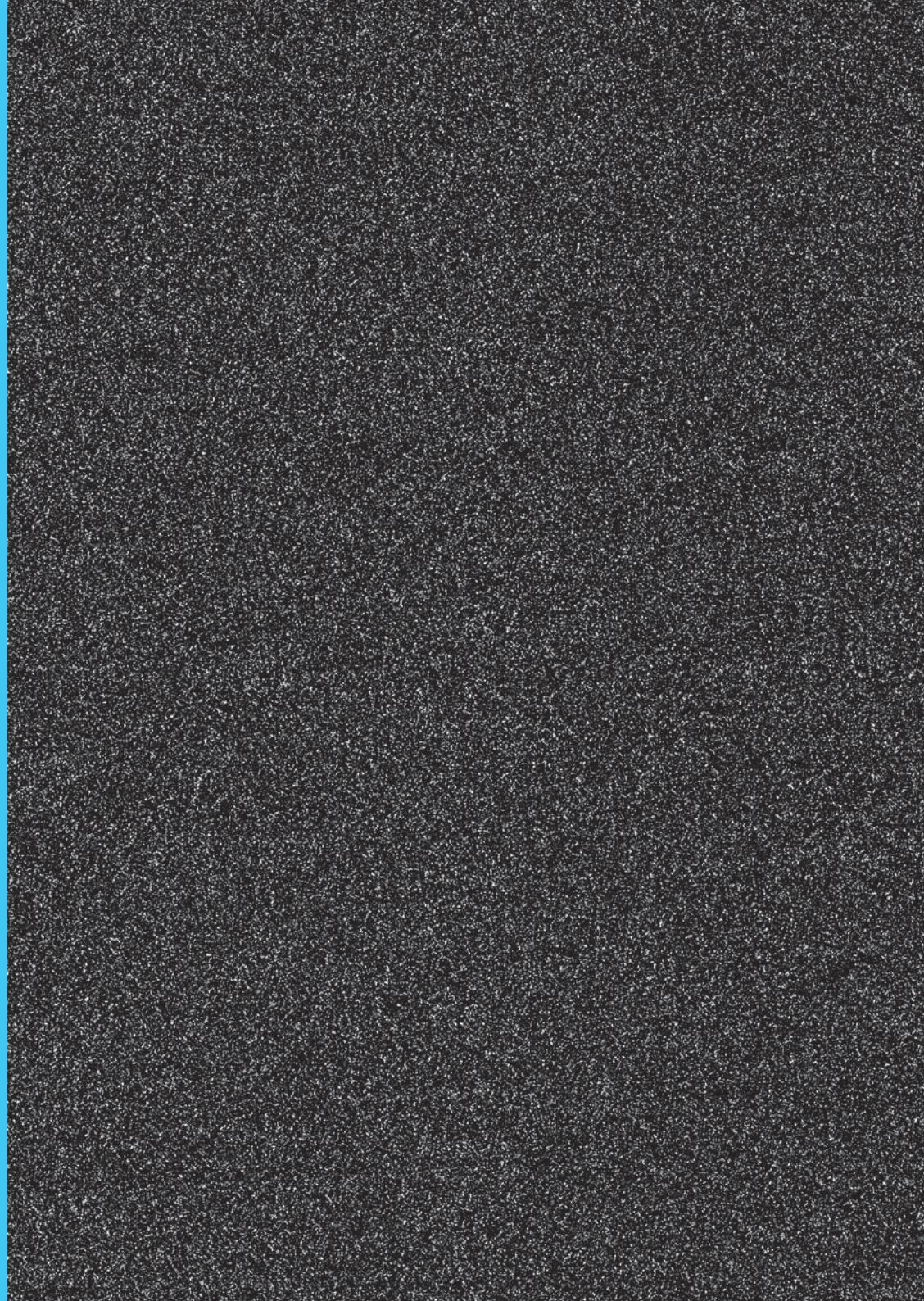
ehugroup



2013 Activity Report

BCMATERIALS IS A RESEARCH CENTER BELONGING TO THE BERC –BASQUE EXCELLENCE RESEARCH CENTERS– NETWORK AND DEVOTED TO MATERIALS, APPLICATIONS AND NANOSTRUCTURES.

MAIN RESEARCH LINES WILL BE RELATED TO THE STUDY OF FUNCTIONAL MATERIALS WITH ADVANCED MECHANICAL, THERMAL, ELECTRIC, MAGNETIC AND OPTICAL PROPERTIES.



BCMaterials

BASQUE CENTER FOR MATERIAL, APPLICATIONS & NANOSTRUCTURES

2013 Activity Report

As Scientific Director of BCMaterials it's for me a pleasure to present this very first activity report of the Center. While BCMaterials' official start was the summer of 2012, it was more a ceremonial than an operational beginning. All had to be built up from the ground and 2013 was the first year of actual scientific activity.

For an institution starting in a time of crisis, this has been a year of intense, but restrained, activity. The first indispensable step was to create the organizational structure, which includes different levels as, management, legal, institutional, and last but certainly not least, the research structure. As a consequence of harsh financial times, the late and restrained budget availability pushed most of the research activity to the second half of the year.

However, thanks to the intense and efficient work of the few people directly hired by the center, and the extraordinary support of the University's research groups that take part in the Center's development, the quantity and quality of the results obtained show a glimpse of the full potential that will be achieved with the steady operation of BCMaterials.

2013 has been the year of showcasing BCMaterials. In this sense I want to highlight the intense activity of visits to other centers, signing of cooperation agreements, attendance to conferences and meetings, amongst other activities that have helped introduce and make BCMaterials known all around the world. While much has been done, there is still much to be done in the upcoming years.

At the same time intense work has been undertaken in house and, at the end of the year all the research lines that had been proposed are up and running, producing results in the form of publications, contributions to conferences, Master and PhD theses, etc. We all hope that the upcoming years will bring increased and intense activity, backed by proper (less restraining) budgets, and the seed of BCMaterials will flourish and yield a rich harvest of scientific progress and technological transfer beneficial to the Basque society.

With this hope I now give you the 2013 activity report, a small taste of what we think the future will bring.

Zamudio, April 27th 2014

José M. Barandiarán
DIRECTOR

ORGANIZATION AND MANAGEMENT

Introduction

Fundación BCMaterials -Basque Center for Materials, Applications and Nanostructures- is a strategic initiative for Basque science system, whose key drivers are Ikerbasque, the Basque Foundation for Science, and the University of the Basque Country, UPV/EHU.

This foundation was created with the objective of developing and establishing a center for cutting-edge research under international quality research in the area of materials science, which is one of the key strategic priorities of European, Spanish and Basque research strategies.

Creating BCMaterials as a research center of excellence for materials science has made sense based on existing groups of excellence in materials science. The Center allows a number of advantages that improve, in Basque Country, the level and productivity of these groups and scientific research in general.

BCMaterials sees its work from the existence of local groups and researchers of excellence in materials science, mainly concentrated in the FCYT, UPV/EHU, and provides improved visibility and knowledge transfer of materials research to the Basque society.

The key elements of BCMaterials differentiating strategy are defined in its mission, vision and values, which are described below:

Mission

The mission of BCMaterials is to develop high-quality interdisciplinary research to cover all aspects of research in functional materials with advanced electric, magnetic and optical properties; from basic to applied.

In order to realize the mission outlined above, BCMaterials sets itself the following aims:

a.) To develop an internationally competitive and recognized science and technology by creating a team of top flight researchers and by carrying out post-graduate training activities of the highest quality.
b.) To use a large- scale European facilities as neutrons and synchrotron radiation for the study of materials by promoting scientific and technological advances worldwide.
c.) To attract private and public funding (both national and international) through fomenting interdisciplinary collaboration as the driving force behind major scientific and technological advances.

Vision

BCMaterials is destined to be internationally reference center for research in the area of magnetic, functional and active materials and nanomaterials.

It is devoted to the quality of publications, image and prestige, based on the excellence of its research, customer satisfaction and people and socially responsible.

Values

Referencing values statements of entities of patronage, BCMaterials assumes:

a.) Leading researcher vocation.
b.) Commitment to the Principles of Excellence.
c.) Effectiveness and efficiency in resource management.
d.) Management transparency.
e.) Satisfaction and development of people.
f.) Open society and contribution to sustainability.

Policies to develop a code of conduct in line with the guidelines of the document "European Charter for Researchers" are planned.

Management System

BCMaterials is involved in consolidating the EFQM management model as a reference, moving in process management and training on the model, promoting and carrying out actions aimed at continually improving and systematizing the use of scorecard indicators. BCMaterials is committed to moving towards making the necessary external recognition to be considered as a benchmark in its scope actions.

The Process Management is a systematization of the modes of action to guide them to the achievement of results through a systematic collection and analysis of data. The implementation of the system involves reflections on allocation of responsibilities and appointment of process owners considering leadership and involvement in process activities and sufficient competition for the implementation, management and process improvement.

To improve the efficiency and optimize the performance management system is necessary a continuous process of identifying and updating technology needs, allowing the best solutions. This includes ensuring the provision of services under the headings of "Information Systems and Technology Platform" on one side, and "Systems Management Applications" on the other, and cover some of the technological requirements in sections Center Technology Infrastructure.

So computer systems and technology platform services provide architecture level as management services and platform support, based on the needs of the service.

Licensing procedures and guarantees of all computer software: we have obtained the software updates to users' computers and licenses, as well as e-mail servers, database, backup, antivirus, etc., in order to keep up with all installed programs on computers in the Center.

According to fundamental concepts of Excellence, during 2013 BCMaterials management system has developed "Managing by Processes" using comparative data and information to drive process improvement. So, indicators of process sheets are being collected taking into account the Balanced Score Card and aligned to BCMaterials strategy.

Also the fundamental Concept "Succeeding Through People" is being considered to develop a culture of trust and empowerment to release full potential of people. In this sense, during 2013 BCMaterials management system has worked on the welcoming protocol, activity report and evaluation of staff and personal skills.

Watching at "European Charter for Researchers" during 2013 BCMaterials has encouraged some activities of mobility as part of a comprehensive human resource policy.

Also BCMaterials contract policies has considered the researchers adhesion conditions to Intellectual Property Rights regulations and requirements of any sponsor or funders. Required results (e.g. theses, publications, patents, reports, new products development, etc.) are considered to set out in the terms and conditions of the contract or equivalent document.

Finally, BCMaterials human resource policy has aimed for a representative gender balance achieving an equal opportunity policy at recruitment without, however, taking precedence over quality and competence criteria.

BCMaterials recognizes that the environment is a determining factor in all human activities. Therefore, the environmental dimension of its activities aim to promote to gradually reduce the environmental impacts of their activities, facilities and services. BCMaterials commits to promote and investigate eco-efficient solutions within their stakeholders with whom it interacts, thus harmonizing the conduct of their activities with the legitimate right of current and future generations to enjoy an adequate environment. Such commitment is assumed and promoted through the establishment of environmental goals, training of and provision of information to employees and the participation in initiatives and ratings relating to sustainability.

RESEARCH

New Equipment

Several urgent equipment for the development of the research lines has been acquired and installed, with funds coming from the support groups, as BCMaterials had not enough budget to cover but small side parts of them. We mention:

a.) Floating zone furnace for metal and oxide single crystal growth.
b.) Z-sizer apparatus for nanoparticle characterization.
c.) Glove box for Li-Na batteries research.
d.) Impedance analyzer for sensor development.

Most equipment has been purchased thanks to the UPV/EHU Scientific Equipment Call, with partial support from research groups funding by the Basque Government and other sources of the support groups. In one case at least, BCMaterials direct support has been needed.

Research Activity

Active (Smart) Materiales

These are materials that present crossed properties so that they re-act in the determined way to a stimulus by changing a different property. They are good candidates for integrating devices and structures that can self-accommodate to changing external conditions and behave as smart devices or systems.Those include: Thermal (thermo-chromic, thermo-electric), Mechanical (Shape Memory Alloys and Polymers, thermo-elastic), Magnetic (magneto-elastic, magneto-resistive, magneto-optic, ferrofluids, Ferromagnetic Shape Memory Alloys, etc.), Electric (photoelectric, advanced piezoelectric materials), Multiferroics, etc.

Ferromagnetic Shape Memory Alloys, FSMAs

DESCRIPTION

FSMAs are magnetic metallic compounds undergoing a martensitic transformation resulting a self-accommodated microstructure which can be controlled by magnetic field alongside thermal and mechanical stimuli. They are of high technological interest as able to develop up to 10% strains as a function of applied magnetic field. Typical compositions include NiMn(Ga,Sb,In,Sn), FeNiGa(Al), CoNiGa(Al), etc. Our goal is to make the BCMaterials a world-leading center in science and engineering of FSMAs and related magneto-structural materials, through materials design for best functionality on the macro and nano-scale, including fabrication processes, basic characterization, structural behavior, advanced physical properties, mechanisms of functions, and theoretical studies.

WORK HAS BEEN CARRIED OUT IN THE FOLLOWING SUBJECTS

Bulk MSM, we develop and optimize the high-performance FSMAs by precise tailoring their composition and substructure. Particularly, we have designed and prepared new series of metamagnetic Mn-based Heusler alloys, Mn-Ni-Sn(Fe) exhibiting larger drop of magnetization than a "classical" metamagnetic shape memory alloys. Experimental and theoretical studies of the structure, phase transformation and functional properties of these new materials alongside with Ni-Mn-Sn(Co) and Ni-Fe-Ga(Co)

MSM are under the way. Also large-scale facilities at ILL, Grenoble (neutrons) and SPring-8 synchrotron, Japan (hard Xray photoelectron spectroscopy) were used to study phonon and electron structure of Ni-Mn-Ga samples.

FSMAs thin films for micro- and nano-actuator applications we have studied the influence of residual stress on the martensitic transformation. Magnetic properties of Ni-Mn-Ga films have been studied by FMR and magnetization measurements. The thermal actuation properties and performance of Ni-Mn-Ga thin film cantilevers have been studied in collaboration with KIT, Karlsruhe.

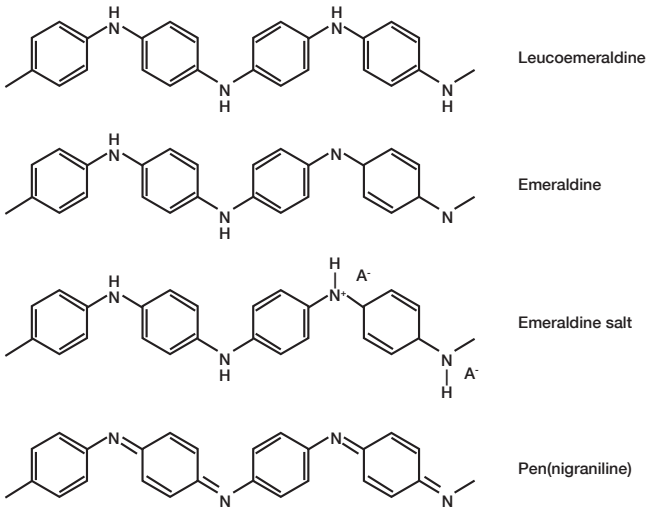


FIG. 1
Different oxidation states of PANI.
"Improving the Processability of Conductive Polymers: The Case of Polyaniline"
J. Ruiz, B. Gonzalo, J.R. Dios, J.M. Laza, J.L. Vilas, L.M Leon.

Ferromagnetic shape memory alloys (NiMnX, X=Ga, In , Sn) have been studied using positron annihilation PALS as a research technique for defects characterization in these alloys.

It has been studied the behaviour of defects in off-stoichiometric Ni-Mn-Ga ferromagnetic shape memory alloys by means of positron lifetime spectroscopy in six ternary alloys after subsequent isochronal annealing at different temperatures up to a maximum

temperature of 700°C. Investigation shows a high dependence of recovery behaviour with composition in NiMnGa ferromagnetic shape memory alloys.

SELECTED RESULTS

"Transformation volume effects on shape memory alloys"; Chernenko, V. A.; L'vov, V. A.; Cesari, E.; Kosogor, A.; Barandiaran, J. M.; Review article. Metals 2013, 3(3), 237-282; doi:10.3390/met3030237. Special Issue "Shape Memory Alloys", Ed. K.Ziebeck.

"Magnetic influence on the martensitic transformation entropy in Ni-Mn-In metamagnetic alloy"; Barandiaran, J.M.; Chernenko, V. A.; Cesari, E.; Salas, D.; Lazpita, P.; Gutierrez, J.; Orue, I.; Applied Physics Letters (2013), 102(7), 071904/1-071904/4.

Aseguinolaza I. R. et al.; Appl. Phys. Lett. 102, 182401 (2013).

Kimura A. et al.; Appl. Phys. Lett.103, 072403 (2013)

COLLABORATIONS

Barcelona (A.Planes), Palma de Mallorca (E. Cesari), Pamplona (V.Recarte), Santander (J. Rodriguez); Germany: KIT, Karlsruhe (M. Kohl), Duisburg Univ. (P. Entel); Finland: Adaptamat; Italy: IENI, Lecco (S.Besseghini), U. Parma (F. Albertini); Russia: Moscow State University (A. Granovsky); Ukraine (V. Golub, V. Lvov, Institute of Magnetism); France: FEMTO, Besanson (L. Hirsinger); USA.- Boise State Univ. (P. Müllner), Lawrence Berkeley National Lab., Advanced Light Source (C. Jenkins), Iowa Univ.-Ames Lab (T. Lograsso); Japan.- Osaka Univ. (T. Kakeshita), Tohoku Univ., Sendai (R. Kainuma), Hiroshima Univ. (A. Kimura).

Smart Polymers

DESCRIPTION

A responsive macromolecule changes its conformation and/or properties in a controllable, reproducible, and reversible manner in response to an external stimulus (solvent, pH, temperature, etc.). These changes can be used to create a large variety of smart devices. The good processing of most smart polymers facilitates their incorporation into devices and adds additional advantages (e.g. all electronic plastics/optical sensors).

WORK HAS BEEN CARRIED OUT IN THE FOLLOWING SUBJECTS

In the area of polymeric materials with shape memory it has determined thermal and mechanical structural changes induced on polycyclooctene when they are crosslinked by gamma radiation. It has been assessed the capacity of the shape memory of the irradiated samples.

In the area of piezoelectric materials, new polyimides have been synthesized by varying the starting anhydride, polymers and copolymers, being obtained with very good prospects. A corona polarization system has been developed which allows the use of high voltages. The piezoelectric properties of polarized polymers and copolymers have been determined; these properties remain constant up to temperatures as high as 170°C.

In the area of smart surfaces there are developing micro / nano-structured polymeric membranes to capture organic pollutants and multilayer surfaces for biomedical applications. Besides the influence of the substituents on the formation of polymeric multilayers from biocompatible polymers onto functionalized polymer films is analyzed. The structuration of glass surfaces using non destructive techniques that are capable of generating regular nanoscale patterns is also under study. The structuration of polystyrene and polycyclooctene coated substrates is also initiated.

SELECTED RESULTS

"Improving the processability of conductive polymers: The case of polyaniline"; Ruiz, J.; Gonzalo, B.; Dios, J.R.; Laza, J.M.; Vilas, J.L.; Leon, L.M.; Advances in Polymer Technology (2013), 32(S1), E180-E188.

"Reversible functionalization of nanostructured polymer surfaces via stimuli-responsive interpolymer complexes"; Ruiz, L.; Garay, M.T.; Laza, J.M.; Vilas, J.L.; Rodriguez-Hernandez, J.; Labrugere, C.; Leon, L.M.; European Polymer Journal (2013), 49(1), 130-138.

COLLABORATIONS

Dr. Senentxu Lanceros (Do Minho University) in the field of piezoelectric polymers. Dr. Andres Fabian Lasagni (Fraunhofer Institute for Material and Beam Technology, Dresden, Germany). Dr. Juan Rodriguez Hernandez from CSIC in the field of smart surfaces.

Hybrid Multiferroics (Magnetoelectric) Materials

DESCRIPTION

Laminar or granular composites formed by a magnetostrictive and a piezoelectric material, either: Metal/ceramic like Metglas - PZT, Metal/polymer like Metglas/Terfenol - PVDF/Poliimide), or other, have raised large attention recently because their technical applications. They are, by large, much more efficient in producing an electric voltage in response to magnetic fields (Magnetoelectric Effect) than natural multiferroic materials like the well known $BiFe_{304}$. The aim is to understand the isolated and coupled behavior of such materials in view to get a very large electric output from a low magnetic excitation to develop extremely sensitive sensors for ELF communications, energy harvesting, etc.

WORK HAS BEEN CARRIED OUT IN THE FOLLOWING SUBJECTS

In the area of *Hybrid Multiferroic Materials,* we have investigated the nucleation rate of the electroactive-phase of PVDF piezopolymer filled with Fe_{203} oxide, 15 nm sized nanoparticles. It has been probed that a 5% weight of Fe_{203} nanoparticles inside the polymeric matrix is enough to get more than an 80% of the piezoelectric-phase within the composite. As the nanoparticle content increases, the degree of crystallinity decreases while the melting temperature of the polymer matrix increases. These facts have large potential for sensors and actuators applications.

In the area of *Magnetoelectric Laminated Composites*, we have followed two different lines:

a.) It has been studied the influence of the epoxy resin used to fabricate our sandwich-like laminated composites. Three different epoxies have been used: M-Bond, Devcon and Stycast. Our results probe that M-Bond, that has the lowest Young's Modulus, is also the best to transfer deformation from the magnetostrictive constituent to the piezoelectric one. This transmission, since it is not perfect, allowed us to estimate a coupling coefficient between both layers of about 0,6. Our experimental results have been also confirmed by Finite Elements numerical simulations.

b.) It has been also studied the influence of the length of the magnetostrictive constituent (metallic glass ribbon) in the magnetoelastic and magnetoelectric response of the composites. We have been able to reach operating frequencies of the magnetoelectric devide over 200 kHz, within the radio frequency range, for a 1 cm long laminated composite. At the same time limitations due to the demagnetizing factor (increasing as the length of the devide decreases) and induced eddy currents in the magnetostrictive constituent, have to be taking into account. We also started the same study with a 0.5 cm long device, reaching the operating frequency of 500 kHz, very promising for radio frequency applications.

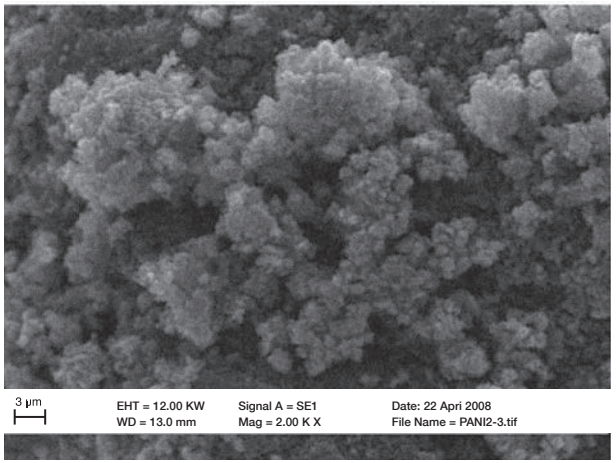


FIG. 2
Scanning electron microscope of the PANI.
"Improving the Processability of Conductive Polymers: The Case of Polyaniline"
J. Ruiz, B. Gonzalo, J.R. Dios, J.M. Laza, J.L. Vilas, L.M Leon.

COLLABORATIONS

Prof. Senen Lanceros-Mendez (Universidade do Minho at Braga, Campus de Gualtar, Portugal) for investigations related with hybrid multiferroic and laminated magnetoelectric compounds. Prof. Daniel Crespo (Universitat Politècnica de Catalunya, Castelldefels, Barcelona, Spain) for fabrication of metallic glasses by the single-roller quenching method. Dr. Rafael Perez del Real (Cantoblanco, Madrid, Spain) for fabrication of metallic glasses by the single-roller quenching method.

SELECTED RESULTS

"Improving the magnetoelectric response of laminates containing high temperature piezopolymers"; Gutierrez, J.; Lasheras, A.; Barandiaran, J.M.; Vilas, J.L.; San Sebastian, M.; Leon, L.M.; IEEE Transactions on Magnetics (2013), 49(1), 42-45.

"Optimization of the Magnetoelectric Response of Poly (vinylidene fluoride)/Epoxy/Vitrovac Laminates"; Silva, M.; Reis, S.; Lehmann C.S.; Martins, P.; Lanceros-Mendez, S.; Lasheras, A.; Gutierrez, J.; Barandiaran, J.M.; ACS applied materials & interfaces (2013). ACS Appl. Mater. Interfaces, 2013, 5 (21), pp 10912-10919.

Nanomagnetism

Nanoscale magnetic materials are the basis of a large number of devices and applications in many human activity fields, like Medicine, Electronics, Computer parts, Information storage, etc. Only a few of them can be explored at the starting of the BCMaterials.

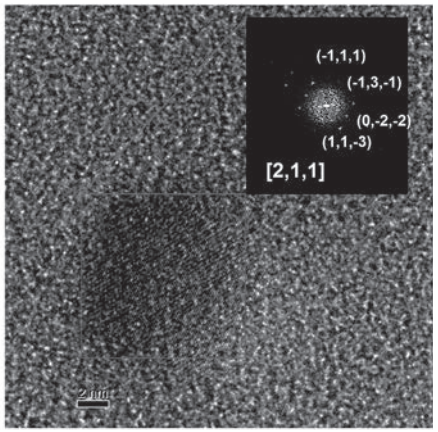


FIG. 3
HRTEM image of an isolated nanoparticle from the t=20 min bacterial sample. The inset shows the diffractogram of the magnetite nanoparticle inside the bacteria.
"Magnetite Biomineralization in Magnetospirillum gryphiswaldense: Time-Resolved Magnetic and Structural Studies"
M.L. Gubieda, A. Muela, J. Alonso, A. Garcia-Prieto, L. Olivi, R. Fernandez-Pacheco, J.M. Barandiaran.

Magnetic Nanoparticles for Biomedical and Industrial Applications

DESCRIPTION

Magnetic Nano-Particles (MNP) have a diverse range of uses from magneto-rheological fluids, MRI contrast or hyperthermia in cancer therapy, to drug delivery. Such and composition, biocompatibility, proper functionalization, etc., in order to obtain the desired properties. Regarding hyperthermia essays, there is also a need for design and construction of equipment producing RF magnetic fields of high frequency and large amplitude, compatible with the

legislation for the human body, proper targeting of the magnetic MNPs into the neoplastic tissue, in situ visualizing of the MNPs, etc.

WORK HAS BEEN CARRIED OUT IN THE FOLLOWING SUBJECTS

In the area of *Magnetic Nanoparticles for Biomedical Applications,* it has performed a thorough analysis of the biomineralization process of magnetite nanoparticles (magnetosomes) produced by magnetotactic bacteria, using a combination of magnetic and structural measurements. This kind of study is essential in order to address new biomedical applications. We have been able to demonstrate the role of bacterial ferritin in the biomineralization process. It has also performed hyperthermia measurements in these magnetosomes, obtaining very high and promising specific absorption rates. Therefore these magnetosomes are ideal for hyperthermia treatments. We have also optimized the extraction process of the magnetosomes, managing to notably increase the amount and cleanliness of the extracted magnetosomes.

We have optimized synthesis methods for the *preparation of Fe_3O_4 nanoparticles* in the 5 – 15 nm range. The seeded-growth method has been used as a suitable synthetic route to finely adjust the size and monodispersity of Fe_{304} NPs surrounded by oleic acid while attaining excellent magnetic properties. Electron magnetic resonance spectroscopy has been proved as a very efficient complementary tool in order to determinate the fine details of size distributions of MNPs and even to estimate directly the size in a system composed of a given type of magnetic nanoparticles. The size and size dispersity affect directly to the efficiency of MNPs for hyperthermia (Specific Absorption Rate, or SAR) and we have demonstrated that EMR provides a direct evaluation of these characteristics almost exactly in the same preparation and with the same concentration as used in hyperthermia experiments. The correlation observed between the SAR and the effective gyromagnetic factor (geff) is extremely remarkable and renders a way to assess directly the heating capacity of a MNP system. In this sense, as preparation methods have yield NPs with a very fine distribution, SAR values higher than 400 W/gFe_{304} have been obtained.

Nevertheless, for biological applications water soluble NPs must be obtained. For this purpose, hydrofobic Fe_{304} nanoparticle with optimized sizes were transferred to water phase by coating MNPs with dodecylamine funcionalized poly (isobutylene-alt-maleic anhidride) polymer. These NPs have been injected in rats with Colocarcinoma tumors induced in the liver and is has been observed that the temperature has increased proportionally to the amount of nanoparticles infused. The functionalized NPS provided with COOH groups can lead further reactions and different biological molecules can be attached. So, in order to reach more easily tumor cells, RGD peptides were anchored to polymer modificated nanoparticles.

Iron nanoparticles have been synthesized biocompatibilized with different polyethylene glycols and certain derivatives thereof, proving to be very interesting materials because of their stability and magnetization.

In the area of nanomagnetism-hyperthermia magnetic nanoparticles have been studied for biomedical and magnetic applicators in the 50 Khz-1 Mhz frequency rate have been designed. In the area of instrumentation for hyperthermia applications, it has been built an Ac Magnetometer for measuring the Specific Absorption Rate (SAR) of magnetic nanoparticles which is crucial to assert their potential for magnetic hyperthermia. To perform this task calorimetric methods are widely used. However, those methods are not very accurate and are difficult to standardize. We obtain AC magnetometry results performed with a lab-made magnetometer that is able to obtain dynamic hysteresis-loops in the AC magnetic field frequency range from 50 kHz to 1 MHz and intensities up to 24 KA.m^{-1}. In this work, SAR values of maghemite nanoparticles dispersed in water are measured by AC magnetometry. We compared the so obtained values with the SAR measured by calorimetric methods. Both measurements, respectively by calorimetry and magnetometry, are in good agreement. Therefore, the built AC magnetometer is a very good way to obtain SAR values of magnetic nanoparticles.

COLLABORATIONS

Prof. L. Fernandez Barquin (University of Cantabria, Spain) and D. A. Venero (ISIS, UK) for small angle neutron scattering in Fe-Ag granular thin films and magnetic interactions. Prof. P. Gorria and Prof. J. Blanco (University of Oviedo, Spain) for XANES spectroscopy analysis in NiO nanoparticles. N. Usov, for Magnetostatic interactions in magnetosome clusters. L. Olivi and G. Aquilanti (ELETTRA, Trieste) for XAS experiments at Elettra

synchrotron. G. Cibin (Diamond, UK) for XAS experiments at Diamond synchrotron. D. Navas (Oporto University), C. Redondo (UPV/EHU) for nanopatterning. Prof. K. Simeonidis (Aristotle University, Greece) and Prof. F. Plazaola, J.A. Garcia (UPV/EHU) for hyperthermia measurements in magnetosomes and inoculated animals. Dr. J. Martinez de la Fuente (Instituto de Nanotecnología de Aragón, Spain) for in vitro experiments and for studying polymer encapsulation of magnetic nanoparticles. The student X. Las Heras who is performing his Ph Thesis in BCMaterials has stayed in INA installations for 6 months. Dr. J. Echevarria (Galdakao Hospital) for in vivo experiments with rats inoculated with magnetic NPs. Prof. W. Parak (Marburg University, Germany) for transferring organic NPs to water phase. Our students have stayed for different periods in Marburg University. Recently Dr. D. Aberasturi defended her Ph Thesis performed in Marburg University and co-directed by Prof. W. Parak. Prof. L.M. Liz-Marzan (CIC Biomagune) for Z potential measurements in dispersion of nanoparticle. Prof. F. Plazaola (UPV/EHU) for hyperthermia measurements of samples and inoculated animals. Prof. Agustin Lambri (National University of Rosario, Argentina); PALS spectroscopy in Polymers. Olivier Sandre (University of Bordeaux), Magnetic Nanoparticles for Hyperthemia.

SELECTED RESULTS

"Magnetostatic interactions in various magnetosome clusters"; Usov, N. A.; Fdez-Gubieda, M.L.; Barandiaran, J.M.; Journal of Applied Physics (2013), 113(2), 023907/1-023907/9.

"Magnetite Biomineralization in Magnetospirillum gryphiswaldense: Time-Resolved Magnetic and Structural Studies"; Fdez-Gubieda, M.L.; Muela, A.; Alonso, J.; Garcia-Prieto, A.; Olivi, L.; Fernández-Pacheco, R. and Barandiarán, J.M; ACS Nano 7 (4), 3297–3305 (2013).

"A wide-frequency range AC magnetometer to measure the specific absorption rate in nanoparticles for magnetic hyperthermia"; Garaio, E.; Collantes, J.M.; Garcia, J.A.; Plazaola, F.; Mornet, S.; Couillaud, F.; Sandre, O.; Journal of Magnetism and Magnetic Materials, available online 27 November 2013.

Magnetic Nanostructures

DESCRIPTION

New properties appear in magnetic materials as dimensions are reduced to a typical magnetic length scale, like domain wall width or exchange correlation length, that lie in the nanometer range. For this reason, artificially patterned nanostructures (top-down) and self assembled nanoparticle arrays (bottom-up) based magnetic materials have an increasing interest, from both fundamental and applied viewpoints.

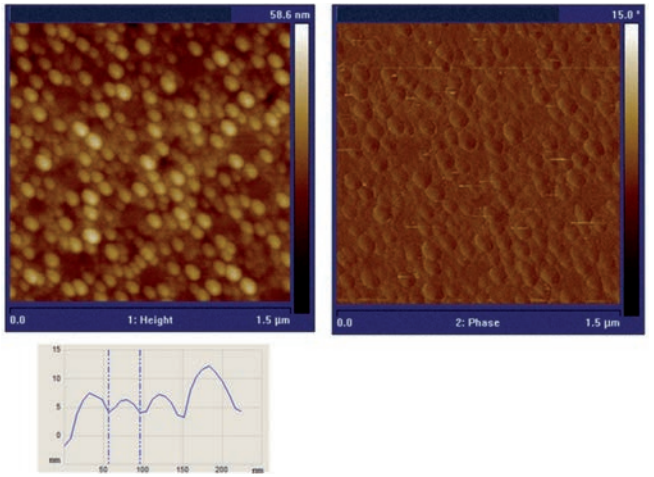


FIG. 4
Nanostructures obtained at the surface upon migration of the PS-b-PAA block copolymer. The self-assembly of the diblock copolymer at the interface induce the formation of micellar assemblies with an average diameter of 40 nm.
"Reversible functionalization of nanostructured polymer surfaces via stimuli-responsive interpolymer complexes"
L. Ruiz, M.T. Garay, J.M Laza, J.L. Vilas, J. Rodriguez-Hernandez, C. Labrugere, L.M Leon.

WORK HAS BEEN CARRIED OUT IN THE FOLLOWING SUBJECTS

In the area of *nanogranular and multilayer films* it has continued with the analysis of Fe-Ag granular thin films, focusing on the evolution of the collective magnetic behaviors with the concentration of Fe nanoparticles. SANS experiments carried out at ISIS neutron

facility have revealed the presence of different granular distributions at low and higher Fe concentrations, and we have contacted with Prof. Ondrej Hovorka from York University in order to perform computational simulations in these promising systems. Nanolithography has been used to prepare nanostructures of Fe-Ag films, in order to study the suppression of correlation lengths between the Fe nanoparticles. Initial results show neat changes as a function of the separation between nanostructures.

We have also fabricated *ultrathin Co/Ni multilayers* pursuing perpendicular magnetic anisotropy. The effective anisotropy of these multilayers has been studied by transverse and polar Kerr effect for different thicknesses and buffer layers. We have investigated the FM thickness dependence of the exchange bias field in FeF_2/FM. For FM layer with low magnetocrystalline anisotropy we have found a deviation from current theoretical models. We have developed a new model to account for these results.

In the area of *patterned nanostructures and self-assembled nanoparticles,* a new line of nano-patterning of thin films using self-assembled structures has been started. Three independent preparation routes have been selected for testing: self-assembled latex nanospheres, hole-mask colloidal lithography and porous aluminium membranes. The first one has been more extensively investigated. Latex spheres have been synthetized (with the help of Dr. M. Laza, Lab. de Química Macromolecular), different coating methods (dip and spin) have been tested, and parameters of processes to reduce latex spheres using a O_2 plasma have been defined. The Reactive Ion Etching (RIE) equipment is now functional after numerous problems. The processes for the other two techniques have been established and trials started.

Dimensionality effects have been investigated in *antiferromagnetic/ ferromagnetic (AF/FM) dots and antidots,* laterally patterned multilayers with stripe domains, crenellated FM films, FM thickness dependence in exchange-coupled systems and ultrathin multilayers with perpendicular anisotropy (PMA). We have studied sine qua non conditions of AF/FM dots and antidots for being used as multidigit memory units. These nanostructures might hold several digits in the same memory cell, which increases in orders of magnitude the magnetic storage density. The micromagnetic structure of these patterned films was studied by photoemission electron microscopy (PEEM) and XMCD at ALS (Lawrence Berkeley National Laboratory). The magnetic domain images reveal the presence of opposite-bias

domains even for zero field cooling. *Laterally patterned multilayers* were fabricated by electron beam lithography to control the nucleation of magnetic topological defects. Depending on lateral multilayer period and the external magnetic field, different domain structures were observed. *Crenellated FeNi thin films* were patterned by interference lithography. We have found inverted hysteresis loops for certain angular conditions and groove depths. We have proposed a theoretical model that accounts for these results. *The FM thickness dependence of the exchange bias field* has been investigated in FeF_2/FM. For FM with low magnetocrystalline anisotropy we have found a deviation from current theoretical models. We have developed a new model for these materials. *Co/Ni ultrathin film multilayers with PMA* are very promising for spintronic devices. PMA is very sensitive to the layer-to-layer interface quality. We have analyzed the anisotropy orientation in Co/Ni multilayers for different thicknesses and buffer layers.

Magnetic nanostructures in vortex state have a great potential for cancer therapies as recent in-vitro experiments have demonstrated. Using interference lithography we have fabricated FeNi nanodisks in vortex state on silicon substrates. Currently we are working on the preparation of these nanostructures on removable substrates, in order to obtain nanodisks in solution.

A different patterning technique, interference lithography (IL), has been used to fabricate *crenellated FeNi lines*. We have found inverted hysteresis loops for certain angular conditions and groove depths, and proposed a theoretical model that explains these results.

IL has also been used to produce *magnetic disks in vortex state* on silicon wafers. The goal of these nanostructures is to be used in biomedical applications. Thus, the next step we are working on is to fabricate them on removable substrates.

Sine qua non conditions of *AF/FM dots and antidots* have been studied for being used as multidigit memory units. These nanostructures might hold several digits in the same memory cell, which increases in orders of magnitude the magnetic storage density. The micromagnetic structure of these patterned films has been studied by photoemission electron microscopy (PEEM) and circular dichroism (XMCD) at the ALS (Lawrence Berkeley National Laboratory). The magnetic domain images reveal the presence of opposite-bias domains even for zero field cooling, which had not been proved before.

COLLABORATIONS

Prof. Ondrej Hovorka (York University, UK) for simulating the magnetic behavior in Fe-Ag granular thin filmsc). Prof. Konstantinos Simeonidis (Aristotle University, Greece) for hyperthermia measurements in magnetosomes. Prof Hosseini-Monfared (University of Zanjan, Iran) for the analysis of the magnetic moment in Mn-Ag polymersf. Prof. P. Gorria and Natalia Rinaldi (University of Oviedo, Spain) for structural analysis in NiO nanoparticles. g). L. Olivi (ELETTRA, Trieste) for XAS analysis of biomineralization in magnetotactic bacteria. Prof. I. K. Schuller (University of California San Diego, UCSD -USA) for the fabrication of AF/FM systems. Prof. C. Miller (University of South Florida, USF -USA) and Prof. C. Garcia (Bogazici Universitesi -Turkey) for the fabrication of ultrathin film multilayers with perpendicular anisotropy. Prof. X. Batlle (Universitat de Barcelona -Spain) for magnetoresistance measurements and synchrotron experiments. Prof. J. M. Alameda (Universidad de Oviedo -Spain) for laterally patterned multilayers, and D. Navas (Universidade do Porto - Portugal) for magnetic simulations and neutrons experiments.

SELECTED RESULTS

"A New Self-Calibrated Procedure for Impact Detection and Location on Flat Surfaces"; Somolinos J.A.; Lopez, A.; Morales, R.; Moron, C.; Sensors (2013), 13(6), 7104-20.

"Controlled nucleation of topological defects in the stripe domain patterns of lateral multilayers with perpendicular magnetic anisotropy"; Hierro-Rodriguez,A.; Velez, M.; Morales, R.; Soriano, N.; Rodriguez-Rodriguez, G.; Alvarez-Prado, L.M.; Martin, J.I. and Alameda, J. M. Physical Review B, 88 174411 (2013).

Advanced Functional Materials

New materials with outstanding properties are continuously appearing (see for instance graphene) in all fields of activity. It is impossible to take care of all of them, but some representative fields of research are already running and will be developed in the first stages of the BCMaterials activity. Those are Materials for Energy, Materials for Sensor and Bio-Sensor and Materials for Science Industry.

Materials for Energy

DESCRIPTION

New materials for energy generation and storage constitute a topic of the greatest significance due to its great economic potential and social impact. Fuel cells, and specially the so-called SOFCs (solid oxide fuel cells), are one of the most promising alternatives for the production of environmentally friendly energy. Chemical energy storage devices (batteries) and electrochemical capacitors (ECs) are among the leading technologies today, critically needed to enable the effective use of alternative energy sources such as solar and wind, and to allow the expansion of electrical or hybrid electrical vehicles. A fundamental understanding of the physical and chemical processes that take place in electrodes, electrolytes and specially in their interfaces is needed to design the next generation of high performance ECs. New separators and electrolytes with increased capacity and conductivity are required to improve efficiency and the possibility of operating at high currents, but also new materials have to be designed to increase service life and to reduce the size and the associated unitary cost.

WORK HAS BEEN CARRIED OUT IN THE FOLLOWING SUBJECTS

In the area of batteries the ionic conductivity needed for their industrial use could be obtained not only improving the mobile ions environment, but also through the improvement of the microstructure characteristics. We have developed a simple and cheap process for the synthesis of Si substituted $LiMn_2O_4$ that is currently one of the most popular cathode materials for Li-ion batteries. The resulting materials are composed of partially sintered particles of 80 nm average size, corresponding to single crystalline phases with cubic spinel structures. Our studies revealed that introducing a

small amount of Si(IV) enhances the electrochemical performance of the spinel, showing higher capacity retention at 1°C. We have also investigated some Na-compounds to incorporate them in sodium-ion batteries. Thus, the $Na_3(VO)_2(PO_4)_2F$ phase has been obtained by a novel single-step hydrothermal method and the presence of V^{4+} ions unambiguously confirmed by ESR spectroscopy. This material has been carbon coated via an impregnation method followed by a flash thermal treatment. This carbon increases the electronic conductivity and Na^+ diffusion ability, enhancing the electrochemical performance of the sodium-vanadium fluorophosphate material. Besides, it has worked on new materials with luminescence properties potentially useful in the energy field. The development of white light emitting diodes (WLEDs) for replacement of the conventional incandescent and fluorescent lamps precise of new red phosphors because the actually employed are chemically unstable and typically expensive. With this aim, we have synthesized and characterized the $Zn_{2-x}Mn_x(SeO_3)F_2$ compound doped at various concentrations by employing mild hydrothermal conditions. We have analyzed the luminescent properties of the octahedrally coordinated Mn^{2+} cations in these phases that show a red emission band with maxima peaking between 648 and 660 nm.

On the other hand, we have extensively employed the ESR/FMR spectroscopy as a key tool to characterize different materials: MOFs and metalloporphyrins devoted to immobilize catalyst on solid surfaces, metal complexes focused on enzyme inhibition, coordination compounds with several pharmacological properties.

In the area of SOFC materials optimization to obtain materials for the energy and mass exchange and storage, the strategy is based on the fact that these devices need to be improved in regard to durability, therefore, with the aim of raising optimization strategies, a detailed knowledge of the processes involved in their degradation is essential. With the same objective porous materials that permit the mass exchange at molecular level is intended to obtain.

COLLABORATIONS

Profs. Jordi Rius, Elies Molins and Dras. Anna Roig and Rosa Palacin, of the Instituto de Ciencia de Materiales, CSIC, Barcelona. Prof. Jesus Rodriguez, of the Departamento de Ciencias de la Tierra y Física de la Materia Condensada (CITIMAC), Universidad de Cantabria, Santander. Prof. Maria Angeles Monge and Dr. Marta Iglesias, of the Instituto de Ciencia de Materiales, CSIC, Madrid. Prof. V. Orera and Drs. A. Larrea and M.A. Laguna of the Instituto de Ciencia de Materiales de Aragón (CSIC- Universidad de Zaragoza). Dr. Lide Mercedes Rodriguez, of the technologic research center IKERLAN-ENERGÍA, Vitoria-Gazteiz. Drs. Ana Aranzabe and Amaya Igartua, of the technologic center IK4-TEKNIKER, Eibar (Gipuzkoa). Dr. Jan van Herle. École Polytechnique Fédérale de Lausanne, Laboratory of Industrial Energy Systems, Laussane (Suiza). Dr. Luis Ortega, of the Departamento de Ciencias, Pontificia Universidad Católica de Perú. Prof. P.R. Slater and Dr. J. M. Porras, School of Chemistry, University of Birmingham, UK. Verónica Palomares, Paula Serras and Pierre Kubiak (UPV/EHU and Energigune, Spain) for XAS analysis of electrochemical reaction in sodium-ion batteries.

SELECTED RESULTS

"Effect of Si(IV) substitution on electrochemical, magnetic and spectroscopic performance of nanosized $LiMn_{2-x}Si_xO_4$"; Iturrondobeitia, A.; Goni, A.; Lezama, L.; Kim, C.; Doeff, M.; Cabana, J.; Rojo, T.; Journal of Materials Chemistry A: Materials for Energy and Sustainability (2013), 1(36), 10857-10862.

"Low temperature red luminescence of a fluorinated Mn-doped zinc selenite"; Orive, J.; Balda, R.; Fernandez, J.; Lezama, L.; Arriortua, M.I.; Dalton Transactions (2013), 42(34), 12481-12494.

Materials for Sensors and Bio-Sensors

DESCRIPTION

Sensors, and specifically magnetic sensors, are nowadays earning an exceptional prominence in many technological areas such as personal electronics, automotive and transportation and bio-medicine. They are also of great importance in their traditional niche of applications: the industrial processes.

New competitive sensors must be produced by microfabrication (MEMS) to benefit from the high sensing density and smooth interfacing with electronic circuitry, as well as low fabrication price and energy consumption. The research in this area must therefore seek for promising functional materials with outstanding

sensing properties but also pay attention to the effects of scaling and the necessity to integration with microelectronic conditioning interfaces.

WORK HAS BEEN CARRIED OUT IN THE FOLLOWING SUBJECTS

Concerning the development of magnetic sensors based on the magneto-impedance (MI) effect, the characterization of the micro-patterned structures developed during last year has been finished. The dependence of the magnetic and transport (impedance) properties on the aspect ratio of the samples has been analyzed. Numerous techniques have been used to perform the characterization. A new method for determining the anisotropy distribution in thin films has been developed. Noise measurements in full working prototypes have been performed to determine the detection limit of the MI samples. Routes to new developments have also been established: preparation of MI samples inserted in coplanar waveguides and definition of processes (and preliminary results) for patterning a micro-coil surrounding the sample for off-diagonal MI and feedback strategies.

SELECTED RESULTS

"Copper(II) Complexes of Tetradentate Pyridyl Ligands Supported on Keggin Polyoxometalates: Single-Crystal to Single-Crystal Transformations Promoted by Reversible Dehydration Processes"; Iturrospe A. et al.; Inorganic Chemistry, 52, 3084, 2013.

"GMI in Nanostructured FeNi/Ti Multilayers With Different Thicknesses of the Magnetic Layers"; Fernandez, E.; Svalov, A.V.; Kurlyandskaya, G.V. and Garcia-Arribas, A.; IEEE Transactions on Magnetics, vol. 49, no. 1, pp. 18-21, 2013.

"Evaluation of a Thin Film Giant Magneto-Impedance Compass"; Garcia-Arribas, A.; Fernandez, E.; Orue, I.; de Cos, D.; Barandiaran, J.M.; Mitxelena, J.M. and Martinez, F.; Sensor Letters, vol.10, pp. 1-4,2013.

"Tailoring the magnetic anisotropy of thin film permalloy microstrips by combined shape and induced anisotropies"; Garcia-Arribas, A.; Fernandez, E.; Svalov, A.; Kurlyandskaya, G.V.; Barrainkua, A.; Navas, D. and Barandiaran, J.M.; The European Physical Journal B, vol. 86, pp. 1434-6028, 2013.

"Determination of the distribution of transverse magnetic anisotropy in thin films from the second harmonic of Kerr signal"; Garcia-Arribas, A.; Fernandez, E.; Orue, I. and Barandiaran, J.M.; Applied Physics Letters, vol.103, pp. 142411, 2013.

COLLABORATIONS

Dr. C. Dolabdjian (University of Caen, France) and Dr. M. Rivas (University of Oviedo, Spain). Several other contacts have been produced to establish new imminent collaborations including: Dr. Prida (U. Oviedo, Spain) and Dr. J. P. Sinneceker (Centro Brasileiro Pesquisas Físicas, Brazil).

Materials for the Industry of Science

The main research activity has been related with the construction of a modified Halbach-type magnetic quadrupole for the DTL (Drift Tube Linac) of the future accelerator of ESS-Bilbao. Design and construction has been performed in cooperation with Antec enterprise, while simulations and magnetic characterization of the device (showing with uniformity and good field gradient for the obtained inner magnetic field) have been performed in cooperation between BCMaterials-UPV/EHU and ESS-Bilbao researchers.

SELECTED RESULTS

"A new magneto-elastic resonance based technique to determine magneto-mechanical parameters of amorphous ferromagnetic ribbons"; Le Bras, Y.; Lasheras, A.; Gutierrez, J.; Mazaleyrat, F.; Greneche, J.M.; Review of Scientific Instruments (2013), 84(4), 043904/1-043904/10.

Agreements with Spanish and Foreign Research Institutions

Taking into account the ongoing collaborations and the forecast evolution of the different research lines, we plan to strength our relationships with a number of research institutions, listed below together with the collaboration subject.

SIGNED

- Universidad de Cantabria, Santander, Spain (Magnetic Shape Memory Alloys, magnetocalorics, nanogranular alloys).
- Instituto de Magnetismo Aplicado "Salvador Velayos", Universidad Complutense, Adif-CSIC, Spain (Magnetic Materials and Magnetoelastic Sensors).
- Instituto de Nanociencias de Aragón, Zaragoza, Spain (Magnetic Nano-Particles, Nanostructures).
- International Nanotechnology Laboratory, Braga, Portugal (Magnetoelectrics).
- INEUSTAR, Asociación Española de la Industria de la Ciencia, Spain (Materials for the Science Industry).
- Center of Physics, University of Minho, Braga, Portugal (Smart Materials).
- Institut fur Mikrostruktur Technik, Karlsruhe Institute of Technology, Germany (Magnetic Shape Memory Films).
- Instituto Potosino de Investigación Científica y Tecnológica, Mexico, (Magnetic Shape Memory Alloys, Magnetocalorics).

UNDER NEGOTIATION

- Boise State University, Boise Idaho, USA (Magnetic Shape Memory Alloys).
- Royal Institution, Davy-Faraday Chair, London, UK (Magnetic Nanoparticles).
- IFW Leibnitz Institute, Dresden, Germany (Magnetic Shape Memory Alloys, Magnetocalorics).
- Institut de Chimie de la Matière Condensée de Bordeaux, France (Materials for Energy).
- Institut Laue Langevin, Grenoble, France (Neutron diffraction).
- Università di Roma 3, Italy (Nanogranular Alloys, Magnetic circular dichroism).
- Moscow State University, Russia (Magneto optics, sensors).
- Osaka University, Japan (Magnetic Shape Memory Alloys).
- Universidad de las Islas Baleares, Palma de Mallorca, Spain (Magnetic Shape Memory Alloys).
- Universidad Pública de Navarra, Pamplona, Spain (Magnetic Shape Memory Alloys, TiO_2 and magnetoimpedance sensors).
- Instituto de Ciencia de Materiales de Madrid-CSIC, Madrid, Spain (Magnetic multilayers, nanostructures).
- Instituto de Microelectrónica de Madrid (CSIC), Madrid, Spain (Sensors, microelectronics).
- Instituto de Investigaciones de Materiales, UNAM, Mexico.

Project Applications during 2013

Mineco

POLYMER/POLYOXOMETALATE SMART COATINGS FOR CHEMICAL AND BIOLOGICAL APPLICATIONS

Combination of organic and inorganic components can lead to hybrid materials with unusual structures and properties originated from synergism between fractions. The appropriate choice of components can allow the resulting material to be processed as smart, stimuli-responsive coatings for applications as sensors-actuators in microelectronics, electro-optics and/or biotechnology, among others.

In this project we propose to prepare smart hybrid surfaces using polymers able to immobilize polyoxometalates (POMs). Such surfaces will be synthetized onto magnetic substrates, either nanoparticles or magnetoelastic resonators, that allow to contacless monitor the system about its mass, so it will be possible to know the evolution of the surface during the synthesis as well as in the interaction with other molecules/systems and evaluate, therefore, their performance as sensors.

Hybrid materials will be prepared by anchoring POMs onto smart functionalized polymer surfaces having inter-polymer complexes. We pretend to prepare surfaces and coatings based on polystyrene and an amphiphilic diblock copolymer: PS-b-PX (PX= PEG, PLys or PAA). These polymeric surfaces can be formed or destroyed depending on environmental conditions and interact with other polymers or chemical species, and in particular, with POMs. Those are anionic metal-oxo clusters that have been regarded as remarkable inorganic building blocks because of their multifunctional nature and have the possibility of anchoring on the above polymeric surfaces either through the coordination sphere of one of their metals, or through formation of extensive hydrogen-bonding networks.

The so prepared devices will be tested as drug delivery systems (isoPOMs grafted on PX = PAA or PLys functions) or as chemical sensors (heteroPOMs grafted on PX = PAA, PLys or PEG functions) after deposited onto Magnetic Nanoparticles or Magnetoelastic cantilever resonators, that act as vectors or detectors of the specific actuation respectively. The final aim of the project is to develop a demonstrator of a sensor based on these compounds.

Mineco
(2014-2016)
Polymer/polyoxometalate smart coatings for chemical and biological applications

Etortek
(2013-2014)
Actimat, development of smart materials, functional materials and processes for advanced materials.

Gaitek
(2013-2014)
Film Speakers

Saiotek
Magtenic shape memory thin films for microdevices (Pemform)

bixkaia:xede
(2014-2015)
Development of dy-free and rare earth-free high energy magnets using nanotechnology

UPV/EHU
(2012)
Other: QDJ-IR Furnace, Z-sizer, Impedance analyzer *

* UPV/EHU call for Scientific equipment co-funded by supporting groups and BCMaterials

Saiotek

MAGTENIC SHAPE MEMORY THIN FILMS FOR MICRODEVICES (PEMFORM)

Magnetic shape memory alloys are materials of great interest for their mechanical, thermal and magnetic actuation properties. In particular, their high density of stored energy makes them extremely competitive in thin film technologies for the manufacture of micro-electro-mechanical systems (MEMS). In this project, we have prepared NiMnGa alloy films on silicon cantilever substrates and we have studied their modes of actuation induced by temperature and magnetic field. The cantilevers have been obtained as result of international collaborations with European laboratories and using major European neutron and synchrotron facilities for atomic level characterization of the films. The obtained knowledge could be transferred to Basque industry in order to be applied.

Etortek

ACTIMAT, DEVELOPMENT OF SMART MATERIALS, FUNCTIONAL MATERIALS AND PROCESSES FOR ADVANCED MATERIALS.

The ACTIMAT Project (2013-2014) is a strategic R&D of the Basque Government (ETORTEK program), which includes a total of 15 Basque technology centers and universities with the common goal of developing knowledge in the field of new materials.

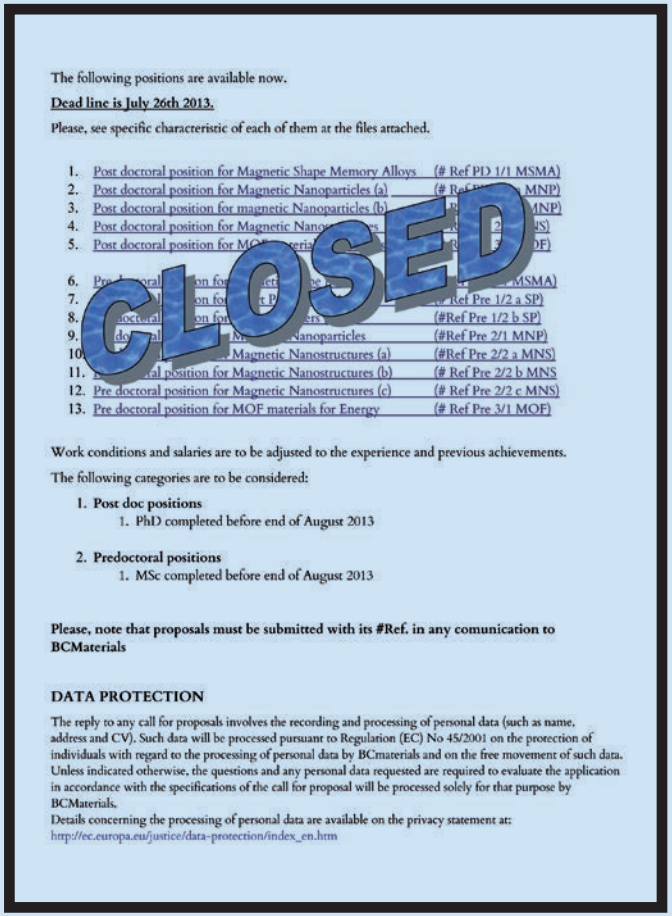
Titled "Development of Smart Materials, Functional Materials and Processes for Advanced Materials," ACTIMAT concentrates its potential in the global scope of strategic materials: smart materials, composites, hybrid materials, biomaterials, nanocompounds, etc.

bizkaia:xede

DEVELOPMENT OF DY-FREE AND RARE EARTH-FREE HIGH ENERGY MAGNETS USING NANOTECHNOLOGY

The proposal presents viable and innovative approaches to produce high coercivity Dy-free Nd-Fe-B magnets and explore ways to fabricate for the first time anisotropic Fe-Co(Ni) and MnBi alloy powders with high coercivity and magnetization that can be used for the development of rare earth-free high performance permanent magnets. High coercivity Dy-free magnets will be synthesized by using die-upset nanocrystalline ribbons and $Nd_2Fe_{14}B$ nanoparticles. Liquid chemistry procedures will be used to synthesize the Fe-Co(Ni) nanoparticles in the tetragonal (L10) or hexagonal (L12) phase, and MnBi nanoparticles in the high anisotropy hexagonal LTP phase. If Fe-Co alloys can be synthesized with the anisotropic L10 structure, they can have an energy product three times higher than that of current Nd-Fe-B. The development of new Dy-free and rare earth free high energy magnets will lead to lower cost more efficient energy and power dense devices and most importantly it will result in a substantial reduction in our dependence upon the critical rare earth elements in permanent magnets.

PEOPLE



The following positions are available now.

Dead line is July 26th 2013.

Please, see specific charcteristic of each of them at the files attached.

1. Post doctoral position for Magnetic Shape Memory Alloys (# Ref PD 1/1 MSMA)
2. Post doctoral position for Magnetic Nanoparticles (a) (# Ref [illegible] MNP)
3. Post doctoral position for magnetic Nanoparticles (b) [illegible] MNP)
4. Post doctoral position for Magnetic Nano[illegible] [illegible]US)
5. Post doctoral position for MC[illegible] [illegible]OF)
6. Pre[illegible] [illegible] MSMA)
7. [illegible] [illegible] Ref Pre 1/2 a SP)
8. [illegible] [illegible] (#Ref Pre 1/2 b SP)
9. [illegible] Nanoparticles (#Ref Pre 2/1 MNP)
10. [illegible] Magnetic Nanostructures (a) (#Ref Pre 2/2 a MNS)
11. [illegible] position for Magnetic Nanostructures (b) (# Ref Pre 2/2 b MNS
12. Pre doctoral position for Magnetic Nanostructures (c) (# Ref Pre 2/2 c MNS)
13. Pre doctoral position for MOF materials for Energy (# Ref Pre 3/1 MOF)

CLOSED

Work conditions and salaries are to be adjusted to the experience and previous achievements.

The following categories are to be considered:

1. **Post doc positions**
   1. PhD completed before end of August 2013
2. **Predoctoral positions**
   1. MSc completed before end of August 2013

Please, note that proposals must be submitted with its #Ref. in any comunication to BCMaterials

DATA PROTECTION

The reply to any call for proposals involves the recording and processing of personal data (such as name, address and CV). Such data will be processed pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by BCmaterials and on the free movement of such data. Unless indicated otherwise, the questions and any personal data requested are required to evaluate the application in accordance with the specifications of the call for proposal will be processed solely for that purpose by BCMaterials.
Details concerning the processing of personal data are available on the privacy statement at:
http://ec.europa.eu/justice/data-protection/index_en.htm

BCMaterials 2013 CALL

Considering the objective of Excellence in research the talent attraction stabilization and continuous motivation of it is necessary, as well. The Center runs all specific aid programs for recruitment, with particular effort on those that allow us to attract excellent researchers in their professional area.

bizkaia:talent

The Basque science, technology and innovation system is aimed at fulfilling the needs of Basque industries, thus improving business competitiveness. This is the reason why the highly qualified professionals and researchers targeted by *bizkaia:talent* should ideally work in strategic areas to the Basque Country. *bizkaia:talent* provide assistance to experts in technology, researchers, professors and professionals working in companies, universities or other organisations. *bizkaia:talent* also give support to highly qualified professionals and researchers who come to work as collaborators, consultants or experts in innovative projects developed in Biscay.

In this area, BCMaterials established a collaboration with Prof. Hadjipanayis, a world leader in research on rare earth magnets, which can provide extensive knowledge in the field, train young researchers in the semi-industrial processing of magnets to achieve the desired microstructure and expected final characteristics.

This collaborative work includes the training of researchers at the Center in the process of synthesis and processing of the magnets, as well as participation in discussions with researchers BCMaterials on research aspects and applications of permanent magnets. Also, through stays at the University of Delaware one may develop tasks related to the project and use the special tools elaborated by the group of Prof. Hadjipanayis team. The project fits perfectly into the strategic lines of BCMaterials as New Materials for Energy (including applications in wind turbines and electric vehicles) and Nanomagnetism where interactions between particles of magnetically hard and soft material are the basis of the coupling which allows the improvement properties, making it possible, if necessary, obtaining free magnets Dysprosium high coercivity (known as “spring magnets”).

BCMaterials 2013 CALL

After approval of the budget a call for researchers was issued and partially covered (*). The following categories were demanded.

POST DOC POSITIONS
PhD COMPLETED BEFORE END OF AUGUST 2013

a.) Structural and dynamical correlations in room-temperature ionic liquid – water mixtures.

b.) **Single crystal studies of magnetic shape memory alloys.**

c.) Magnetite nanoparticles biosynthetized by magnetotactic bacteria.

d.) **Structural and magnetic correlations in magnetic nanoparticles of biomedical interest.**

e.) Magnetization dynamics in thin Films and nanostructures.

f.) MOFs materials for specific analyte sensing.

PREDOCTORAL POSITIONS
MSC COMPLETED BEFORE END OF AUGUST 2013

a.) **Influence of the structural defects on the properties of metamagnetic shape memory alloys.**

b.) **Preparation of polymer multilayer systems to optimize biomedical devices.**

c.) **Immobilization of polyoxometalates on tailored polymeric surfaces and applications in sensors.**

d.) Preparation, characterization and encapsulation of ferrite NPs for applications in biomedicine.

e.) Magnetic interactions and interface phenomena in nanostructured thin films.

f.) Dimensionality effects in antiferromagnetic/ ferromagnetic nanostructures.

g.) **Nano-discs with magnetic vortex state for biomedical applications.**

h.) **MOF materials for energy and mass exchange and storage.**

(*) Written in bold letters.

OTHERS

IKERBASQUE

ML Saboungi. **January 2014.**
S. Lanceros. **Applied 2013**

IKERBASQUE FELLOW

Markus Gruner. **Applied 2013**

SELF FUNDED PEOPLE

Gerardo Garcia
PhD Student funded by Instituto Potosino de Investigación Científica y Tecnológica, Mexico. **6 months**

Adriana Huizar de Felix
PhD Student funded by Universidad Autónoma de Nuevo León, Mexico.
6 months

Merivan Sesmaz
PhD Student funded by Firat University, Department of Physics, Turkey. **9 months**

Flor Gomez
Post doctoral fellowship from Departamento de Educación, México.
3 months

SELF FUNDED PEOPLE APPOINTED FOR 2014:

Prof Kiyonori Suzuki
Sabbatical from Monash University, Australia. **6 months**

Dr. Diego Muraca
Post doctoral fellowship from Campinas, Brazil.
6 months starting Feb. 2014

Dr. Fenghua CHEN
Post doctoral fellowship from Taiyuan University of Science and Technology, P. R. China. **6 months**

Juan Pablo Camarillo Garcia
PhD Student funded by Instituto Potosino de Investigación Científica y Tecnológica, Mexico.

Flor Gomez, Post doctoral fellowship from Departamento de Educación, Mexico. **6 months**

PERSONNEL AT DATE

Director: Jose Manuel Barandiaran
General manager: Jose Luis Vilas
IT manager: Juan Ignacio Tel

ADSCRIBED FACULTY (11)

Maria Luisa Fernandez-Gubieda
Catedrática de Universidad

Jon Gutierrez
Titular de Universidad

Alfredo Garcia
Titular de Universidad

Jose Angel Garcia
Catedrático de Universidad

Luis Lezama
Catedrático de Universidad

Maite Insausti
Titular de Universidad

Juan Manuel Gutierrez
Catedrático de Universidad

Maribel Arriortua
Catedrático de Universidad

Luis Manuel Leon
Catedrático de Universidad

Volodymyr Chernenko
Investigador Ikerbaske

Rafael Morales
Investigador Ikerbasque

POST DOCS FROM BCMaterials (4)

Maria San Sebastian
Javier Alonso
Irene Urcelay
Daniel Salazar

OTHER POST DOCS / TECHNICAL STAFF (7)

Andrey Svalov
Pablo Alonso
Jorge Feuchwanger
Santiago Reinoso
Jose Manuel Laza
Veronica Palomares
Ana Abad

PRE DOCS FROM BCMaterials (6)

Nuria Garcia
Ariane Sagasti
Iraultza Unzueta
Jagoba Martin
Laura Bravo
Maite Goiriena

OTHER PRE DOCS (3)

Andoni Lasheras
Iván Rodriguez
Xabier Lasheras

Total Researchers (faculty + post docs) **23**

Total Predocs **9**

Technical and administrative **2**

GROSS TOTAL:
34 people involved
by December 31, 2013

PEOPLE

Personnel at date

DIRECTOR
José Manuel Barandiarán
GENERAL MANAGER
José Luis Vilas
IT MANAGER
Juan Ignacio Tel

ADSCRIBED FACULTY
María Luisa F.z-Gubieda
Jon Gutiérrez
Alfredo García
José Ángel García
Luis Lezama
Maite Insausti
Juan Manuel Gutiérrez
Maribel Arriortua
Luis Manuel León
Volodymyr Chernenko
Rafael Morales

POST DOCS FROM BCMATERIALS
Maria San Sebastian
Javier Alonso
Irene Urcelay
Daniel Salazar

OTHER POST DOCS / TECHNICAL STAFF
Andrey Svalov
Pablo Alonso
Jorge Feuchwanger
Santiago Reinoso
José Manuel Laza
Verónica Palomares
Ana Abad

PRE DOCS FROM BCMATERIALS
Nuria Garcia
Ariane Sagasti
Iraultza Unzueta
Jagoba Martin
Laura Bravo
Maite Goiriena

OTHER PRE DOCS
Andoni Lasheras
Iván Rodríguez Aseguinolaza
Xabier Lasheras


J. M. Barandiaran


José Luis Vilas


J. Ignacio Tel


M. L. Fernández-Gubieda


J. M. Gutiérrez


Maribel Arriortua


Javier Alonso


Irene Urcelay


Jagoba Martin


Laura Bravo


Jon Gutiérrez


Alfredo García


Luis Lezama


Maite Insausti


Luis León


Volodymyr Chernenko


Rafael Morales


M. San Sebastián


Daniel Salazar


Nuria García


Ariane Sagasti


Iraultza Unzueta


Maite Goiriena

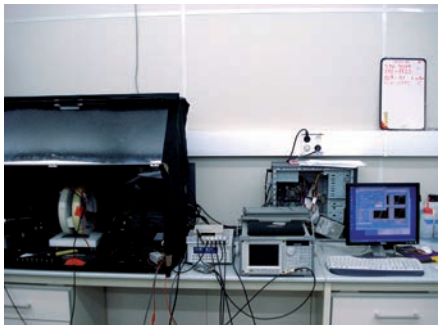

Xabier Las Heras

BCMATERIALS IS A RESEARCH CENTER BELONGING TO THE BERC (BASQUE EXCELLENCE RESEARCH CENTERS) NETWORK AND DEVOTED TO MATERIALS, APPLICATIONS AND NANOSTRUCTURES.

MAIN RESEARCH LINES WILL BE RELATED TO THE STUDY OF FUNCTIONAL MATERIALS WITH ADVANCED MECHANICAL, THERMAL, ELECTRIC, MAGNETIC AND OPTICAL PROPERTIES.

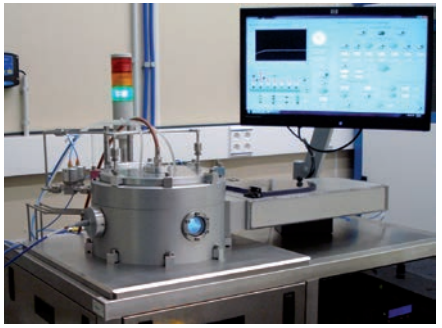
BCMaterials was created to operate at the Leioa Campus of the UPV/EHU based on the existing groups of Excellence in materials science. The Center was designed to improve the level and productivity of such groups and the overall scientific research of the Basque Country in the field of materials science and technology. It will add to others preexisting in Biscay, conform a hard core of research institutes grouped in the future Scientific Park of the University of the Basque Country, and contribute to the Campus of Excellence, recently accorded to the UPV/EHU. The present (provisional) location of the center is the Technological park of Biscay in Derio-Zamudio.

“The international quality research in the area of material science is one of the key strategic priorities of European, Spanish and Basque research strategies”

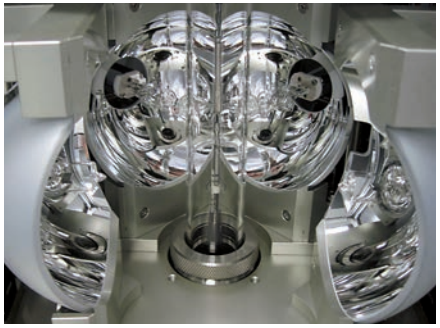


MOKE. Magneto Optic Kerr Effect
System for thin film magnetization measurements

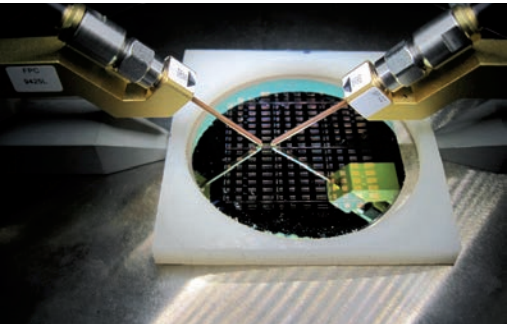
Sputtering machine for thin film deposition



RIE. Reactive Ion etching
System

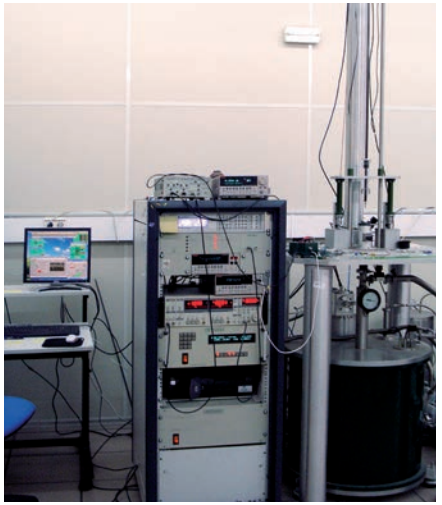


Detail of the ellipsoidal mirrors of the floating zone furnace for single crystal growth



Probe station for direct on Wafer High frequency impedance measurements

Induction furnace for alloy melting

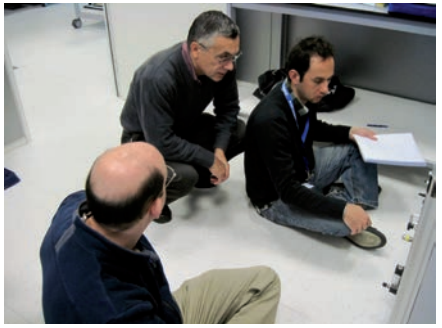


VSM. Vibrating Sample Magnetometer
with a 14 Tesla superconducting coil

Floating zone furnace for single crystal growth

Standard Chemical facilities

Glove box for reactive compounds handling



BCMaterials researchers operating the floating zone furnace for single crystal growth

BCMaterials researchers testing a focusing magnetic quadrupole for proton accelerators

The modern society of welfare is founded on the scientific and technologic advances that allow for a general increase of life quality in most developed countries. The search for new and better performing materials in sectors, such as industry production, transport, biomedical or energy and environment is key in order to improve our life quality.

Based on the Excellence of the material science groups at the UPV/EHU BCMaterials was funded. The Center was designed to improve the level and productivity of such groups and the overall scientific research of the Basque Country. BCMaterials joins a number of preexisting Basque Excellence Research Centres (BERC) in Biscay, creating a cluster of research institutes grouped at the University of the Basque Country's future Scientific Park, as well as contributing to the Campus of Excellence, recently awarded to the UPV/EHU.

MISSION

The mission of BCMaterials – Basque Center for Materials, Applications and Nanostructures – is to develop high-quality interdisciplinary research to cover all aspects of research in functional materials with advanced electric, magnetic and optical properties; from basic to applied.

In order to realize the mission outlined above, BCMaterials sets itself the following aims:

- To develop an internationally competitive and recognized science and technology by creating a team of top flight researchers and by carrying out post-graduate training activities of the highest quality.
- To use a large-scale European facilities as neutrons and synchrotron radiation for the study of materials by promoting scientific and technological advances worldwide.
- To attract private and public funding (both national and international) through fomenting interdisciplinary collaboration as the driving force behind major scientific and technological advances.

VISSION

BCMaterials is destined to be internationally reference center for research in the area of magnetic, functional and active materials and nanomaterials.

It is devoted to the quality of publications, image and prestige, based on the excellence of its research, customer satisfaction and people and socially responsible.

VALUES

Referencing values statements of entities of patronage, BCMaterials assumes:

- Leading researcher Vocation
- Commitment to the principles of Excellence.
- Effectiveness and efficiency in resource management.
- Management transparency.
- Satisfaction and development of people.
- Open society and contribution to sustainability.

Presenting an internal seminar at BCMaterials

“BCMaterials wants to develop an internationally competitive and recognized science and technology post-graduate researchers: Master students are already working in the different research lines”

DIFFUSION OF RESULTS

In order to make the center visible to the local research community and to present it in other audiences, a number of talks, seminars and conferences have been organized. In addition we tried to participate in conferences already organized by other institutions by organizing symposia within them or promoting the presence of BCMaterials members in the Committee.

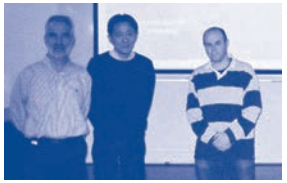
Talks and Seminars

1. 11/08/2012 *Bioinspired Materials,* Francisco del Monte, Instituto de Ciencia de Materiales de Madrid, CSIC, Spain.
2. 11/23/2012 *Magnetic nanostructures: From exchange softening in nanostructured alloys to charge-transfer ferromagnetism in capped nanoparticles,* Kiyonori Suzuki, Department of Materials Engineering, Monash University, Australia.
3. 12/03/2012 *Science and Technology of Modern Permanent Magnet Materials,* George C. Hadjipanayis (2012 Distinguished Lecturer of the IEEE Magnetics Society), Department of Physics and Astronomy, University of Delaware, USA.
4. 02/25/2013 *Buckyball Maracas: The inside (and outside) of endohedral fullerenes story,* Luis Echegoyen, Robert A. Welch Professor University of Texas at El Paso, USA.
5. 03/06/2013 *Cómo hacer y donde encontrar nanosistemas,* Maite Insausti, UPV-EHU, BCMaterials, Spain.
6. 03/13/2013 *Las bacterias también producen nanopartículas,* Maria Luisa Fernandez-Gubieda, UPV-EHU, BCMaterials, Spain.
7. 04/24/2013 *Nano electrónica y mentes artificiales,* Jose Manuel Barandiaran, UPV-EHU, BCMaterials, Spain.
8. 05/01/2013 *Spring School on Magnetic Materials and Applications.*
9. 06/20/2013 *Framework for developing high frequency magnetic materials,* Michael McHenry. IEEE Distinguished Lecturer, Materials Science and Engineering Department, Carnegie Mellon University, USA.
10. 06/21/2013 *Artificial ferromagnetic nanostructures with periodic lateral contrasts in magnetization,* Adekunle Adeyeye, IEEE Distinguished Lecturer; Department of Electrical & Computer Engineering, National University of Singapore, Singapore.

11. 07/18/2013 *Microeddy Bordoni-type relaxation controls spin glass transitions?,* Sergey Kustov.
12. 09/06/2013 *Development of NiMnGa/Polymer Composite Materials,* Prof. Hideki Hosoda.
13. 09/20/2013 *Magneto-Optic Analysis of Magnetic Microstructures,* Rudolf Schaefer, IEEE Distinguished Lecturer, Leibniz Institute for Solid State and Materials Research (IFW), Dresden, Germany.
14. 10/15/2013 *Seminar: Caracterización Dieléctrica de Materiales y Soluciones en Medida de Impedancia Agilent Technologies.*
15. Ineustar. The Spanish Industry Association of Science INEUSTAR, held its Annual General Meeting in BCMaterials facilities. Founded in 2010 and headquartered in Euskadi, INEUSTAR consists on an association of companies dedicated to the conception, design, construction, operation and maintenance of facilities and scientific instruments in any field.
16. Mettler -Toledo. Flash-DSC Seminar. BCMaterials host a seminar on Flash DSC and its Applications. Different experts gave a broad view on the most recent advances in the field and the topics cover all aspects of the research in polymeric and thin film metallic materials from basic concepts to some applications.
17. Club de Magnetismo y Spanish Chapter of the IEEE Magnetic Society. The Annual Meeting of Spanish Chapter of the IEEE Magnetic Society and of Club de Magnetismo have been held in BCMaterials facilities. Among other things, the meeting has included the conferences of Dr. Russell Cowburn from the University of Cambridge, UK (Towards 3-dimensional spintronics) and Dra. Mª Luisa Fernández-Gubieda, from the UPV/EHU-Leioa (Nanopartículas magnéticas producidas por bacterias).
18. Semana de la Ciencia. The thirteenth edition of the Zientzia Astea, Week of Science, Technology and Innovation of the UPV / EHU, which was held from 6 to 10 November in the three Basque capitals, has brought together a large number of people all ages about the many activities, games and science-related demonstrations that have taken place in a fun and educational environment. BCMaterials has involved bringing some of its researchers to the various activities that have taken place.

Programme for the 11th Annual
Convention of the Spanish Magnetism Club

Prof. Hadjipanayis



Prof. Suzuki

Prof. Echegoyen

BCMaterials is presented to Ineustar

Prof. McHenry

Prof. Adeyeye

Prof. Kustov

Prof. Schaefer

Spanish Chapter of the IEEE Magnetic Society meeting

Week of Science

Organization of conferences

New Materials for a Better Life!

Associated to the Spring School on Materials the second edition of the Workshop on "New Materials for a Better Life!" took place on May the 9th, 2013 at the "Paraninfo" of the Faculty of Science & Technology, UPV/EHU, Leioa Campus, Biscay. This year it was devoted to magnetic materials, covering a large range of applications, lectured by first order speakers from all around the world including a round table about new materials and innovation, with researchers, as well as industrial and government representatives.

Other Conferences on Materials

V.A. Chernenko was co-organizer of Symposium *"Magnetic shape-memory alloys and Magnetocaloric effect"* at DICNMA 2013 conference, San Sebastian and a member of Program Committee of DICNMA 2013.

V.A. Chernenko is a member of International Conference Committee of ICFSMA 2013, Boise, USA.

V.A. Chernenko is a member of European Advisory Organizing Committee of ICOMAT 2014.

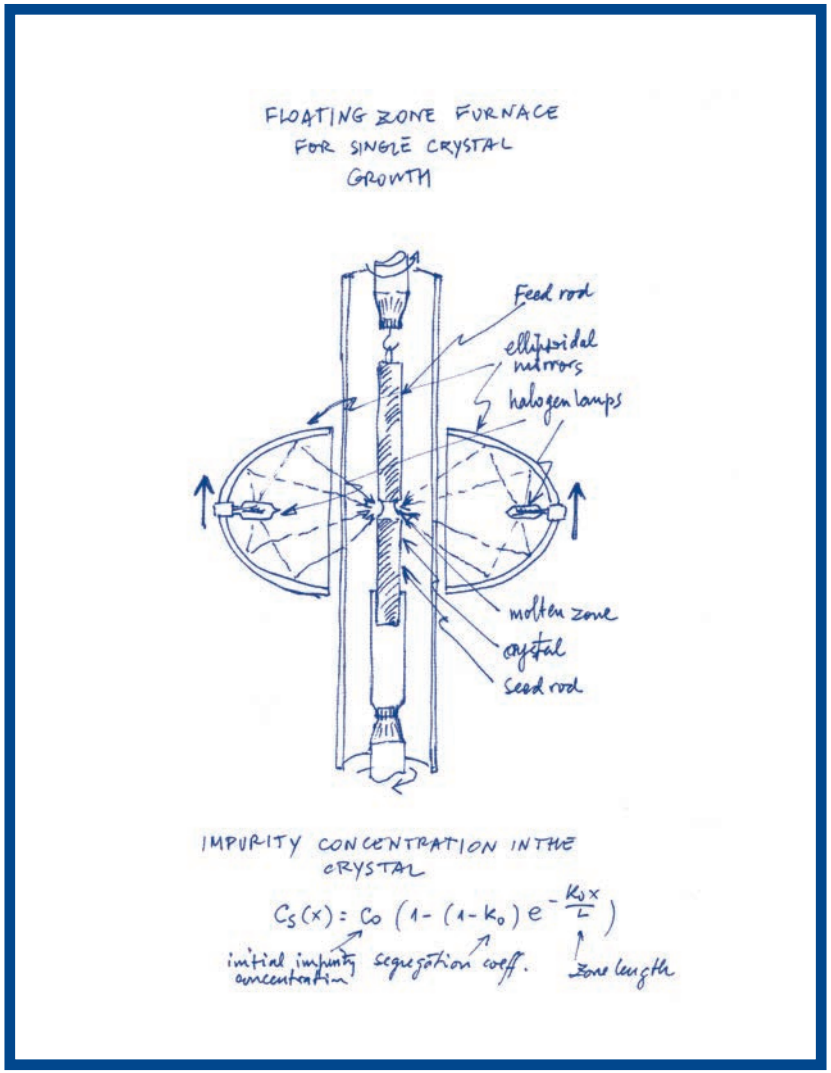
Jon Gutierrez has been co-organizer (with Cristophe Doblajdian from Caen Univeristy) of the Symposium on *"Magnetic sensors"* at the ICMAST 2013 in Prague.

Jon Gutierrez is a member of the Program Committee of the EMSA Conference to be held in Vienna in July 2014.

Appointement for organizing ICMAST 2014 in BCMaterials has been accorded. Conference chairs will be Jon Gutierrez and Jose Manuel Barandiaran. They are currently preparing all aspects of this conference. This will be the fourth edition and the forecast attendance is over 200 delegates.

Maribel Arriortua and Luis Lezama were organizers of the symposium of Inorganic Chemistry at the Bienal de Química in Santander.

Maribel Arriortua is organizer of the Conference on Crystallography and Sustainability.



HIGH LEVEL EDUCATION

Master and Doctorate

Master in New Materials

All BCMaterials faculty and some researchers do lecture or supervise master thesis in the Master in New Materials.

After an intense campaign of advertising, including the presentation of a video uploaded to Youtube, we got 64 pre-registrations at the UPV/EHU. From those 23 candidates were selected, and finally 17 started the course. Adding 5 more from the University of Cantabria this year we have 22 regular students from which 6 are physicists, 12 chemists and 4 have other degrees.

We offered 5 fellowships to develop the master thesis at BCMaterials, Energigune offered 3 and Nanogune 2 more.

All BCMaterials students are already working in the different research lines.

Lectures in other Masters

In addition several faculty and researchers of BCMaterials are lecturing in other Masters, like:

- Máster en Ingeniería Física.
- Máster Universitario en Análisis Forense (Mención de Excelencia).
- Máster Universitario en Cuaternario: Cambios Ambientales y Huella Humana.
- Máster Universitario en Química Sintética e Industrial (Mención de Excelencia).
- Máster Universitario en Nuevos Materiales.

V.A. Chernenko gave a course on "Martensitic Phase Transitions" for doctorate and master students of Osaka University, Japan.

Doctorate in Materials Science and Technology

It has been evaluated by UNIBASQ positively and it has been too evaluated this year by ANECA and, at this moment, some bureaucratic aspects should be corrected, all the academic aspects being correct.

The Doctorate in Materials Science and Technology get 50 PhDs at this moment and there have been defended 10 PhDs this year, 40% of them being internationals.

Half of the defended thesis have been developed along the research lines of BCMaterials.

Spring School on Materials

BCMaterials host the Spring School on Materials. The Spring School on Magnetic Materials and Applications gave a broad view on the most recent advances in the field. The lecturers were chosen among the most influential ones in their respective fields and the topics cover all aspects of the research in Magnetic Materials from basic concepts to applications in biomedicine, energy, magnetic recording, magnetocalorics, industry of science, etc., with special emphasis on nanomagnetism as a guiding line in many of them.

The School was aimed to postgraduate students and young researchers in materials sciences, as well as to professionals that want to update their knowledge. There were 20 students and young researchers attending the lectures.

OTHER ACTIVITIES

Large Facilities Proposals and Measurements

DATES: 10-14 FEBRUARY 2013
EXPERIMENT: 20125173. IN SITU ANALYSIS OF ELECTROCHEMICAL REACTION OF SODIUM VANADIUM FLUOROPHOSPHATES IN SODIUM-ION BATTERIES.

BEAMLINE: XAFS – Elettra (Trieste)
PROPOSERS: V. Palomares, P. Serras, T. Rojo, P. Kubiak, J. Alonso, M.L. Fdez-Gubieda

RESULTS: XANES spectra of the $Na_3V_2O_{2x}(PO_4)_2F_{3-2x}$ samples corresponding to different points at the charging process, from 3.6V to 4.3V have indicated a the progressive oxidation of the vanadium inside the samples. By comparing these spectra with those corresponding to V^{3+}, V^{4+} and V^{5+} standards, we observe that at the initial stage (C-3.6V), vanadium is in a mixture of V^{4+} and V^{3+} state, while at the end of the charging, we mainly have a mixture of V^{4+} and V^{5+}. The V^{3+} amount keeps constant during the charge/discharge process and seems to play no role in it. All the intermediate states can be quite accurately reproduced by a linear combination of the initial and final states.

DATES: 27-28 MAY 2013
EXPERIMENT: RB1310481: INTERMEDIATE Q-RANGE STUDY OF $Fe_{35}Ag_{65}$ AND $Fe_{15}Ag_{85}$ THIN FILMS

BEAMINE: NIMROD – ISIS (Oxfordshire)
PROPOSERS: D. Alba Venero, L. Fernandez Barquin, S. Langridge, J. Alonso, M.L. Fdez-Gubieda

RESULTS: We have observed the presence of very small particles (5 Angstroms) in the 15% Fe sample, with a few larger particles. For the 35% Fe sample then again there are the small particles but also larger particles (~50 and also ~100 Angstroms in radius). These larger particles are genuinely from the sample and not the Ag as the scattering is very intense. A more quantitative analysis is in progress.

DATES: 24-27 JULY 2013
EXPERIMENT: SP8577: IN SITU ANALYSIS OF ELECTROCHEMICAL REACTION OF SODIUM VANADIUM FLUOROPHOSPHATES IN SODIUM-ION BATTERIES

BEAMLINE: B18 – Diamond (Oxfordshire)
PROPOSERS: V. Palomares, P. Serras, T. Rojo, P. Kubiak, J. Alonso, M.L. Fdez-Gubieda

RESULTS: We have been able to follow the evolution of the oxidation state of V both during the charge and the discharge of the sample $Na_3V_2O_2(PO_4)_2F$. At the initial stage, vanadium is in V^{4+} state, while at the end of the charging, we mainly have a mixture of V^{4+} and V^{5+}($V^{4.8+}$). The process is nearly reversible.

DATES: 20-23 MAY 2013
EXPERIMENT: 20125003: EXAFS STUDY OF THE MAGNETITE BIOSYNTHESIS BY MAGNETOSPIRILLUM GRYPHISWALDENSE

BEAMLINE: XAFS – Elettra Sincrotrone (Trieste, Italia)
PROPOSERS: A. Garcia Prieto, M.L. Fdez-Gubieda, A. Muela, J. Alonso

RESULTS: 77K Fe K-edge EXAFS spectra were obtained at specific stages of the magnetite biosynthesis process followed by Magnetospirillum gryphiswaldense. Currently, these spectra are being analyzed and will allow us to probe the local surroundings of the Fe atoms from the preliminary ferrihydrite phase at the beginning of the biosynthesis process to the final pure magnetite phase.

"Polarized neutron reflectometry of single and double ferromagnetic nanodot arrays in vortex configuration states" at ILL neutrons facility (Grenoble)

"Tuning pinned spin configurations in exchange-biased Ni/FeF2 nanostructures" at Advanced Light Source - Lawrence Berkeley National Laboratory (Berkeley).

12 shifts at CERN-INTC-2013-028, INTC-P-388, entitled "Atomic scale properties of magnetic Mn-based alloys probed by Emission Mössbauer spectroscopy".

Visits to Foreign Laboratories

An intense research collaboration allways needs interchanges in both directions. Due to budget restrictions this year the stay in foreign laboratories (of more than 4 weeks duration) has been not so intense:

V.A. Chernenko: Osaka University, 1 month.

Rafa Morales: UC San Diego, sabbatical, 6 months.

Jon Gutierrez: Braga University and INL, 1 month.

APENDIX

FULL RESEARCH PRODUCTION IN 2013

Total publications by BCMaterials involved people in 2013

TOTAL PUBLICATIONS BY BCMaterials INVOLVED PEOPLE IN 2013

I.
Autonomous generator based on Ni-Mn-Ga microactuator as a frequency selective element. Krupa, M. M.; Skirta, Y. B.; Barandiaran, J. M.; Ohtsuka, M.; Chernenko, V. A. EPJ Web of Conferences (2013 **F1:**_**Q:**__

II.
Magnetoelastic anomalies exhibited by Ni-Fe(Co)-Ga polycrystalline ferromagnetic shape memory alloy. Lazpita, Patricia; Chernenko, Volodymyr A.; Barandiaran, Jose M.; Gutierrez, Jon; Hosoda, Hideki; Rodriguez-Velamazan, Jose A. Materials Transactions (2013)
F1: 0.588 Q: 2

III.
Magnetic influence on the martensitic transformation entropy in Ni-Mn-In metamagnetic alloy. Barandiaran, J. M.; Chernenko, V. A.; Cesari, E.; Salas, D.; Lazpita, P.; Gutierrez, J.; Orue, I.; Applied Physics Letters (2013), 102(7), 071904/1-071904/4.
F1: 3,844 Q: 1

IV.
Magnetic field and atomic order effect on the martensitic transformation of a metamagnetic alloy. Barandiaran J M; Chernenko V A; Cesari E; Salas D; Gutierrez J; Lazpita P; Journal of physics. Condensed Matter (2013), 25(48), 484005.
F1: 2,355 Q: 2

V.
Transformation volume effects on shape memory alloys. Chernenko, Volodymyr A.; L'vov, Victor A.; Cesari, Eduard; Kosogor, Anna; Barandiaran, Jose M.; Metals (2013), 3(3), 237-282.
F1:__ **Q:** _

VI.
Lattice instability of Ni-Mn-Ga ferromagnetic shape memory alloys probed by hard X-ray photoelectron spectroscopy. Kimura, A.; Ye, M.; Taniguchi, M.; Ikenaga, E.; Barandiaran, J. M.; Chernenko, V. A.; Applied Physics Letters (2013), 103(7), 072403/1-072403/4.
F1: 3,844 Q: 1

VII.
Direct evidence of the magnetoelastic interaction in Ni2MnGa magnetic shape memory system. Recarte, V.; Perez-Landazabal, J. I.; Sanchez-Alarcos, V.; Cesari, E.; Jimenez-Ruiz, M.; Schmalzl, K.; Chernenko, V. A.; Applied Physics Letters (2013), 102(20), 201906/1-201906/4.
F1: 3,844 Q: 1

VIII.
Martensitic transformation and magnetic anisotropy in Ni-Mn-Ga/NaCl(001) thin films probed by ferromagnetic resonance. Aseguinolaza, I. R.; Golub, V.; Barandiaran, J. M.; Ohtsuka, M.; Muellner, P.; Salyuk, O. Y.; Chernenko, V. A.; Applied Physics Letters (2013), 102(18), 182401/1-182401/4.
F1: 3,844 Q: 1

IX.
Improving the magnetoelectric response of laminates containing high temperature piezopolymers. Gutierrez, Jon; Lasheras, Andoni; Barandiaran, Jose Manuel; Vilas, Jose Luis; San Sebastian, Maria; Leon, Luis Manuel; IEEE Transactions on Magnetics (2013), 49(1), 42-45
F1: _ Q:_

X.
Relevance study of bare and coated zero valent iron nanoparticles for lindane degradation from its by-product monitorization. I. San Román, M.L. Alonso, L. Bartolomé, A. Galdames, E. Goiti, M. Ocejo, M. Moragues, R.M. Alonso, J.L. Vilas, Chemosphere, 93, 7, 1324-1332, (2013)
F1: 3,137 Q: 1

XI.
Temperature dependent magnetostrains in polycrystalline magnetic shape memory Heusler alloys. Chernenko, V. A.; Barandiaran, J. M.; Lvov, V. A.; Gutierrez, J.; Lazpita, P.; Orue, I. Journal of Alloys and Compounds
F1: 2,39 Q: 1

XII.
Magnetostatic interactions in various magnetosome clusters. Usov, N. A.; Fdez-Gubieda, M. L.; Barandiaran, J. M.; Journal of Applied Physics (2013), 113(2), 023907/1-023907/9.
F1: 1,067 Q: 3

XIII.
Magnetic disorder in diluted FexM100-x granular thin films (M=Au, Ag, Cu; x < 10 at.%); D. Alba Venero, L. Fernández Barquín, J. Alonso, M. L. Fdez-Gubieda, L. Rodríguez Fernández, R. Boada and J. Chaboy. J. Phys.: Condens. Matter 25 276001 (2013) F1: 2,355 Q: 2

XIV.
Magnetite Biomineralization in Magnetospirillum gryphiswaldense: Time-Resolved Magnetic and Structural Studies. M.L. Fdez-Gubieda, Alicia Muela, Javier Alonso, Ana García-Prieto, Luca Olivi, Rodrigo Fernández-Pacheco, and José Manuel Barandiarán; ACS Nano 7 (4), 3297–3305 (2013)
F1: 12,062 Q: 1

XV.
Interplay between microstructure and magnetism in NiO nanoparticles: breakdown of the antiferromagnetic order. N. Rinaldi–Montes, P. Gorría, D. Martínez–Blanco, J. A. Blanco, L. Fernandez Barquín, J. Rodríguez–Fernández, I. de Pedro, M. L. Fdez–Gubieda and J. Alonso; Nanoscale, 2013 (DOI:10.1039/C3NR03961G).
F1: 6,233 Q: 1

XVI.
Determination of the distribution of transverse magnetic anisotropy in thin films from the second harmonic of Kerr signal. Garcia-Arribas, A.; Fernandez, E.; Orue, I.; Barandiaran, J. M. Applied Physics Letters, vol.103, pp. 142411, 2013.
F1: 3,844 Q: 1

XVII.
A. García-Arribas, E. Fernández, A. Svalov, G. V. Kurlyandskaya, A. Barrainkua, D. Navas and J. M. Barandiaran: *"Tailoring the magnetic anisotropy of thin film permalloy microstrips by combined shape and induced anisotropies",* The European Physical Journal B, vol. 86, pp. 1434-6028, 2013
F1: 1,282 Q: 3

XVIII.
Exchange biased FeNi/FeMn bilayers with coercivity and switching field enhanced by FeMn surface oxidation. A. V. Svalov, P. A. Savin, V. N. Lepalovskij, A. Larrañaga. V. O. Vas'kovskiy, A. Garcia Arribas, and G. V. Kurlyandskaya. AIP ADVANCES 3, 092104 (2013)

XIX.
Hysteretic and anhysteretic tensile stress–strain behavior of Ni–Fe(Co)–Ga single crystal: Experiment and theory. Anna Kosogora, Victor A. L'vova, b, Volodymyr A. Chernenkoc, Elena Villae, Jose M. Barandiaranc, Takashi Fukudaf, Tomoyuki Teraif, Tomoyuki Kakeshitaf. Acta Materialia, Volume 66, March 2014, Pages 79–85
F1:3,941 Q:1

OTHER PUBLICATIONS

I.
Effect of Si(IV) substitution on electrochemical, magnetic and spectroscopic performance of nanosized LiMn2-xSixO4. Iturrondobeitia, Amaia; Goni, Aintzane; Lezama, Luis; Kim, Chunjoong; Doeff, Marca; Cabana, Jordi; Rojo, Teofilo; Journal of Materials Chemistry A: Materials for Energy and Sustainability (2013), 1(36), 10857-10862.
F1:- Q:-

II.
Inhibition behavior on alkaline phosphatase activity, antibacterial and antioxidant activities of ternary methimazole-phenanthroline-copper(II) complex. Urquiza, Nora M.; Soledad Islas, M.; Dittler, Maria Laura; Moyano, Maria A.; Manca, Silvia G.; Lezama, Luis; Rojo, Teofilo; Martinez Medina, Juan J.; Diez, Maximiliano; Lopez Tevez, Leonor; et al; Inorganica Chimica Acta (2013), 405, 243-251.
F1: 1,687 Q: 3

III.
Low temperature red luminescence of a fluorinated Mn-doped zinc selenite. Orive, Joseba; Balda, Rolindes; Fernandez, Joaquin; Lezama, Luis; Arriortua, Maria I.; Dalton Transactions (2013), 42(34), 12481-12494.
F1: 3,806 Q: 1

IV.
Enhanced electrochemical performance of vanadyl (IV) Na3(VO)2(PO4)2F by ex-situ carbon coating. Serras, Paula; Palomares, Veronica; Kubiak, Pierre; Lezama, Luis; Rojo, Teofilo; Electrochemistry Communications (2013), 34, 344-347.
F1: 4,425 Q: 1

V.
Fe-TPP Coordination Network with Metalloporphyrinic Neutral Radicals and Face-to-Face and Edge-to-Face – Stacking. Fidalgo-Marijuan, Arkaitz; Barandika, Gotzone; Bazan, Begona; Urtiaga, Miren Karmele; Lezama, Luis; Arriortua, Maria Isabel; Inorganic Chemistry (2013), 52(14), 8074-8081.
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VI.
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PhD Thesis Successfully Defended in 2013

I.
Idoia Castellanos
Preparación y caracterización de nanopartículas de Pd, PdFe y Fe3O4; potenciales agentes inductores de hipertermia magnética.
Abril 2013

II.
Amaia Iturrospe
Síntesis, caracterización química y estudio estructural de sistemas basados en heteropolianiones de wolframio y silicio o germanio y complejos de cobre con ligandos N4 tetradentados.
Mayo 2013

III.
Nagore Pérez
Nanopartículas Metálicas Biocompatibilizadfas con surfactantes Poliméricos.
Octubre 2013

IV.
Eduardo Fernández
Thin Film Magnetoimpedance Microstructures for Sensing Applications.
Noviembre 2013

V.
Iñigo Fernández
Síntesis y caracterización de nuevos copolímeros amino-sintético.
Diciembre 2013

Selected Conference Contributions

VOLODYMYR CHERNENKO

Donostia International Conference on Nanoscaled Magnetism and Applications
DICNMA 2013
Invited lecture

Symposium Magnetic shape memory alloys: from fundamentals to applications - 7A. XII IMRC Congress.
August 11-15, 2013, Cancun, Mexico
Invited lecture

The fourth International Conference on FSMAs
ICFSMA '13

International Symposium on Non-ergodic behavior in martensites.
January, Duisburg

JOSE MANUEL BARANDIARAN

Nanobiomaterials. Zing Conference.
Lanzarote, Spain
Febrero 2013
Invited lecture

TMS
San Antonio, Texas
Invited lecture

Easter Island Nanoscience Conference
Chile
Invited lecture

Flash DCS Conference
Zurich
Invited lecture

Donostia International Conference on Nanoscaled Magnetism and Applications
DICNMA 2013
Invited lecture

Symposium Magnetic shape memory alloys: from fundamentals to applications - 7A XII IMRC Congress.
August 11-15, 2013, Cancun, Mexico
Invited lecture

M. LUISA FDEZ-GUBIEDA

Magnetic nanoparticles from magnetotactic bacteria: the process of biomineralization Nanobiomaterials. Zing Conference.
Lanzarote, Spain
Febrero 2013
Invited lecture

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