



HISTORIAL CIENTÍFICO-TÉCNICO DE LOS ÚLTIMOS CINCO AÑOS DEL EQUIPO DE INVESTIGACIÓN (SCIENTIFIC/TECHNICAL RECORD DURING THE LAST FIVE YEARS OF THE RESEARCH TEAM)

Según el artículo 45 de la Resolución de convocatoria el equipo de investigación es el compuesto por el personal investigador que desarrolla la línea de investigación en la que se integrará el investigador candidato.

(According to what is established in article 45 of Call Resolution, the research team is defined as the one formed by the researchers developing the research line in which the candidate is to participate)

Especificar los trabajos de investigación desarrollados, publicaciones, proyectos, patentes, la capacidad formativa pre y posdoctoral y cualquier otro aspecto de interés.

(Please specify the research work that the team has developed, publications, funded projects, patents, capacity for providing guidance and training and any other aspect that may be of interest).

CUMPLIMENTAR PREFERIBLEMENTE EN INGLÉS – FILL IN BETTER IN ENGLISH

Current members of the Group of Nanomagnetism and Magnetization Processes:

Staff:

Dr. Manuel Vázquez, Profesor de Investigación del CSIC

Dr. Oksana Fesenko, Investigadora Científica del CSIC

Dr. Agustina Asenjo, Investigadora Científica del CSIC

Dr. Rafael Pérez, Científico Titular del CSIC

Doctors:

Dr. Miriam Jaafar, researcher

Dr. Cristina Bran, postdoc

Dr. Tatiana Sánchez, postdoc

Students:

Esther Calle

Eider Berganza

Jose Ángel Fernández

The Group of Nanomagnetism and Magnetization Processes (GNMP) is a highly productive research team of the Instituto de Ciencia de Materiales de Madrid (ICMM) (Institute of Materials Science of Madrid) of the Consejo Superior de Investigaciones Científicas (CSIC) (Spanish National Research Council).

The research lines of the group are within the general field of Magnetism and Magnetic Materials. Recent activities are mainly devoted to individual nanowires (dots) and their ordered arrays, to nanohole thin films (antidots) and microwires, with specific relevance of developments in magnetic force microscopy. Samples are prepared at the laboratory by various techniques as electrodeposition (nanowires, nanotubes) and sputtering (antidots) on anodic alumina porous templates, and rapid solidification (microwires). Research is focused to magnetic domain observation, magnetization reversal process (i.e., controlled domain wall motion), and magnetotransport properties. Technological applications are also addressed, exploiting the ultrasoft magnetic nature of microwires as sensing elements in sensor devices, and profiting of the self-assembled pores in anodic alumina membranes for the magnetic functionalization of ordered nanostructures.

From academic and dissemination viewpoints, in the period 2012-2017, a total of 11 PhD thesis were defended by the team, while over 160 publications on the different topics were published with an impact factor $h \sim 20$. These achievements have allowed the group to gain international reputation facilitating the establishment of a number of collaborations with international groups (S. Parkin, O. Gutfleisch, R. Cowburn, O. Kazakova, K. Nielsch, M. Farle, M. Groenefeld, R. Ibarra, J.M. de Teresa, J. Kosel, A. Labarta, X. Battle, J. Gómez-Herrero or P. Grutter,).

Regarding facilities, the research team has different laboratories and measurement techniques:

-Sample preparation: Anodization & electrodeposition laboratory; Magnetron sputtering growth laboratory; Ultrafast solidification laboratory.

-Magnetic characterization: Magnetometry & magnetotransport laboratory (Vibration Sample Magnetometry (VSM), Anisotropic Magnetic



Resistance (AMR), Giant Magnetic Impedance (GMI) & Ferromagnetic Resonance measurements); Scanning probe microscopy & surface magnetism laboratory (Variable Field Magnetic Force Microscopy (VFMFM), Magneto-optic Kerr effect magnetometry).
-Technical magnetism laboratory: Fluxmetric induction technique, Switching field fluctuation measurement.

RESEARCH INTERESTS

We can distinguish three main research interests:

1- Magnetic microwires

- Multilayer and bi-phase magnetic microwires

These microwires are of interest to be employed as sensing elements in devices, but also to more fundamental new studies on magnetic interactions. They consist of a core (typically magnetic) prepared by quenching and drawing rapid solidification technique, and several concentric nano and microlayers (magnetic or not). They can be magnetically considered as single or two phases. Outer layer determines the magnetic state of the core by magnetoelastic coupling (through the stresses induced by them). In addition, magnetostatic coupling in bi-phase microwires gives rise to phenomena of fundamental and applied interest as: magnetostatic bias effect on the soft core so obtaining, spin-valve like hysteresis loops; or asymmetric giant magnetoimpedance and stress impedance. Several studies have been performed looking for technological applications profiting of the outstanding magnetic properties of those microwires, and four patents were filed in the last years.

- Dynamics of single-wall propagation in bistable magnetic microwires

The magnetization reversal process of bistable microwires is characterized by the nucleation and propagation of a single domain wall. The distribution of the fluctuating switching field has been experimentally determined as a function of temperature. Particularly, outstanding results concern the theoretical understanding of the reversal process considering magnetostrictive and structural defects contributions to the dynamics of switching process. Recent experimental studies on the dynamics of the wall propagation have allowed the group to confirm that the wall speed can reach several kilometers per second. Present studies are focused on the controlled motion of single domain walls by local magnetic fields, to discuss on the actual Walker limit, and alternative propagation modes.

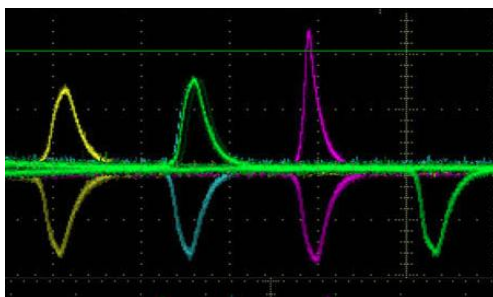


FIGURE 1- Sequences of induced signals at the pickup coils along a bistable microwire where the collapse of two domain walls propagating in opposite directions is detected. (A. Jimenez et al. Eur Phys J B 86 (2013) 113)

2-Nanowires & nanoparticles: nanoscale magnetism

The Anodization & Electrodeposition Laboratory at the Institute of Material Science of Madrid-CSIC is well consolidated and the group is



pioneer in Spain in the fabrication of ordered arrays of metallic nanostructures by electrochemical route, and their magnetic characterization.

The preparation of nanoporous membranes (typically alumina) is performed by anodization processes where long range hexagonal ordering is induced by self-assembling or nano-imprint. Anodic alumina membranes are subsequently employed as templates for the preparation of different ordered nanostructures. The membranes are also employed as masks to reproduce ordering onto oxide and metallic surfaces by ion irradiation and implantation.

Self-assembled nanopores are filled by electroplating with metallic elements to obtain highly-ordered hexagonal arrays of densely packed metallic single nanowires (NW) as FeNi, Fe, Co, FeCo, CoNi and multilayered nanowires as Co/Cu.

In the last years the research team has explored how to control the composition (alloy or multilayer character), geometry and crystalline structure (see Fig. 1) of nanowires to tailor their magnetic anisotropy from transversal to axial direction. Moreover, they have improved the scientific equipment and the skills of the group to characterize nanowires and their arrays.

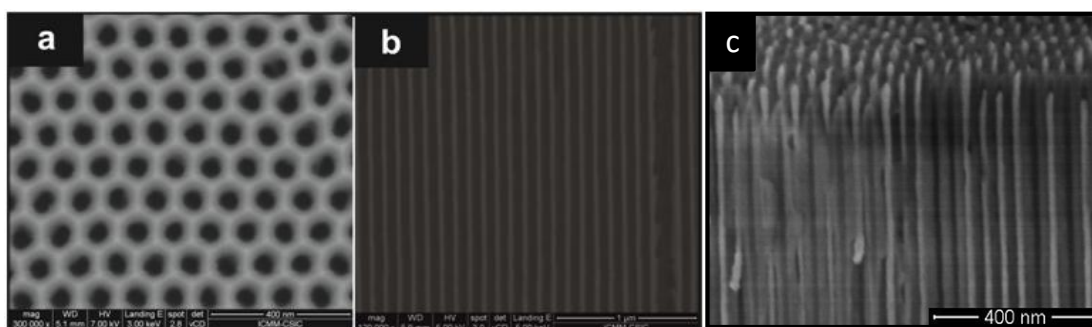


FIGURE 2- (a) Top view of an empty alumina template; (b) cross-section SEM images of CoFe nanowires with diameter of 40 nm inside the AAO template; (c) Cross-section SEM image of an array of Co nanowires with controlled crystal phase and magnetocrystalline anisotropy. (M. Vazquez and L.G. Vivas, *Phys. Status Solidi B* 248, 2368 (2011))

Various replica/antireplica processes allow us the production of a broad spectrum of high-ordered magnetic nanocomposites reproducing the original ordering as nanohole or antidot arrays in metallic membranes (i.e., Ni, Py), mechanically hard nanostructures for imprinting (i.e., TiN), polymeric membranes with embedded magnetic nanoparticles (i.e., CoNi, FePt), or nanoparticle-like Co structures on polymeric surfaces.

Magnetization process studies of magnetic nanowires are being performed on single magnetic nanowires (Ni, FeNi, Fe and Co, FeCoCu), and on arrays of magnetic nanowires (multilayer Co/Cu, single magnetic NW) and nanotubes. Investigation was firstly focused on their magnetization reversal process and the role played by the magnetostatic interactions between nanowires which depend on their geometrical arrangement determined by the geometrical parameters as ratio diameter to hexagonal lattice constant, or ordering degree.

- *Magneto-optic Kerr effect*

Characterization of individual nanowires, after release from the template, has been performed recently by Magneto-optical Kerr effect, that has allowed to experimentally measure the local hysteresis loops of individual nanowires. This technique has been employed also for magnetic microwires mentioned in the first section.

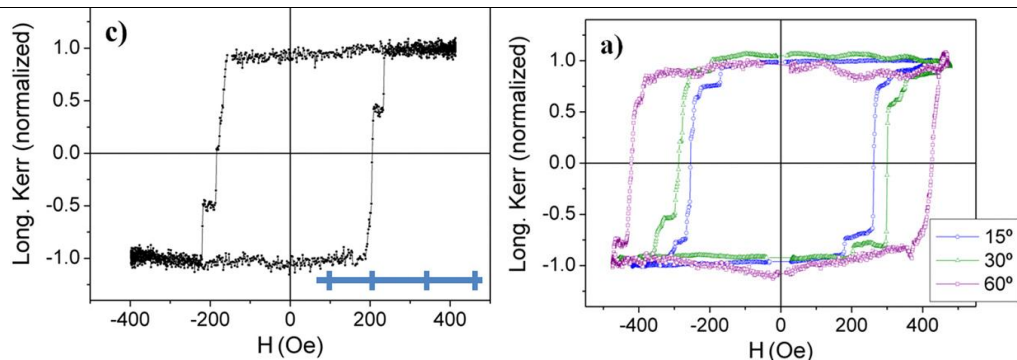


FIGURE 3- MOKE local hysteresis loop of a FeCo nanowire modulated in diameter (100-130 nm), and the angular dependence of its coercivity (E. Palmero et al., Nanotechnology 26 (2015) 461001).

- PEEM-XMCD (Photoemission electron microscopy combined with X-ray magnetic circular dichroism)

Very recently, a continued investigation has been performed to experimentally determine the magnetic configuration at the surface but also at the inner section of *individual cylindrical nanowires* with modulations in diameter and in composition (multisegment / multilayer).

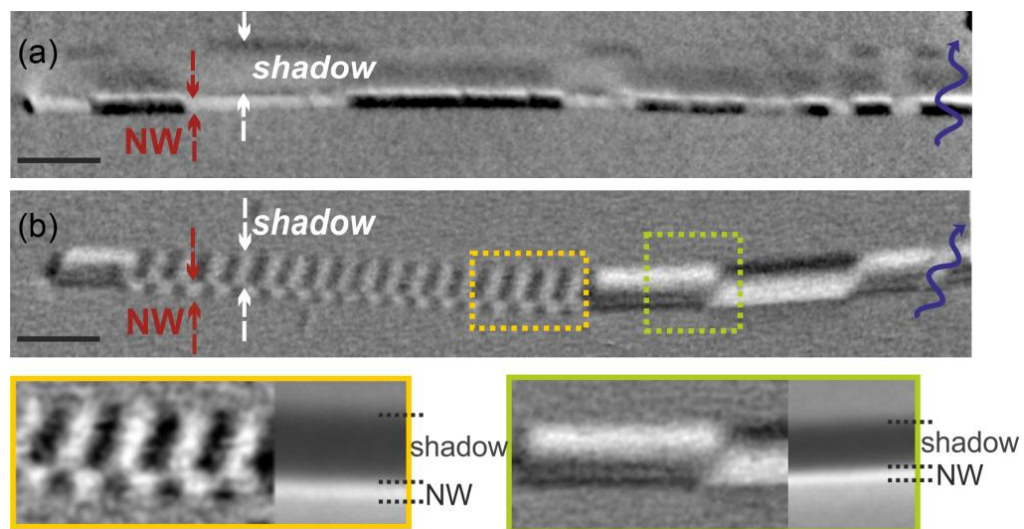


FIGURE 4- PEEM-XMCD images of images of (a) Co85Ni15 and (b) Co65Ni35 nanowires showing transverse and vortex domains (C. Bran et al. Phys. RevB. 96 (2017)125415

- Micromagnetic Simulations

The demagnetization process of nanowires in the arrays as well as in individual nanowires after their release from the templates has been recently performed using different codes (i.e., MAGPAR, mumag). Some specific data are illustrated in figure 5.

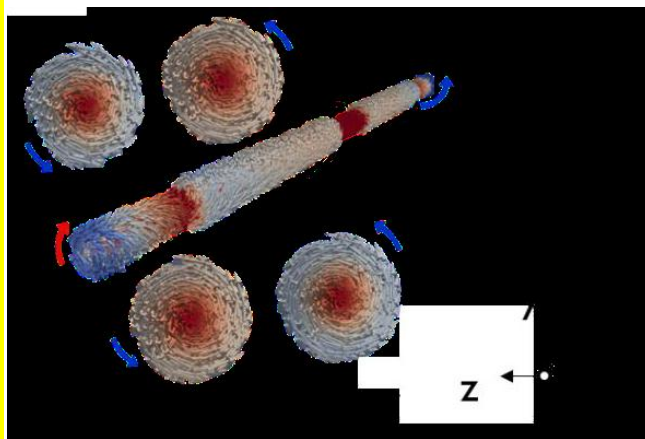


FIGURE 5. Images of micromagnetic simulations of the magnetization distribution at the remanence state for arrays of seven Co nanopillars with diameter of 75 nm (Y. Ivanov et al. *Nanotechnology* 24 (2013) 475703), and of an individual CoFe nanowire with modulations in diameter (J.A. Fernandez-Roldan, submitted)

3- Magnetic force imaging

Force microscopy has the ability to detect all kinds of short- and long-range tip-sample interaction forces, among them, electrostatic, magnetostatic, van der Waals, chemical and mechanical interactions. At the Laboratory of Magnetic Force Microscopy (MFM) of the ICMM-CSIC the characterization of the surface of materials is performed. Topography information of various materials is first achieved by atomic force microscopy, AFM. Concerning magnetic force microscopy, the laboratory is leader in Spain in the topic of magnetic domains and domain walls (DWs) observation (i.e., individual nanowires, antidot thin films and lithographed nanostructures). In the last years the MFM group has different research interests

- *Study of Magnetic Nanostructures by Magnetic Force Microscopy.*

MFM is an advanced technique for domain observation. It has a very good resolution and sensitivity to characterize different nanoobjects.

The Laboratory of Magnetic Force Microscopy of the ICMM-CSIC is a reference in this area because of the developments they perform to improve the lateral resolution and sensitivity of the technique. In recent years various advances in MFM technique were carried out in the group. In that sense, it is important to mention the use of home-made MFM probes with specific coating or the combination of Magnetic Force Microscopy / Kelvin Probe Force Microscopy combination (MFM + KPFM) to separate the electrostatic interaction from the magnetic signal. They have a strong interaction with companies to develop new prototypes of microscopes.

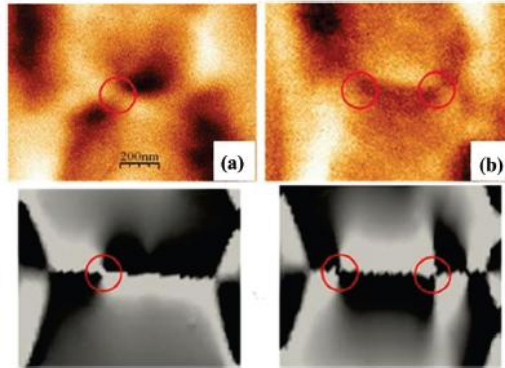


FIGURE 6. High-resolution MFM images (up) and results of micromagnetic simulation (down) for vortex (a) and double vortex (b) DWs in a Cobalt nanostripe. (*Phys.Rev. B* 87, 184410 (2013))

- Reversal Magnetization process by Variable Field Magnetic Force Microscope (VFMFM).

A new variable external field magnetic force microscope has been developed recently. The most outstanding feature of the system is its capability to perform stable images under a variable external magnetic field that can be applied both in-plane and out-of-plane directions. The VFMFM system of the Laboratory of Magnetic Force Microscopy of the ICMM-CSIC can be used to perform images under externally applied magnetic field up to 100mT.

A direct study of the magnetization reversal process of spin structures of nanoscale magnetic elements is particularly interesting and hard to achieve. In this respect, VFMFM is an advanced technique which can become a powerful “local” technique to study the switching process at the nanometer scale when *in situ* magnetic field is applied. The research team is leader in Spain in this topic. They have several collaborations to study different samples in addition to the samples prepared in the same group

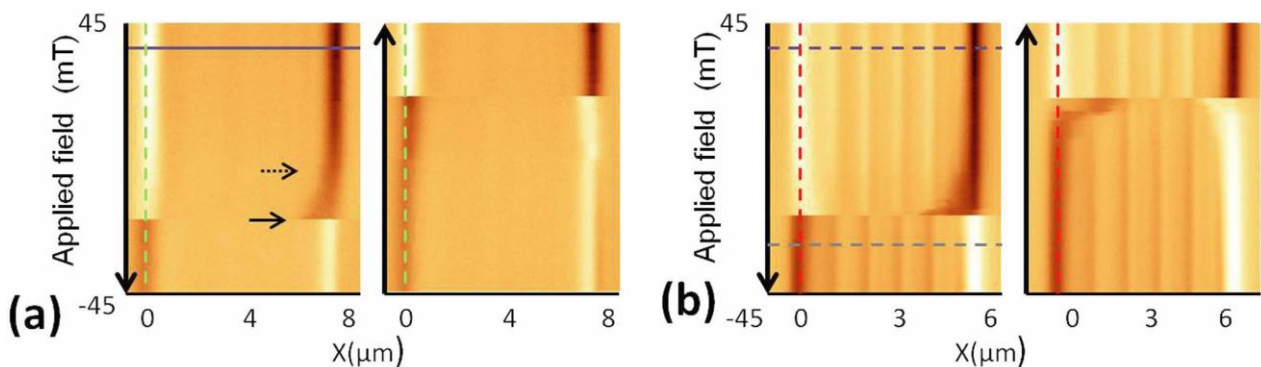


FIGURE 7.- Non-standard MFM based image of FeCoCu bamboo-like nanowires (a) with homogeneous diameter and (b) bamboolike geometry. (a) Two critical fields have been marked with arrows. (b) In the bamboo-like nanowires, a DW propagated towards the opposite end, jumping from one pinning site to the next (E. Berganza et al. *Sc. Rep.* 6 (2016) 29702).

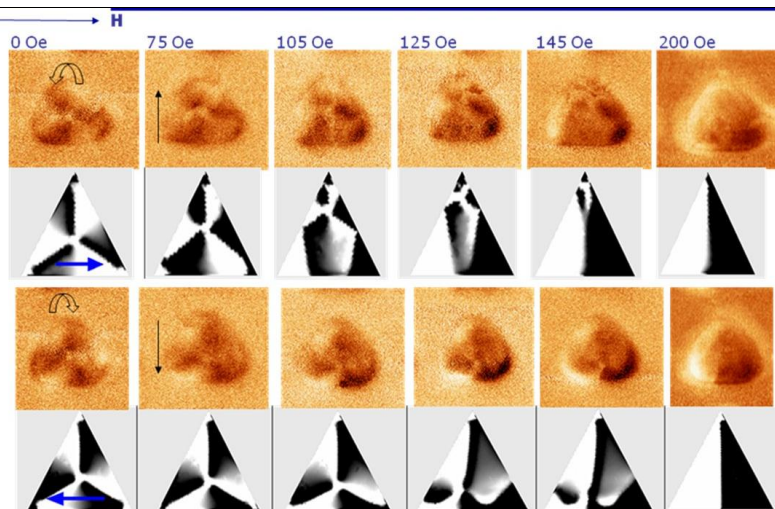


Figure 8. High-resolution VFMFM images and results of micromagnetic simulation for the magnetization process of a vortex state in triangular nanodots. (Phys.Rev. B 81 (5), 054439 (2010))

- Topographic and mechanical characterization of surfaces by Scanning Probe Microscopy.

In addition to the magnetic properties, the group is able to study other properties such as mechanical, electrical or chemical on different surfaces and in different controlled environments (N_2 or high vacuum). These studies were performed on samples of the group or collaborations.

Furthermore, the Scanning Probe Microscopy Service of the ICMM-CSIC was recently established as an internal and external service to supply surface characterization in a broad range of research activities.

Training experience.

The members of the Research Group have a large experience in the training of scientific personnel. In the last 6 years, the scientific staff has supervised 12 PhD students. Most of them nowadays working in the most prestigious Research Centers and Universities (<http://www.icmm.csic.es/gnmp/>). In addition, there are three PhD students.

The researchers of the ICMM-CSIC supervise the undergraduate, master students and PhD students from Spain and foreign countries and receive visiting Prof. and post-doc researchers.

PhD SUPERVISION

PHD STUDENT: David González Trabada

TITLE: Plantillas Nanoestructuradas por impresión y anodización para el crecimiento de redes ordenadas de nanohilos y nanotiras de Co

DATE: September of 2017

SUPERVISOR: Manuel Vázquez Villalabeitia y David Navas Otero

PHD STUDENT: Roberto Moreno Ortega

TITLE: The ultrafast magnetisation dynamics and the role of the exchange interactions



DATE: June of 2017

SUPERVISOR: Oksana Fesenko

PHD STUDENT: Ester María Palmero Rodríguez

TITLE: Magnetization processes in modulated magnetic nanowires

DATE: December of 2016

SUPERVISOR: Manuel Vázquez Villalabeitia / Cristina Bran / Rafael Pérez del Real

PHD STUDENT: Rhimou ElKammouni

TITLE: Single and biphasic magnetic microwires: microwave behaviour and temperature dependence

DATE: April 2015

SUPERVISOR: Manuel Vázquez Villalabeitia

PHD STUDENT: Pablo Nieves Cordones

TITLE: Micromagnetic models for high-temperature magnetization dynamics

DATE: May of 2015

SUPERVISOR: Oksana Fesenko

PHD STUDENT: Alejandro Jimenez Villada

TITLE: Single domain wall propagation dynamics and magnetization process in magnetic microwires

DATE: January 2015

SUPERVISOR: Manuel Vázquez Villalabeitia

PHD STUDENT: Óscar Iglesias Freire

TITLE: Advances in magnetic force microscopy

DATE: June of 2014

SUPERVISOR: Agustina Asenjo

PHD STUDENT: Karla Marina Jaimes Merazzo

TITLE: Ordered magnetic antidot arrays

DATE: July of 2012

SUPERVISOR: Manuel Vázquez Villalabeitia / Rafael Pérez del Real

PHD STUDENT: Mariana Paiva Proença

TITLE: Magnetism at the nanoscale: nanowires, nanotubes and their ordered arrays

DATE: October of 2012

SUPERVISOR: Joao Pedro Araujo / Manuel Vázquez Villalabeitia

PHD STUDENT: Ignacio Minguez Bacho

TITLE: Nanostructures Fabrication: Porous Anodic Alumina and ZnO nanorods

DATE: June of 2012

SUPERVISOR: Manuel Hernandez Velez / Manuel Vázquez Villalabeitia

PHD STUDENT: Laura Gonzalez Vivas

TITLE: On the magnetic and structural properties of Co and Co-based nanowire arrays

DATE: June of 2012

SUPERVISOR: Manuel Vázquez Villalabeitia / Oksana Chubykalo Fesenko

PHD STUDENT: Unai Atxitia Macizo

TITLE: Modeling of ultrafast laser-induced magnetization dynamics within the Landau-Lifshitz-Bloch approach

DATE: March of 2012

SUPERVISOR: Oksana Chubykalo Fesenko



Thesis in progress

PHD STUDENT: Eider Berganza Eguiarte
TITLE: Advanced MFM imaging of magnetic nanostructures: domain wall control and magnetization processes.
Estimated DATE: May of 2018
SUPERVISOR: Agustina Asenjo / Miriam Jaafar

PHD STUDENT: José Ángel Fernández Roldán
TITLE: Magnetic configuration and magnetization processes in nanowires.
Estimated DATE: January of 2019
SUPERVISOR: Manuel Vázquez Villalabeitia / Rafael Pérez del Real / Oksana Chubykalo Fesenko

PHD STUDENT: Esther Calle Ramírez
TITLE: Time-resolved dynamics of a single domain wall in amorphous microwires.
Estimated DATE: May of 2019
SUPERVISOR: Rafael Pérez del Real

Postdoc SUPERVISION

Dr. Cristina Bran, 2012-2017
Dr. Miriam Jaafar, 2016-2017
Dr. Alejandro Jiménez, 2016-2017
Dr. Nikita Kulesh, 2015-17
Dr. Alejandro Pereira, 2014
Dr. Juan Luis Palma Solorza, 2014
Dr. Yuri Ivanov, 2012-2013
Dr. Tatiana Sánchez Fernández, 2016-2017

Senior Visiting Researchers

Prof. Laura H. Lewis from Northeastern University, Boston, USA. May-July 2015
Prof. Dr. Paula G. Bercoff, from the Faculty of Mathematics, Astronomy and Physics, National University of Córdoba, Argentina. February to March 2016
Dr. Oana Dragos, from National Institute of Research and Development for Technical Physics, Iasi, Romania. May to July 2014

Master thesis

-Xabier Boyat grant from The Institut National des Sciences appliquées of Strasbourg, France. Master thesis student in mechanical and magnetic properties of polycarbonate membranes with thin film coating. Supervisor: Agustina Asenjo and Miriam Jaafar, 2015

-Jorge Alexis Guzmán Villa, grant from Autonomous University of Ciudad Juárez (UACJ), Mexico. Master thesis student in surface of magnetic nanostructures. Supervisor: Manuel Vázquez and Agustina Asenjo, 2014

Supervision visiting students

Yu-Sheng Chen, grant from Yuan-Ze University, TaoYuan, Taiwan. Working on Magnetic Nanowires and arrays. Visited the group from May to December 2016. Supervisor: Cristina Bran and Manuel Vazquez.

Jonathan Zamora, grant from Universidad Nacional Autónoma de México. Working on Hard magnetic microwires. Visited the group from



September 2016 to February 2017. Supervisor: Rafael Perez and Manuel Vazquez

Jessi Meier, DAAD grant from Karlsruhe Institute of Technology, Germany, working on Modulated magnetic nanowires. July-October 2015. Supervisor: Cristina Bran and Manuel Vazquez

Majid Peighambari, grant from Sahand University of Technology, Tabriz, Iran (PhD student on Modulated Magnetic Nanowires). Supervisor: Cristina Bran and Manuel Vazquez. February - December 2016

Dieivase da Silva Chrischon, grant from Federal University of Santa Maria, Santa Maria-RS, Brazil. (Ph.D. student in magnetic nano and microtubes). Supervisor: Manuel Vázquez and Cristina Bran., 2014-2015

Ana M^o Cabanas, supported by Univ. Arica, Chile (PhD student; FORC analysis of bistable magnetic microwires). Supervisor: Rafael Perez and Manuel Vazquez; 2015-2016

Irene Iglesias, grant from Emmanuel Kant Federal University of Baltic, Kaliningrad, Russia. Working on Biphasic magnetic microwires. Visited the group from May to July 2015

Irina Machay, grant from Emmanuel Kant Federal University of Baltic, Kaliningrad, Russia. Working on Magnetic microwires with asymmetric shell. Visited the group from May to June 2015. Supervisor: Manuel Vazquez

Irenej Poláček, visiting grant from Technical University of Kosice, Slovakia, working on biomedical functionalization of magnetic microwires. Visiting the group from October 2014 to February 2015. Supervisor: Manuel Vázquez

Daniela R. B. Valadão, CNPq grant from the University of Natal, Brazil. Working on magnetic nanowires. Visited the group from September to October 2013. Supervisor: Manuel Vazquez

Marcella Cogo Muniz, grant from the Federal University of Uberlândia-Brasil. Working on Magnetic nanowire arrays. Visited the group from June to August 2013. Supervisor: Manuel Vazquez

Ksenia Chichai, visiting grant from Emmanuel Kant Federal University of Baltic, Kaliningrad, Russia. Working on Bimagnetic Phase Magnetic microwires. Visited the group from September to November 2014. Supervisor: Manuel Vázquez

Ali Fardi Ilkhchy, grant from Iranian Ministry of Science Research and Technology. Working on Nanowire arrays, synthesis and magnetism. Visited the group from December 2013 to July 2014. Supervisor: Manuel Vázquez

Yang Yong Zhao, grant from the University of Science and Technology Beijing, China. Working on magnetic microwires for memory alloys. Visited the group from December 2013 to March 2014. Supervisor: Manuel Vázquez

Cristopher Antonio Morales Concha, grant from the University of Santiago de Chile. Working on micromagnetic simulations. Visiting the group from March to October 2013. Supervisor: Manuel Vázquez

Tobias Warnatz, DAAD grant from the University of Applied Science Zwickau, Germany. Working on Magnetic nanowires and arrays. Visited the group from August to October 2012. Supervisor: Manuel Vázquez and Cristina Bran.

Victor Morin, grant from the ENS of Cachan in Paris, France. Working on temperature dependence of magnetic microwires magnetic. Visited the group from June to August 2012. Supervisor: Manuel Vázquez

Carlos Moya Álvarez, FPI grant from the University of Barcelona. Visited the group from October to December 2013 and May to June 2012. Supervisor: Agustina Asenjo

Philipp Szary, grant from the Institute for Experimental Physics/ Solid State Physics, Ruhr-University Bochum, Germany. Working on Magnetic microwires. Visited the group from March to June 2012. Supervisor: Giovanni Badini.



Supervision of undergraduate students

- Carlos Gutiérrez, Prácticas Externas UCM, 2018, Supervisor: Rafael Pérez del Real
- Raúl Chamorro, Prácticas Externas UCM, 2018, Supervisor: Rafael Pérez del Real
- Miguel Ángel Pulido, Prácticas Externas UAM, 2018, Supervisor: Miriam Jaafar / Agustina Asenjo
- Diego Trabajo Fin de Grado, UAM, Supervisor: Miriam Jaafar/ Julio Gómez-Herrero
- Ana Díaz Quijada, Prácticas Externas UCM, 2017, Supervisor: Rafael Pérez del Real
- Raúl Izquierdo, Prácticas Externas UAM, 2017, Supervisor: Agustina Asenjo/ Miriam Jaafar
- Ángel Ibabe, Prácticas Externas UCM, 2017, Supervisor: Agustina Asenjo/ Miriam Jaafar
- Julian Martínez Hernandez. Prácticas Externas UAM. 2014 Supervisor: Agustina Asenjo

Scientific Results of Group of Nanomagnetism and Magnetization Processes during the last 5 years (Scopus at 22 Dec 2017) H index=20 for this period

Publications (papers with IP>3 are shown in bold)

1. Berganza, E., Jaafar, M., Bran, C., Fernández-Roldán, J.A., Chubykalo-Fesenko, O., Vázquez, M., Asenjo, A., "Multisegmented Nanowires: A Step towards the Control of the Domain Wall Configuration", (2017) **Sci. Rep.**, 7 (1), art. no. 11576.
DOI: 10.1038/s41598-017-11902-w
2. Rotarescu, C., Moreno, R., Fernández-Roldan, J.A., Trabada, D.G., Nemes, N.M., Fehér, T., Bran, C., Vázquez, M., Chiriac, H., Lupu, N., Óvári, T.-A., Chubykalo-Fesenko, O., "Effective anisotropies in magnetic nanowires using the torque method", (2017) J. Magn. Magn. Mater., 443, pp. 378-384.
DOI: 10.1016/j.jmmm.2017.07.059
3. John, R., Berritta, M., Hinzke, D., Müller, C., Santos, T., Ulrichs, H., Nieves, P., Walowski, J., Mondal, R., Chubykalo-Fesenko, O., McCord, J., Oppeneer, P.M., Nowak, U., Münzenberg, M., "Magnetisation switching of FePt nanoparticle recording medium by femtosecond laser pulses", (2017) **Sci. Rep.**, 7 (1), art. no. 4114, . Cited 3 times.
DOI: 10.1038/s41598-017-04167-w
4. Klein, P., Onufer, J., Ziman, J., Badini-Confalonieri, G.A., Vazquez, M., Varga, R., "Effect of Annealing on Domain Wall Mass in Amorphous FeCoMoB Microwires", (2017) IEEE Trans. Magn., 53 (11), art. no. 7894167, .
DOI: 10.1109/TMAG.2017.2692253
5. Bran, C., Fernandez-Roldan, J.A., Palmero, E.M., Berganza, E., Guzman, J., Del Real, R.P., Asenjo, A., Fraile Rodríguez, A., Foerster, M., Aballe, L., Chubykalo-Fesenko, O., Vazquez, M., "Direct observation of transverse and vortex metastable magnetic domains in cylindrical nanowires", (2017) **Phys. Rev. B**, 96 (12), art. no. 125415, . Cited 2 times.
DOI: 10.1103/PhysRevB.96.125415
6. Vargas-Estevez, C., Blanquer, A., Dulal, P., Pérez del Real, R., Duch, M., Ibáñez, E., Barrios, L., Murillo, G., Torras, N., Nogués, C., Stadler, B.J.H., Plaza, J.A., Esteve, J., "Study of Galfenol direct cytotoxicity and remote microactuation in cells", (2017) **Biomaterials**, 139, pp. 67-74.
DOI: 10.1016/j.biomaterials.2017.05.049
7. Goiriena-Goikoetxea, M., Guslienko, K.Y., Rouco, M., Orue, I., Berganza, E., Jaafar, M., Asenjo, A., Fernández-Gubieda, M.L., Fernández Barquín, L., García-Arribas, A., "Magnetization reversal in circular vortex dots of small radius", (2017) **Nanoscale**, 9 (31), pp. 11269-11278.
DOI: 10.1039/c7nr02389h
8. Moreno, R., Ostler, T.A., Chantrell, R.W., Chubykalo-Fesenko, O., "Conditions for thermally induced all-optical switching in ferrimagnetic alloys: Modeling of TbCo", (2017) **Phys. Rev. B**, 96 (1), art. no. 014409, . Cited 1 time.
DOI: 10.1103/PhysRevB.96.014409



9. Wang, F.Z., Salikhov, R., Spasova, M., Liébana-Viñas, S., Bran, C., Chen, Y.-S., Vazquez, M., Farle, M., Wiedwald, U., "Doubling of the magnetic energy product in ferromagnetic nanowires at ambient temperature by capping their tips with an antiferromagnet", (2017) **Nanotechnology**, 28 (29), art. no. 295402, .
DOI: 10.1088/1361-6528/aa77b7
10. Kolesar, V., El Kammouni, R., Kubliha, M., Labas, V., Vazquez, M., "Temperature Microsensor/Microactuator Based on Magnetic Microwire for MEMS Applications", (2017) **IEEE Trans. Magn.**, 53 (4), art. no. 7604079, .
DOI: 10.1109/TMAG.2016.2619905
11. Hudak, R., Polacek, I., Klein, P., Sabol, R., Varga, R., Zivcak, J., Vazquez, M., "Nanocrystalline Magnetic Glass-Coated Microwires Using the Effect of Superparamagnetism Are Usable as Temperature Sensors in Biomedical Applications", (2017) **IEEE Trans. Magn.**, 53 (4), art. no. 7814333, .
DOI: 10.1109/TMAG.2016.2628181
12. P. Del Real, R., Raposo, V., Martinez, E., Hayashi, M., "Current-Induced Generation and Synchronous Motion of Highly Packed Coupled Chiral Domain Walls", (2017) **Nano Letters**, 17 (3), pp. 1814-1818. Cited 1 time.
DOI: 10.1021/acs.nanolett.6b05132
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DOI: 10.1007/s00339-011-6569-8

FUNDED PROJECTS

PROJECT TITLE: Arrays of nanodots and antidots: magnetization and transport
FUNDED BY: Spanish Science Ministry (MAT2010-20798-C05-01)
SINCE: January 2011 TO: December 2013
MAIN RESEARCHER: Manuel Vázquez Villalabeitia

PROJECT TITLE: REFREPERMAG "Rare earth free permanent magnets"
FUNDED BY: 7º Framework Program
SINCE: May 2012 TO: April 2015
MAIN RESEARCHER: Manuel Vázquez Villalabeitia (at ICMM)

PROJECT TITLE: Magnetic nanowires and their tridimensional arrays for advanced technologies
FUNDED BY: M.E.C. (MAT2013-48054-C2-1-R)
SINCE: January 2015 TO: December 2017
MAIN RESEARCHER: Manuel Vázquez Villalabeitia/Agustina Asenjo Barahona

PROJECT TITLE: Development of a new technology for the application in wireless battery charging in the range of 20-150 kHz.
FUNDED BY: MINECO (RTC-2016-4820-4)
SINCE: September 2016 TO: December 2018
MAIN RESEARCHER: Rafael Pérez del Real

PROJECT TITLE: Engineering magnetic nanowires for green technologies
FUNDED BY: MINECO (MAT2016-76824-C3-1-R)
SINCE: January 2017 TO: December 2019
MAIN RESEARCHER: Agustina Asenjo Barahona / Rafael Pérez del Real

PROJECT TITLE: Nuevas fronteras del nanomagnetismo fundamental y aplicado, NANOFrontMAG
FUNDED BY: Autonomous Government of Madrid (S2013/MIT-2850)
SINCE: October 2013 TO: September 2017
MAIN RESEARCHER: Rodolfo Miranda, Manuel Vázquez Villalabeitia (ICMM)

PROJECT TITLE: FORCE-FOR-FUTURE
FUNDED BY: MICINN (CSD2010-00024)
SINCE: January 2011 TO: December 2015
MAIN RESEARCHER: Ricardo García García. Agustina Asenjo Barahona responsable at GNMP

PROJECT TITLE: "Multiscale modeling of femtosecond spin dynamics" (FEMTOSPIN) FP7-NMP2011-SMALL-5
FUNDED BY: 7º Framework Program(grant agreement 281043)
SINCE: January 2012 TO: December 2015
MAIN RESEARCHER: Oksana Fesenko (at ICMM)

PROJECT TITLE: Study of new types of magnetization dynamics and materials for applications in low consuming spintronics and magnetic recording.
FUNDED BY: MINECO (MAT2013-47078-C2-2-P)



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SINCE: January 2014 TO: December 2017
MAIN RESEARCHER: Oksana Fesenko

PROJECT TITLE: ARQUIMEDES.
FUNDED BY: European Social Fund and Greek national funds (MIS 383576)
SINCE: January 2013 TO: December 2016
MAIN RESEARCHER: D.Kechrakos /Oksana Fesenko (at ICMM)

PROJECT TITLE: Theory and multiscale modelization of systems based on magnetic skyrmions for spintronic applications in low consuming technologies.
FUNDED BY: MINECO (FIS2016-78591-C3-3-R)
SINCE: January 2017 TO: December 2019
MAIN RESEARCHER: J. Camarero/Oksana Fesenko(at ICMM)

CONTRACTS WITH COMPANIES

TITLE: Development of antennas using pke technology
COMPANY: PREMO
SINCE: 23-5-2016 TO:31-12-2017
MAIN RESEARCHER: Rafael Pérez del Real

TITLE: Study on EM protection of electrical bundles to fast EM transients
COMPANY: EADS France
SINCE: 15-9-2013 TO:14-09-2016
MAIN RESEARCHER: Rafael Pérez del Real

TITLE: Sub-micrometer wire for electric power generation, water purification and environmental sensors
COMPANY: Nagoya Industrial Research Inst., NISRI
SINCE: January 2009 TO: December 2012
MAIN RESEARCHER: Kaneo Mohri an Manuel Vazquez Villalabeitia (ICMM)

TITLE: Sub-micrometer wire for electric power generation, water purification and environmental sensors
COMPANY: Nagoya Industrial Research Inst., NISRI
SINCE: January 2009 TO: December 2012
MAIN RESEARCHER: Kaneo Mohri and Manuel Vazquez Villalabeitia (ICMM)

PATENTS

AUTHORS: M. Jaafar, A. Asenjo, J.M. de Teresa, J. Pablo-Navarro, J. Gómez-Herrero, P. Ares, C. Magén
TITLE: Sistem for an atomic forces microscope
COUNTRY: Spain
REFERENCIA: P201731292

AUTHORS: M. Vázquez, R. ElKammouni, V. Rodionova, K. Chichay, I. Baraban, N. Perov
TITLE: Microactuator based on bimagnetic coated core/shell microwires with asymmetric external shell and the use of it
COUNTRY: Europe/Russia
REFERENCIA: EP17382418.6

AUTHORS: R. P. del Real, M. Vázquez, E. Palmero, A. Asenjo, C. Bran
TITLE: Sensors based on arrays of magnetic nanowires
COUNTRY: Spain
REFERENCIA: ES2558624-B1



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Y COMPETITIVIDAD**



AUTHORS: M. Vázquez, V. Kolesar
TITLE: Temperature sensor for electromechanical systems and its fabrication procedure
COUNTRY: Spain
REFERENCIA: ES1641.1023

AUTHORS: M. Vázquez, V. Kolesar
TITLE: Procedure & apparatus to measure DC-field based on magnetostrictive effect in magnetic wires
COUNTRY: Europe
REFERENCIA: EP15195921



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