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## EXECUTIVE SUMMARY

The activity recorded covers the full year 2015, and corresponds to the people assigned to the main research lines of BCMATERIALS, from the University, Ikerbasque and BCMATERIALS staff.

### ORGANIZATION AND MANAGEMENT OF THE CENTER

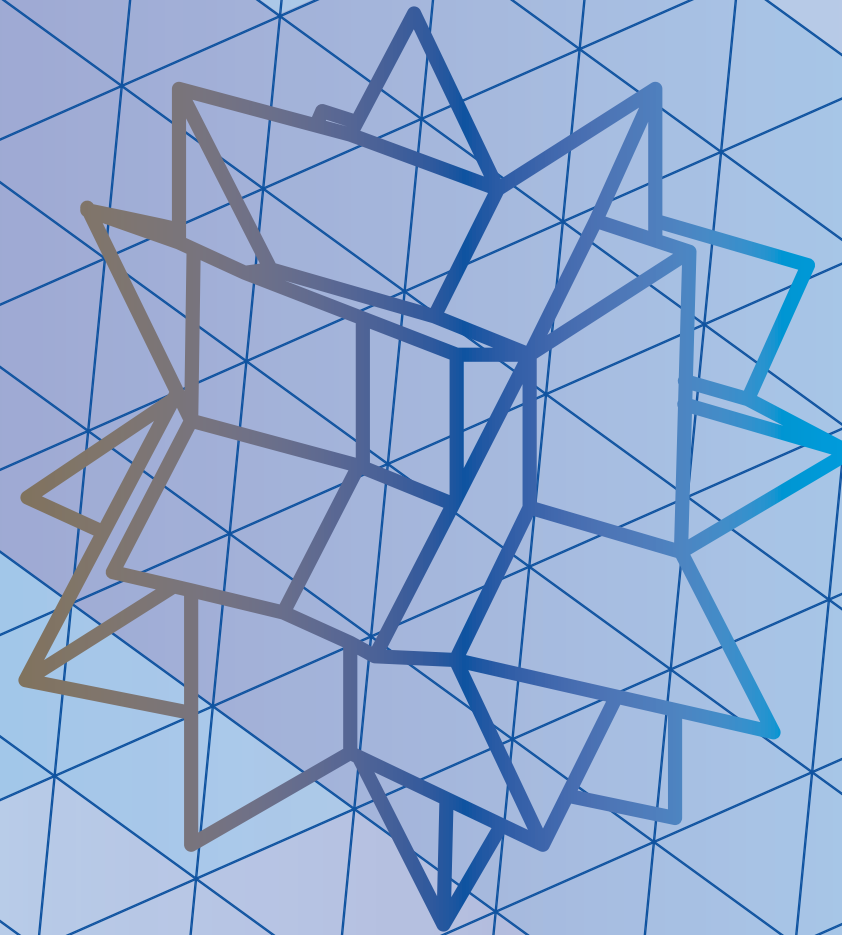
During this year we have started to implement the Advanced Management system lead by Euskalit. In line with this system, we have constituted several committees, implemented the 5S system in the laboratories and adopted the European Code of Conduct for Research Integrity as our reference guide to Excellency.

### PEOPLE

Some researchers left in 2015 and new ones have been incorporated. In addition, international researchers have been temporary incorporated during 2015.

### RESEARCH ACTIVITY

Intense research work has been developed with remarkable results in all lines. A summary of the results and main achievements is presented.



### DISSEMINATION OF RESULTS

Has been carried out through organization and participation in Conferences and meetings, talks and seminars.

### HIGH LEVEL EDUCATION

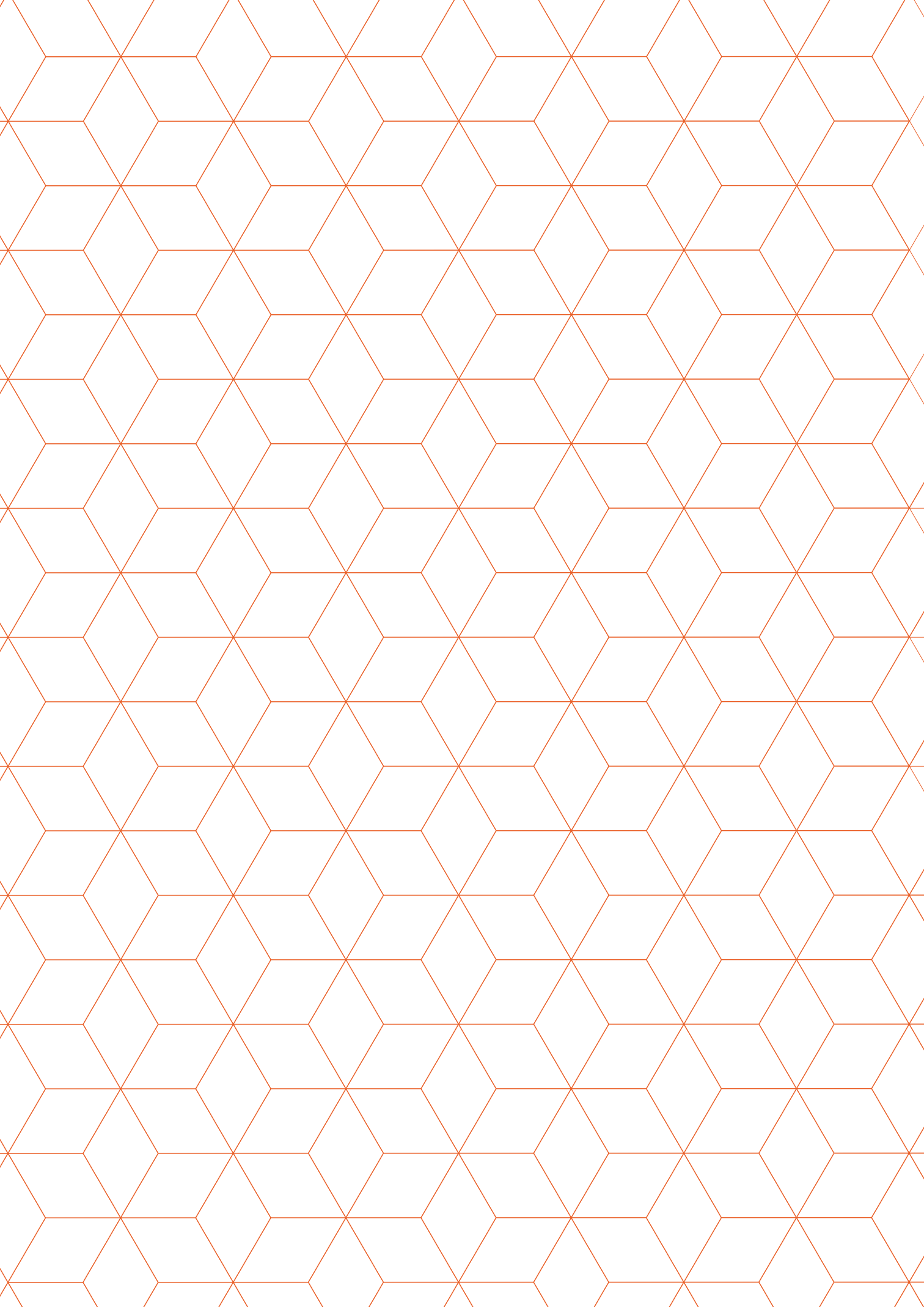
Two spring schools on Characterization Techniques for Materials were organized in 2015. A further push on both, the interuniversity Master in New Materials and the doctoral program on Materials Science and Technology have resulted in 4 PhD and 5 Master thesis defended in 2015. A new successful initiative was carried out this year: the first edition of summer internships for undergraduate students.

### OTHER ACTIVITIES

Other activities, such as large facilities experiments and visits to international laboratories have also been implemented during 2015.

### MAIN RESEARCH PRODUCTION IN 2015

About 80 research papers, in peered review journals and proceedings, have been published during 2015, together with a large number of invited contributions to conferences.





Director's letter:

It's for me a pleasure to present the 2015 annual report of **BCMATERIALS**. 2013 was the first year of actual scientific activity, and 2014 settled the operation, incorporated new people and started opening the center to the world, with new projects and collaborations. Thanks to the intense and efficient work of the people directly hired by the center, and the extraordinary support of the University's researchers, the quantity and quality of the results harvested in 2015 are reaching the expected figures for steady operation of **BCMATERIALS**.

During this year, once the center reached his cruising speed, the general manager, Jose Luis Vilas returned to his position at the University and a new Manager, Naiara Elejalde, has been appointed. I wish to thank Jose Luis for the taking off of **BCMATERIALS**, and welcome on board Naiara, that already has put the boat full steam ahead.

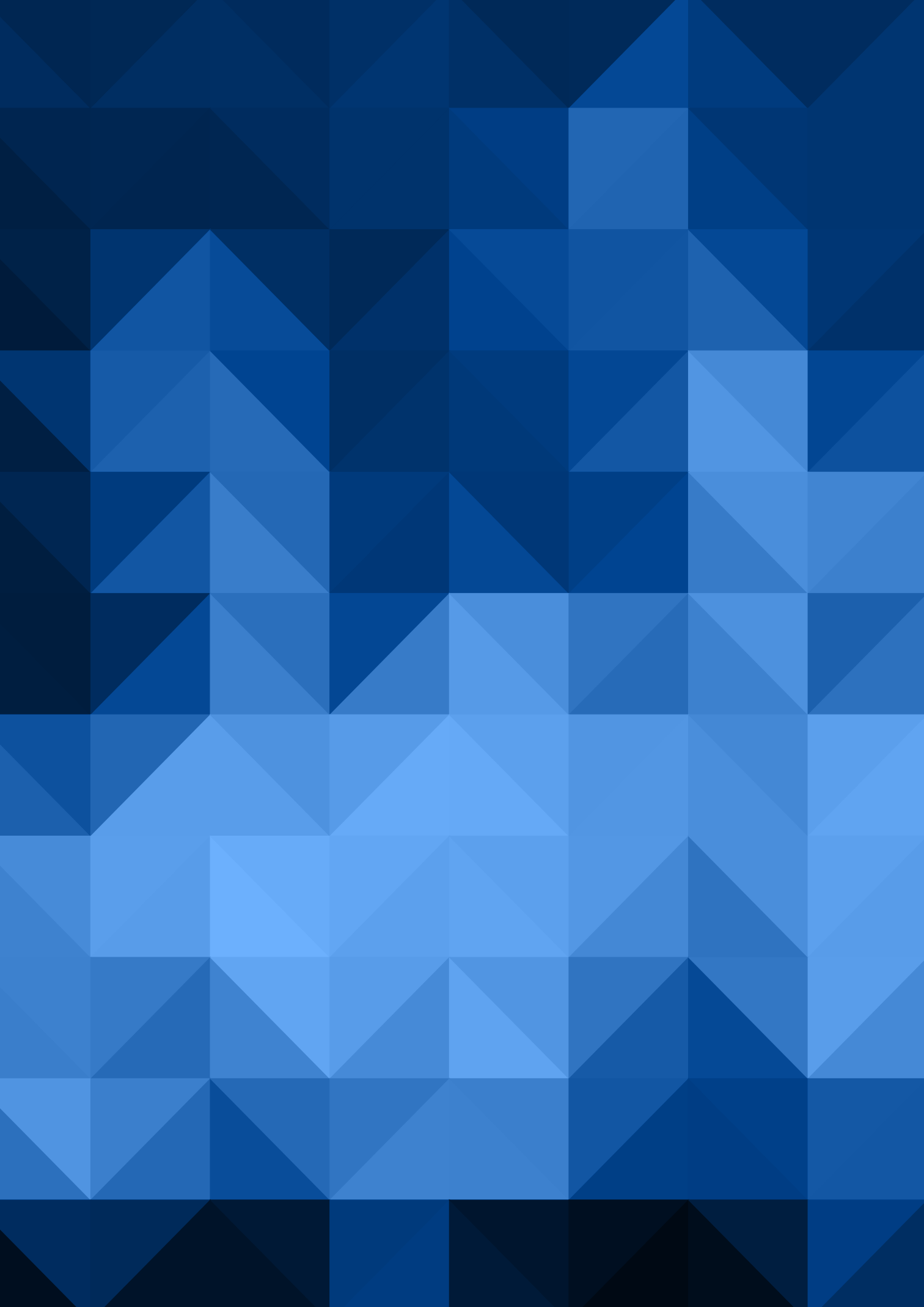
In 2015, thanks to former efforts, we have overcome the incubation period and **BCMATERIALS** is now well known all around the world. We have been a preferred destination for a number of visiting scientists and new and fruitful research agreements have been signed.

At the same time, intense work has been undertaken in house and, during the year, all the research lines are running softly, producing increased results in the form of publications, contributions to conferences, Master and PhD theses, etc. During the last 3 years, we have reached over 100 publications and received over 100 citations during 2015 year. In the upcoming years the activity will indeed increase, yielding a rich harvest of scientific achievements and technological transfers that will be highly beneficial for the Basque society.

With this in mind, I offer you this 2015 activity report, a sample of what we think the center can accomplish in future years and the expected yield of an excellence research center.

With my best regards,

**JOSÉ MANUEL BARANDIARÁN**  
SCIENTIFIC DIRECTOR  
DERIO, JANUARY 27TH, 2016



# ORGANIZATION AND MANAGEMENT OF THE CENTER





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## Organization and Management

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FUNDACIÓN BCMATERIALS  
—BASQUE CENTER FOR MATERIALS,  
APPLICATIONS AND NANOSTRUCTURES— is a  
strategic initiative for Basque science system,  
whose key promoters 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** —**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.*





## MISSION

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.



## VISION

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



## VALUES

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.

## Vision

BCMATERIALS is destined to be an 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, 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.*

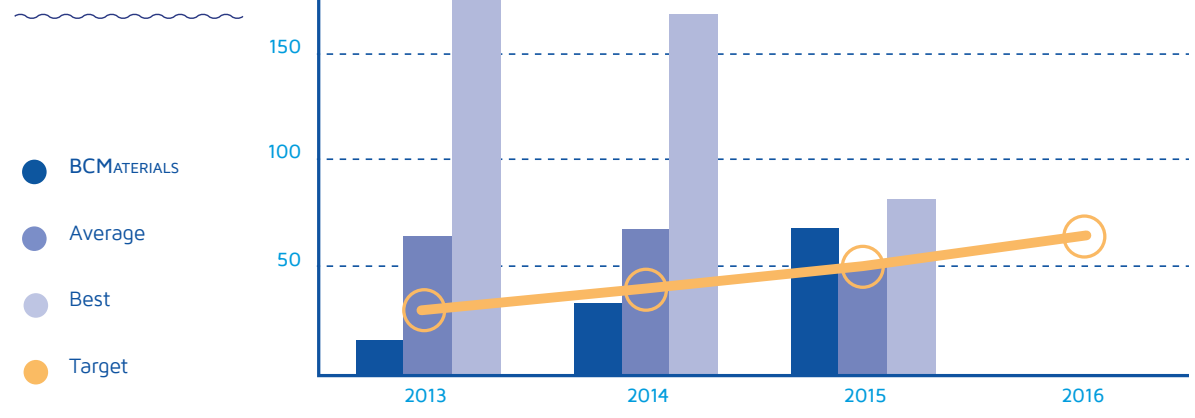
## Management system

During 2015 we renewed our COMMITMENT to EXCELLENCE/ADVANCED MANAGEMENT, demonstrating a clear commitment to excellence in all areas, by implementing the Advanced Management model lead by Euskalit. Over the last few years, this has been reflected in our work aimed at innovating and improving management by processes.

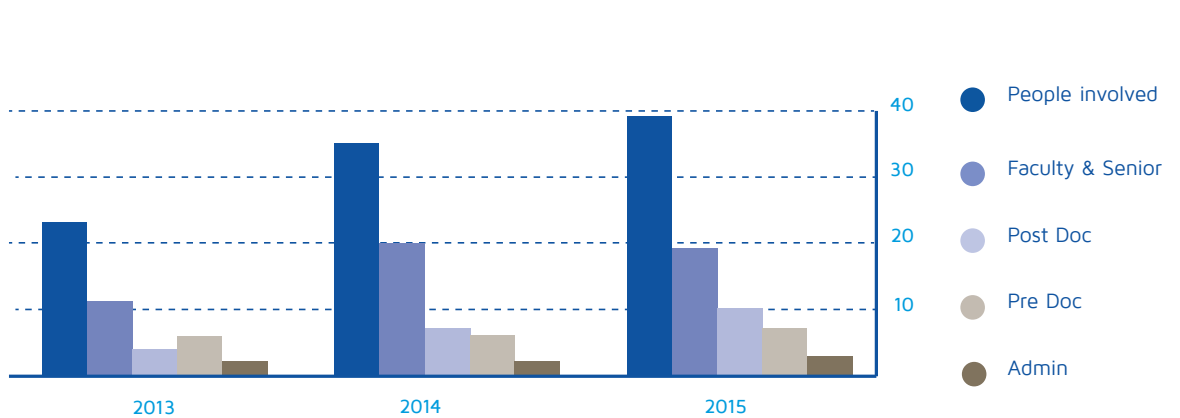
Implementation of the Advanced Management system involves reflections on allocation of responsibilities and appointment of process owners considering leadership and involvement in process activities and sufficient competition for the implementation, management and process improvement.

A steering committee and an Ethics committee have been established to secure excellence across BCMATERIALS and the fulfilment of our strategic plan 2015-2018. The 5S system has been implemented at the laboratories for continuous improvement, as well as the adoption of the European code of conduct for research integrity. People are at the core of excellency, and as such, during 2015 we have started taking steps towards obtaining the Euraxxes HR Logo, by performing our first HR autoevaluation.

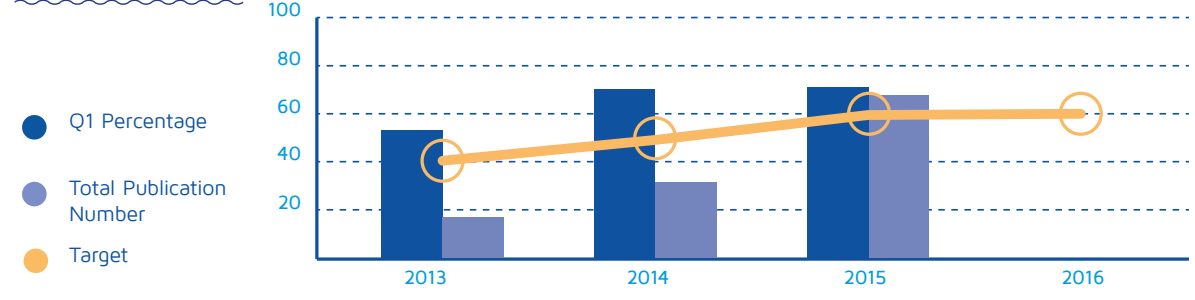
Total Number of Indexed Publications



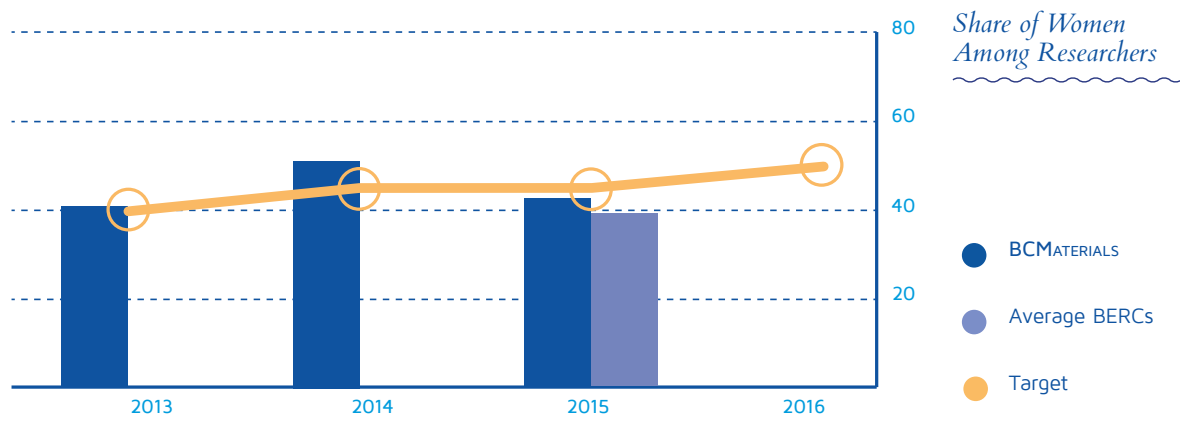
Personnel at Date



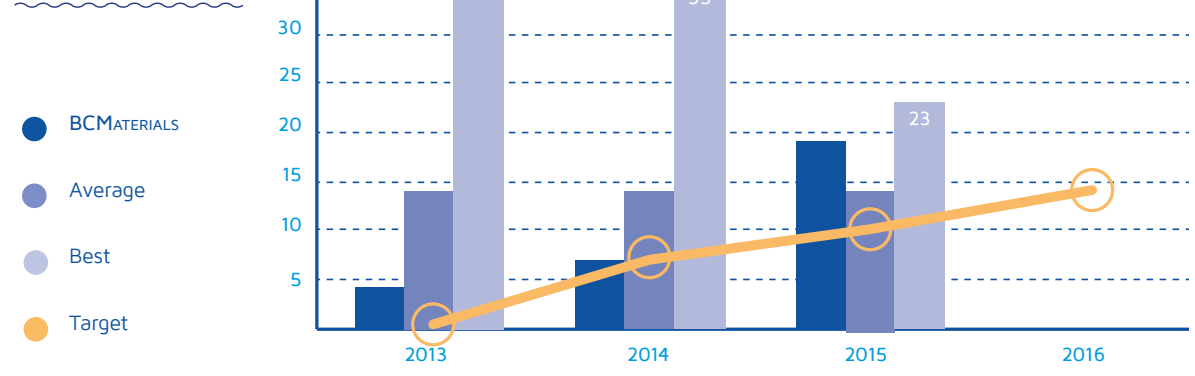
Q1 Publications Percentage



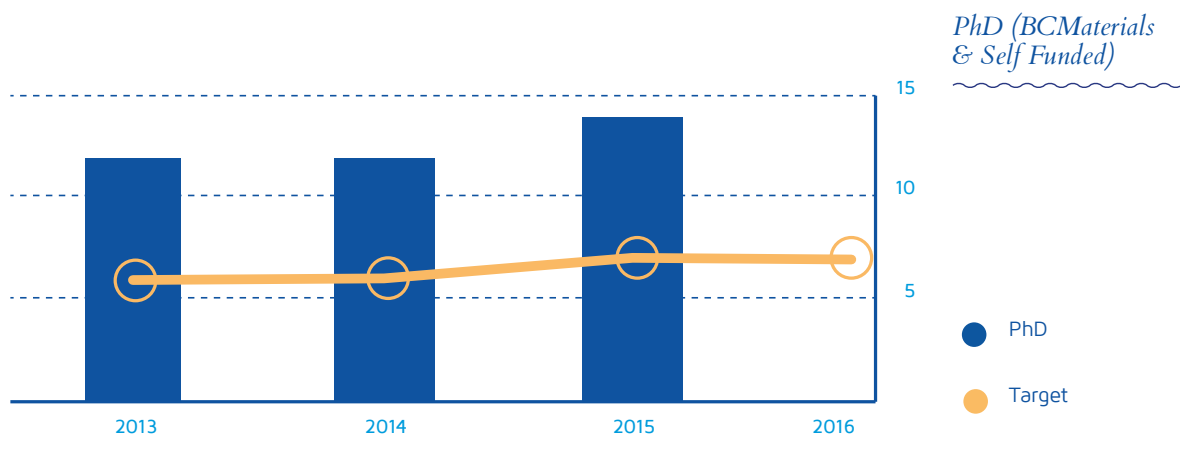
Share of Women Among Researchers



Share of BCMaterials Publications / BERCS



PhD (BCMATERIALS & Self Funded)



14

15



# PEOPLE







José Manuel Barandiarán

María Luisa Fernández-Gubieda

Luis Manuel León

Daniel Salazar

María San Sebastián

Lourdes Marcano

Volodymyr Chernenko

Naiara Elejalde

Irene Urcelay

Eduardo Fernández

María Isabel Arriortua

Catarina Lopes

Beñat Artetxe

Luis Lezama

Maite Insausti

Jagoba Martín-Caballero

Roberto Fernández

Juan M. Gutiérrez-Zorrilla

Alicia Muela

Jon Gutiérrez

Ariane Sagasti

Nuria García

Estibaliz Legarra Saez

Xabier Lasheras

Rafael Morales

Alfredo García-Arribas

Aintzane Goñi

Begoña Bazán

Andrés Martín Cid

Maite Goiriena-Goikoetxea

Izaskun Gil de Muro

José S. Garitaonandia

Leyre Pérez

José Ángel García

Paula Serras

Iraultza Unzueta

Anabel Pérez-Checa

Galina V. Kuryandokaya

Javier Alonso

Ana García-Prieto

Fernando López Arbeloa

Irati Rodrigo

Andoni Lasheras

Juan Ignacio Tel



# PEOPLE

## Personnel (4):

- 📦 Scientific Director: *José Manuel Barandiarán.*
- 📦 Managing Director: *Naiara Elejalde.*
- 📦 Administrative manager: *Iñaki Serna.*
- 📦 IT manager: *Juan Ignacio Tel.*

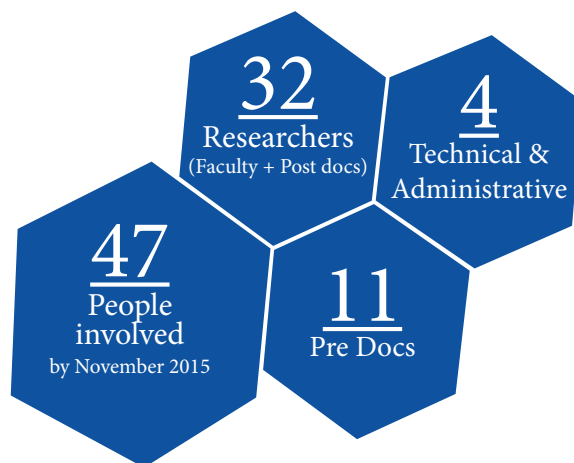
## Faculty and senior researchers (20):

- 📦 María Isabel Arriortua (*Professor*).
- 📦 María Luisa Fernández-Gubieda (*Professor*).
- 📦 José Ángel García (*Professor*).
- 📦 Juan Manuel Gutiérrez-Zorrilla (*Professor*).
- 📦 Luis Manuel León (*Professor*).
- 📦 Fernando López-Arbeloa (*Professor*).
- 📦 Luis Lezama (*Professor*).
- 📦 Alicia Muela (*Senior Lecturer*).
- 📦 Volodimir Chernenko (*Ikerbasque Professor*).
- 📦 Rafael Morales (*Ikerbasque Professor*).
- 📦 Begoña Bazán (*Senior Lecturer*).
- 📦 Alfredo García Arribas (*Senior Lecturer*).
- 📦 Ana García Prieto (*Senior Lecturer*).

- 📦 Jose Garitaonaindia (*Senior Lecturer*).
- 📦 Izaskun Gil del Muro (*Senior Lecturer*).
- 📦 Aintzane Goñi (*Senior Lecturer*).
- 📦 Jon Gutiérrez (*Senior Lecturer*).
- 📦 Maite Insausti (*Senior Lecturer*).
- 📦 Leyre Perez (*Senior Lecturer*).
- 📦 Galina Kurlyandskaya (*Senior Research Associated*).

## Post docs BCMaterials (10):

- 📦 Maria San Sebastian.
- 📦 Javier Alonso.
- 📦 Eduardo Fernández.
- 📦 Irene Urcelay.
- 📦 Paula Serras.
- 📦 Daniel Salazar.
- 📦 Beñat Artetxe.
- 📦 Roberto Fernández.
- 📦 Estibaliz Legarra.
- 📦 Catarina Lopes.



#### Other post docs (2):

- 📦 Santiago Reinoso.
- 📦 Verónica Palomares.

#### Pre docs from BCMaterials (7):

- 📦 Nuria Garcia.
- 📦 Ariane Sagasti.
- 📦 Jagoba Martin.
- 📦 Maite Goiriena.
- 📦 Xabier Lasheras.
- 📦 Anabel Perez.
- 📦 Andrés Martín.

#### Other pre docs (4):

- 📦 Andoni Lasheras.
- 📦 Lourdes Marcano.
- 📦 Iraultza Unzueta.
- 📦 Irati Rodrigo.

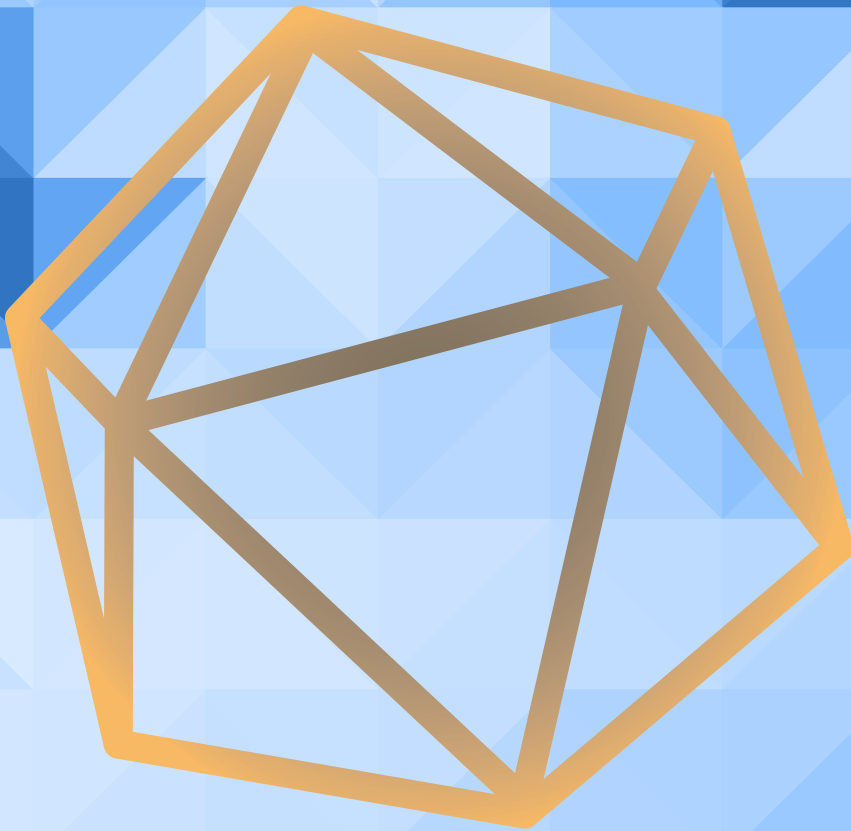
#### Self funded & visitors (11):

- 📦 Prof. George Hadjipanayis, (*University of Delaware, USA*) 2 MONTHS.
- 📦 Prof. Harikan Srinanth, (*University of South Florida, USA*) 1 MONTHS.
- 📦 Dr. Diego Muraca, (*University of Campinas, Brazil*) 6 MONTHS.
- 📦 Dr. Igor Galetich, (*Erasmus Mundus ACTIVE, Ukraine*) 6 MONTHS.
- 📦 Dr. Adriana Huizar de Félix, (*Post Doc, Universidad de Nuevo León, México*) 12 MONTHS.
- 📦 Christian Omar Aguilar, PhD, (*Instituto Potosino de Investigación, México*) 4 MONTHS.
- 📦 Netzahualpille Hernández, PhD, (*Universidad de Nuevo León, México*) 10 MONTHS.
- 📦 Kristen Stojak, PhD, (*University of South Florida, USA*) 1 1/2 MONTHS.
- 📦 Hovhannes Dashtoyan, (*Erasmus BAKIS, PhD, University of Armenia*) 6 MONTHS.
- 📦 Eugen Seif, (*Erasmus Internship, Germany*) 5 MONTHS.
- 📦 Luca Copparo, (*Italy*) 6 MONTHS.





# RESEARCH ACTIVITY





## RESEARCH ACTIVITY

Intense research work has been developed with remarkable results in all lines. A summary of the results and main achievements is presented.

### A ACTIVE SMART MATERIALS

#### A.1

##### Magnetic Shape Memory Alloys, MSMAs

DR. V.A. CHERNENKO (IKERBASQUE), J. M. BARANDIARÁN

#### A.2

##### Smart Polymers and surfaces

PROFS. L. LEÓN, J.M. GUTIÉRREZ-ZORRILLA

### B NANOSTRUCTURED MATERIALS

#### B.1

##### Magnetic Nanoparticles for Biomedical Applications

PROFS. M. L. FERNÁNDEZ-GUBIEDA, M. INSAUSTI

#### B.2

##### Magnetic Nanostructures

PROF. R. MORALES (IKERBASQUE), DR. A. GARCÍA ARRIBAS

### C ADVANCED FUNCTIONAL MATERIALS

#### C.1

##### Materials for Energy

PROFS. M. ARRIORTUA, L. LEZAMA

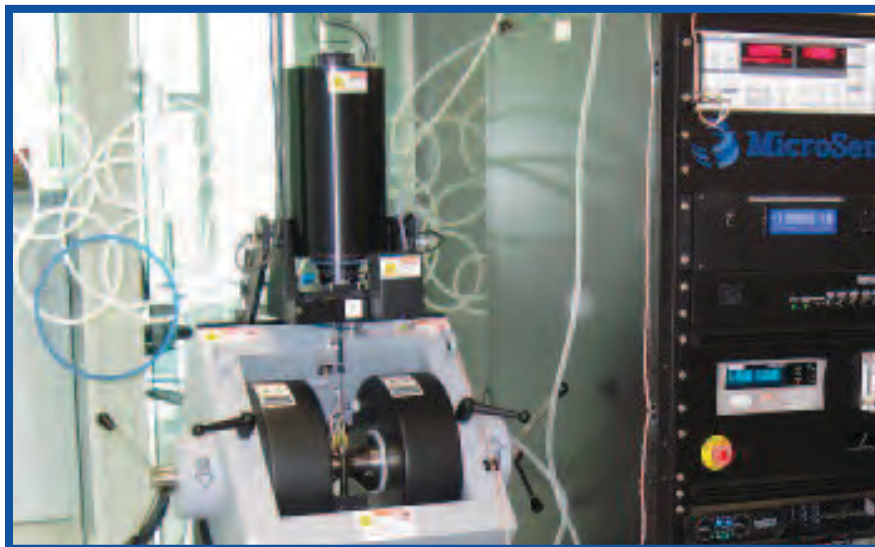
#### C.2

##### Materials for Sensors and Bio-Sensors

DR. J. GUTIÉRREZ, DR. GALINA KOURLYANDKAYA

## New Equipment

A New Vibrating Sample Magnetometer (Microsense VE-7) was commissioned at the end of 2014 and has been fully operative during 2015.



**Left image:** New Vibrating Sample Magnetometer (VSM)  
The new Microsense 2.2 Tesla Vibrating Sample Magnetometer (VSM) installed at BCMaterials is a versatile instrument of high resolution at room temperature (0.08  $\mu\text{emu}$ ) and at temperatures (0.5  $\mu\text{emu}$ ), with large temperature scan (77-1000K) in a 10 mm ID chamber, higher signal to noise ratio (temperature option), lowest field noise (< 5 mOe RMS), automatic sample rotation standard and fast and easy operation.

## Research Lines

A complete revision of research lines was carried out by the International Scientific Committee (6 & 7 March 2015).

ISC members in that task were:

- 📦 *Quentin Pankhurst (Inst. Bio-Medical Engineering, Univ. College, London).*
- 📦 *Antonio Hernando (U. Complutense & Inst. de Magnetismo Aplicado, IMA).*
- 📦 *María Vallet (U. Complutense, Madrid).*
- 📦 *Alexander Granovski (Faculty of Physics, Moscow State University).*

### A) Active (Smart) Materials

These are materials that present crossed properties so that they re-act in 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. 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.

**A**   
**ACTIVE SMART  
MATERIALS**

## A.1.- MAGNETIC SHAPE MEMORY ALLOYS, MSMAs

DR. V. A. CHERNENKO (IKERBASQUE), PROF. J. M. BARANDIARÁN

MSMAs are magnetic metallic compounds undergoing a thermoelastic martensitic transformation. 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.

Work at the BCMATERIALS encompass the following subjects:

- ❖ *Development and optimization of high-performance MSMAs by precise tailoring of the composition and structure.*
- ❖ *Experimental and theoretical studies of the structure, phase transformation and functional properties.*
- ❖ *Development of MSMAs thin films and micropillars for micro- and nano-actuator applications.*
- ❖ *Studies of the influence of the defects on the structural and magnetic properties.*

### Collaborations:

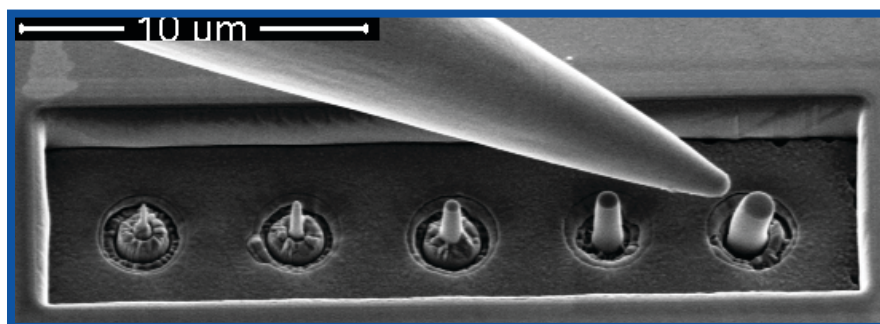
Univ. of Barcelona (A. Planes), Palma de Mallorca (E. Cesari), Pamplona (V. Recarte), Santander (J. Rodríguez); Karlsruhe Institute of Technology (M. Kohl), Duisburg Univ. (P. Entel); IENI, Lecco (S. Besseghini), Univ. Parma (F. Albertini); Moscow State University (A. Granovsky); Institute of Magnetism Ukraine (V. Golub, V. Lvov); FEMTO, Besançon (L. Hirsinger); Boise State Univ. (P. Müllner), Osaka Univ. (T. Kakeshita), Tokyo Institute of Technology (H. Hosoda), Hiroshima Univ. (A. Kimura), etc.

### Selected Results

Spectroscopic evidence of band Jahn-Teller distortion upon martensitic phase transition in Heusler-type Ni-Fe(Co)-Ga ferromagnetic shape-memory alloy films; *K. Sumida; K. Shirai; S. Zhu; Taniguchi, M.; Ye, M.; S. Ueda; Y. Takeda; Y. Saitoh; I. R. Aseginolaza; José Manuel Barandiarán; Volodymyr A. Chernenko; Kimura, A.; PHYSICAL REVIEW B, 91, 134417 (2015).*

Magnetic analysis of martensitic and austenitic phases in metamagnetic NiMn(In, Sn) alloys; *Patricia Lázpita; Janire Escolar; Volodymyr A. Chernenko; José Manuel Barandiarán; JOURNAL OF ALLOYS AND COMPOUNDS, 644, 883-887 (2015).*

Transformation volume effect on the magnetic anisotropy of Ni-Mn-Ga thin films; *Victor A. L'vov; Golub, V.; Salyuk, O. Y.; José Manuel Barandiarán; Volodymyr A. Chernenko; JOURNAL OF APPLIED PHYSICS, 117, 033901 (2015).*



**Left image:** NIMnGA nanopillars obtained in collaboration with CIC Nanogune.

## A.2.- SMART POLYMERS AND SURFACES

PROFS. L. LEÓN, J. M. GUTIÉRREZ-ZORRILLA

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 plastic electronic/optical sensors).

Work has been carried out in

- ⊠ *Shape memory Polymers applied to self healing surfaces.*
- ⊠ *Block copolymers for nanodot generation.*
- ⊠ *Hybrid Polymer/Inorganic systems for advanced applications.*
- ⊠ *Active/Smart Hybrid surfaces for thin film sensors.*

## Collaborations

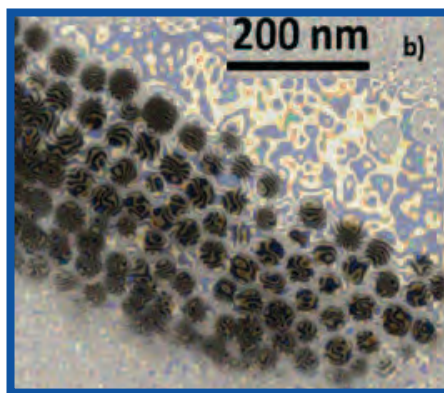
Prof. Senen Lanceros (University Do Minho, Braga); Dr. Andres Fabian Lasagni (Fraunhofer Institute for Material, Dresden). Dr. Juan Rodríguez Hernández (CSIC, Madrid). Self healing surfaces made of Shape Memory Polymers.

### Selected Results

Polymeric Shape-Memory Micro-Patterned Surface for Switching Wettability with Temperature; *N. García-Huete; J.M. Cuevas; J.M. Laza; José L. Vilas; Luis M. León; POLYMERS, 7, 1674-1688 (2015).*

High-temperature polymer based magnetoelectric nanocomposites; *Alberto Maceiras; P. Martins; R. Gonçalves; G. Botelho; E. Venkata Ramana; S. K. Men-diratta; María San Sebastián; José L. Vilas; S. Lanceros-Méndez; Luis M. León, EUROPEAN POLYMER JOURNAL, 64, 224-228 (2015).*

**Right image:** Electron holography in a self assembled array of magnetosomes (in collaboration with the Institute of Nanotechnology of Aragon).



## B

**NANOSTRUCTURED MATERIALS**

### B) Nanostructured Materials

Nanoscale processed 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. BCMATERIALS develop activity in two main fields of Nanomaterials.

#### **B.1.- MAGNETIC NANOPARTICLES FOR BIOMEDICAL APPLICATIONS**

PROFS. M.L. FERNÁNDEZ GUBIEDA, M. INSAUSTI

Magnetic Nano-Particles (MNP) have a diverse range of uses from magnetorheological fluids, MRI contrast or hyperthermia in cancer therapy, to drug delivery. Such applications require the production of monodisperse nanoparticles with well-controlled size and composition, biocompatibility, adequate functionalization, etc., in order to obtain the desired properties.

Work has been carried out in

- ⚡ *Synthesis of MNP, either Chemical (inverse micelle, sol-gel, etc.), or Biological, by magnetotactic bacteria.*
- ⚡ *Structural and magnetic characterization of MNPs.*
- ⚡ *Hyperthermia therapy studies for liver metastasis of colon-rectum cancer.*

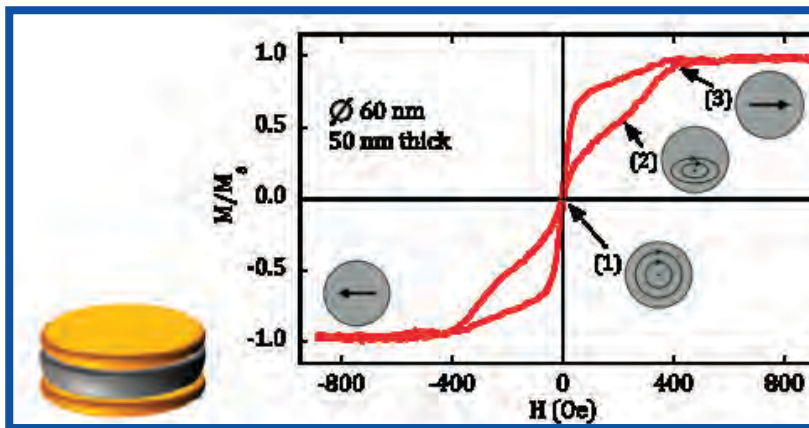
#### **Collaborations**

Prof. L. Fernández Barquín (University of Cantabria, Spain); D. A. Venero (ISIS, UK); L. Olivi and G. Aquilanti (ELETTRA, Trieste) ; G. Cibin (Diamond, UK); Prof. K. Simeonidis (Aristotle University, Greece); Dr. J. Martínez de la Fuente (Instituto de Nanotecnología de Aragón, Spain) Dr. J. Echevarría (Galdakao Hospital) ; Prof. W. Parak (Marburg University, Germany); Prof. L.M. Liz-Marzan (CIC Biomagune).

## Selected Results

Anisotropy effects in magnetic hyperthermia: A comparison between spherical and cubic exchange-coupled  $\text{FeO}/\text{Fe}_3\text{O}_4$  nanoparticles; *H. Khurshid; Javier Alonso; Z. Nemati; M. H. Phan; P. Mukherjee; María Luisa Fernández-Gubieda; José Manuel Barandiarán; H. Srikanth*, *JOURNAL OF APPLIED PHYSICS*, 117, 17A337 (2015).

The impact of the chemical synthesis on the magnetic properties of intermetallic  $\text{PdFe}$  nanoparticles; *Idoia Castellanos-Rubio; Maite Insausti; Izaskun Gil de Muro; D. Carolina Arias-Duque; Juan Carlos Hernández-Garrido; Teófilo Rojo; Luis Lezama*, *JOURNAL OF NANOPARTICLE RESEARCH*, 2015, 17:229 (2015).



**Left image:** Structure and hysteresis loop of Permalloy nanodisks, showing the evolution of the vortex state.

## B.2.- MAGNETIC NANOSTRUCTURES

PROF. R. MORALES (IKERBASQUE), DR. A. GARCÍA ARRIBAS

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.

Work has been carried out in:

- ❖ *Patterned thin films and multilayers.*
- ❖ *Permalloy magnetic nanostructures in vortex state ( $\text{FeNi}$  nanodisks) by interference lithography and hole-mask colloidal lithography.*



## Collaborations

Prof. I. K. Schuller (University of California San Diego, UCSD -USA); Prof. Waldemar Macedo (Centro de Desenvolvimento da Tecnologia Nuclear -Brazil) and Prof. C. García (Universidad Técnica Federico Santa María -Chile); Prof. X. Batlle (Universitat de Barcelona -Spain) ; Prof. J. M. Alameda (Universidad de Oviedo -Spain), and D. Navas (Universidade do Porto -Portugal).

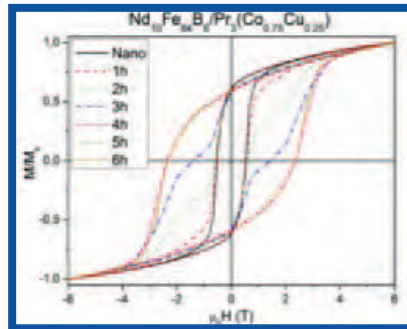
## Selected Results

Exchange-Bias Phenomenon: The Role of the Ferromagnetic Spin Structure; *Rafael Morales; Ali C. Basaran; J. E. Villegas; D. Navas; N. Soriano; B. Mora; C. Redondo; X. Batlle; Ivan K. Schuller, PHYSICAL REVIEW LETTERS, 114, 097202 (2015).*

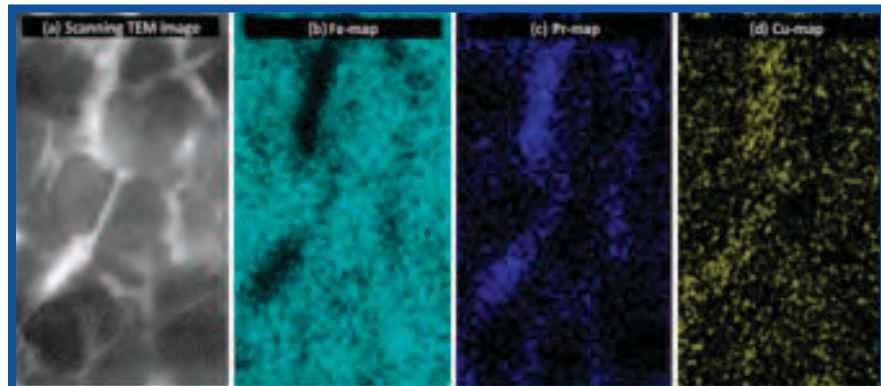
Giant magnetoimpedance biosensor for ferrogel detection: Model system to evaluate properties of natural tissue; *Galina V. Kurlyandskaya; Eduardo Fernández; A. P. Safronov; Andrey Svalov; I. Beketov; A. Burgoa Beitia; Alfredo García-Arribas; F. A. Blyakhman, APPLIED PHYSICS LETTERS, 106, 193702 (2015).*

5  
30  
5

**Right image:** Increase in coercivity by grain boundary infiltration with a PrCoCu eutectic alloy.



**Right image:** Element distribution in the grains.



## C) Advanced Functional Materials

New materials with outstanding properties are continuously appearing with specific applications. Some representative fields of research are developed in BCMATERIALS, as:



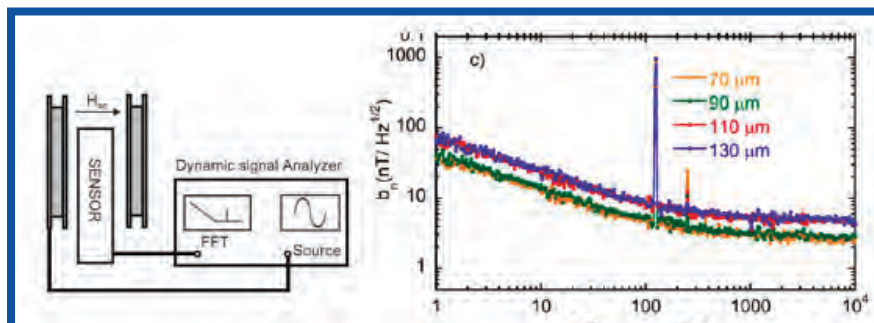
### C.1.- MATERIALS FOR ENERGY

PROFS. M. ARRIORTUA, L. LEZAMA

New materials for energy generation and storage constitute a topic of the greatest significance due to its great economic potential and social impact. Solid oxide fuel cells (SOFC), chemical batteries and High performance permanent magnets (PM) based on rare earth metals are among the leading technologies today, critically needed to enable the effective use of alternative energy sources such as solar and wind, and electrical or hybrid electrical vehicles.

Work has been carried out in:

- ✧ *Design and synthesis of new anodes and cathodes.*
- ✧ *Characterization and modeling of electrode surfaces and electrode-electrolyte interfaces.*
- ✧ *Nanostructured electrolyte and electrode materials for SOFC's.*
- ✧ *Development of high coercivity, Dy free magnets by grain boundary engineering.*



Left image: Measuring set-up and noise figures of Magneto-Impedance sensor elements of different widths (In collaboration with the University of Caen, France).

### Collaborations

Prof. G. Hadjipanayis (University of Delaware, USA); Profs. Jordi Rius, Elies Molins and Dras. Anna Roig and Rosa Palacín (Instituto de Ciencia de Materiales, CSIC, Barcelona); Prof. Jesús Rodríguez (Universidad de Cantabria, Santander); Prof. María Ángeles Monge and Dr. Marta Iglesias (Instituto de Ciencia de Materiales, CSIC, Madrid); Prof. V. Orera and Drs. A. Larrea and M.A. Laguna (Instituto de Ciencia de Materiales de Aragón, CSIC-Universidad de Zaragoza); Dr. Lide Mercedes Rodríguez (technologic research center IKERLAN-ENERGÍA, Vitoria-Gazteiz); Drs. Ana Aranzabe and Amaya Igartua (technologic center IK4-TEKNIKER, Eibar Gipuzkoa); Dr. Jan van Herle (Ecole Polytechnique Fédérale de Laussane, Laussane, Switzerland); Dr.

Luis Ortega (Pontificia Universidad Católica de Perú); Prof. P.R. Slater and Dr. J. M. Porras (School of Chemistry, University of Birmingham, UK).

### Selected Results

High-Voltage Cathode Materials for Lithium-Ion Batteries: Freeze-Dried  $\text{LiMn}_{0.8}\text{Fe}_{0.1}\text{M}_{0.1}\text{PO}_4/\text{C}$  ( $\text{M} = \text{Fe}, \text{Co}, \text{Ni}, \text{Cu}$ ) Nanocomposites; *Amaia Iturrondobeitia; Aintzane Goñi; Izaskun Gil de Muro; Luis Lezama; Chunjoong Kim; Marca Doeff; Jordi Cabana; Teófilo Rojo*, ACS INORGANIC CHEMISTRY, 54 (6), PP 2671–2678 (2015).

Evaluation of Fe-22Cr mesh as a composite cathode contact material for intermediate solid oxide fuel cells; *Aroa Morán-Ruiz; Karmele Vidal; Aitor Larrañaga; José Manuel Porras-Vázquez; Peter Raymond Slater; María Isabel Arriortua*, INTERNATIONAL JOURNAL OF HYDROGEN ENERGY, 40 (14), 4804–4818 (2015).

High coercivity in rare-earth lean nanocomposite magnets by grain boundary infiltration; *Rajasekhar Madugundo; Daniel Salazar-Jaramillo; José Manuel Barandiarán; George C. Hadjipanayis*, 2016 IN PRESS.

## C.2.- MATERIALS FOR SENSORS AND BIO-SENSORS

DR. J. GUTIÉRREZ, DR. GALINA KOURLYANDKAYA

Sensors are nowadays earning an exceptional prominence in many areas such as personal electronics, automotive and transportation and bio-medicine. They are also of great importance in 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:

- ⊠ *Development of magnetic sensors based on the magneto-impedance (MI) Magnetoelastic resonance and hybrid magnetolectric materials: formed by magnetostrictive and piezoelectric layers.*
- ⊠ *NanoPorous materials as Polyoxo Metalates (POM) and Metal-Organic Frameworks (MOF).*

### Collaborations

Dr. C. Dolabdjian (University of Caen, France); Dr. M. Rivas (Univ. of Oviedo, Spain); Dr. Prida (Univ. of Oviedo, Spain); Dr. J. P. Sinnecker (Centro Brasileiro Pesquisas Físicas, Brasil); Prof. Senén Lanceros-Méndez (Universidade do Minho at Braga, Campus de Gualtar, Portugal); Prof. Daniel Crespo (Universitat Politècnica de Catalunya, Castelldefels, Barcelona, Spain); Dr. Rafael Pérez del Real (Cantoblanco, Madrid, Spain).

## Selected Results

Equivalent Magnetic Noise of Micro-Patterned Multilayer Thin Films Based GMI Microsensor; *Eduardo Fernández; Alfredo García-Arribas; José Manuel Barandiarán; Andrey Svalov; Galina V. Kurlyanskaya; C. P. Dolabdjian*. IEEE SENSORS JOURNAL, 11, 6707-6714 (2015).

Size effects on the magnetoelectric response on PVDF/Vitrovac 4040 laminate composites; *M. Silva; P. Martins; Andoni Lasheras; Jon Gutiérrez; José Manuel Barandiarán; S. Lanceros-Méndez*. JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS, 377, 29-33 (2015).

Functionalization of Krebs-Type Polyoxometalates with N,O-Chelating Ligands: A Systematic Study; *Beñat Artetxe; Santiago Reinoso; Leire San Felices; Pablo Vitoria; Aroa Pache; Jagoba Martín; Juan M. Gutiérrez-Zorrilla*". ACS INORGANIC CHEMISTRY, 54 (1), 241-252 (2015).

## AGREEMENTS WITH SPANISH AND FOREIGN RESEARCH INSTITUTIONS

New research agreements have been signed during 2015 with:



Universidade de Campinas (Brasil)



Instituto de Materiales Avanzados Universidad Pública de Navarra



ESS Bilbao



University of South Wales (Australia)

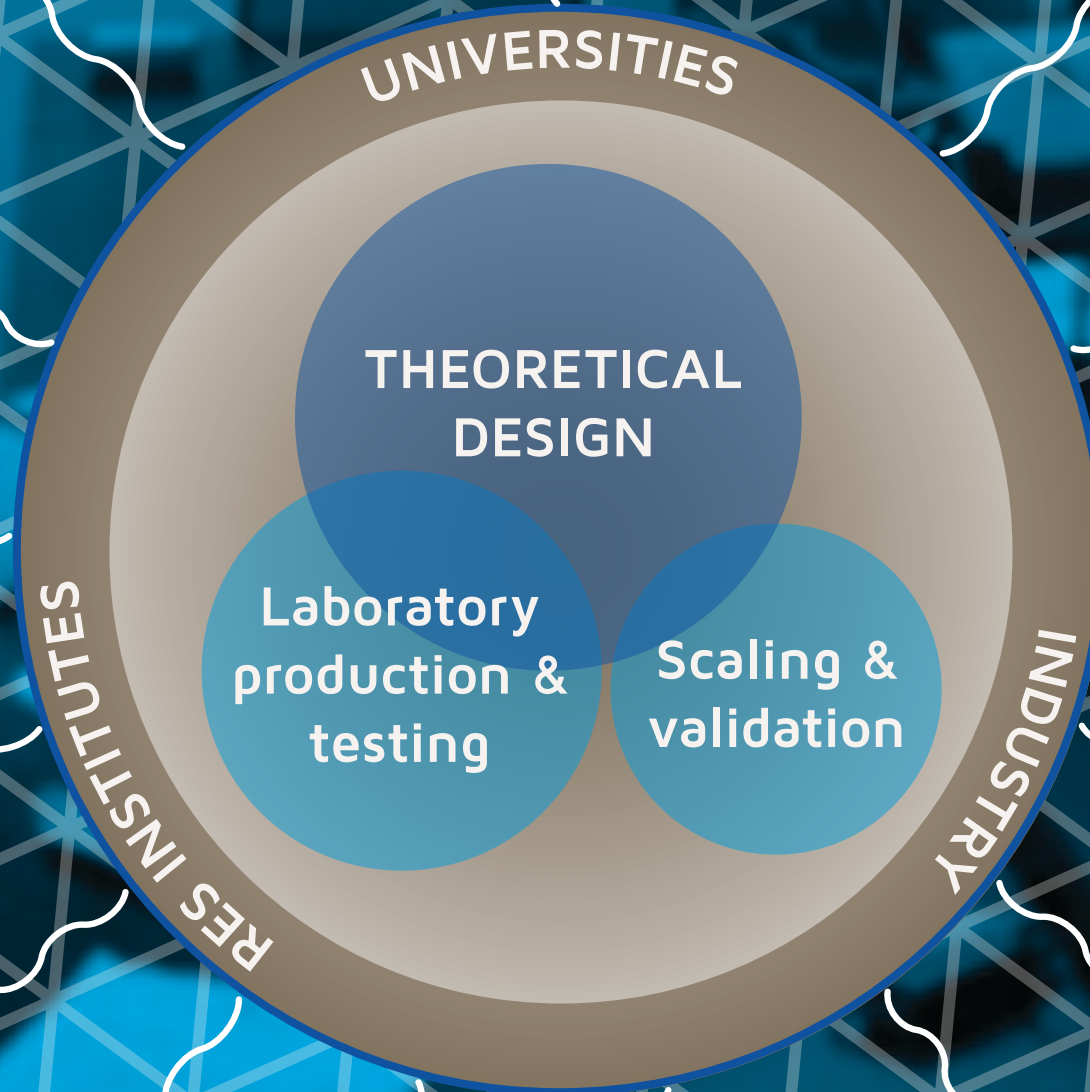




## New Research Projects during 2015

Quite a number of new projects have been accorded and /or started during 2015. They are summarized in the following:

	<i>Funding Organism / Program</i>
<b>National Projects</b>	
1.- Novel magnetic nanostructures for biomedical applications (2015-2016)	BIZKAIA TALENT (AYD-000-266)
2.- Hiring Prof. Senen Lanceros (2016)	BIZKAIA TALENT
3.- Functional properties and non-equilibrium processes in shape memory alloys and related ferroic materials (FUNSAFE) (2015-18)	MINECO (MAT-2014-56116- R)
4.- Estrategia en Materiales para Fabricación Avanzada (ACTIMAT) (2015-16)	ELKARTEK (Gobierno Vasco)
5.- Desarrollo de Actividades de Investigación Fundamental Estrategica en Almacenamiento de Energía Electroquímica y Térmica (CICe 2105) (2015-16)	ELKARTEK (Gobierno Vasco)
6.- Health Monitoring de Estructuras, Componentes y Sistemas aeronáuticos a lo largo de su ciclo de vida (ARHEIM-IV) (2015)	ELKARTEK (Gobierno Vasco)
7.- Microtecnologías para la Competitividad Industrial y Economía del Conocimiento II (MCHEAP-II) (2015)	ELKARTEK (Gobierno Vasco)
<b>International Projects (EU)</b>	
1.- NOVel, critical materials free, high Anisotropy phases for permanent MAGnets, by design (NOVAMAG) 2016-19	H2020 RIA
2.- International Network on Advanced high energy PErmanent Magnets (INAPEM) 2016-18	H2020 RISE
3.- Rosa Martín	MSC INDIVIDUAL FELLOWSHIP
<b>Projects with Private Companies</b>	
1.- New High temperature shape memory alloys (HTSMA) (2015)	ALSTOM
2.- Aplicaciones de los materiales con memoria de forma en electrodomésticos (2016)	BSH ELECTRODOMÉSTICOS ESPAÑA, S.A.



UPPSALA  
UNIVERSITET  
Uppsala  
University

TECHNISCHE  
UNIVERSITÄT  
DARMSTADT  
T. University  
Darmstadt

ICCRAM  
Universidad de  
Burgos

東北大学  
Tohoku University

UNIVERSITAS  
DELAWARE  
University of  
Delaware

DONAU UNIVERSITÄT  
KREMS  
Danube University  
Krems

Technion  
Israel Institute of Technology  
Technion

VAC  
VACUUMSCHMELZE  
Vacuumschmelze

ΔΗΜΟΚΡΙΤΟΣ  
NRC Demokritos

MBN nanomaterialia  
Nanomaterialia

Fraunhofer  
Fraunhofer IWKS

cea  
CEA-LETI

CRF  
CENTRO RICERCA  
FIAT  
FIAT Research  
Center

ARELEC  
ARELEC





# DISSEMINATION OF RESULTS



# DISSEMINATION OF RESULTS

In order to make the center visible to the local research community, a number of talks, seminars and conferences have been organized.

## Invited Talks and Seminars

External speakers talks during 2015 include:

- I. *DIMITRIS KOUZUDIS: Magneto-elastic Materials and their use as sensors.*
- II. *VASUDEVA SIRUGURI: Metastabilities across first-order transitions in magnetic functional materials.*
- III. *IVAN SCHULLER: (IEEE Distinguished Lecturer) 35 Years of Metallic Superlattices.*
- IV. *HARI SRINKANTH: Magnetic Nanoparticles for electronics and biomedicine.*
- V. *HORACIO FLORES ZÚÑIGA: Efectos calóricos en aleaciones ferromagnéticas con memoria de forma.*
- VI. *SADIMICHI MAEKAWA: Spin Mechatronics: Mechanical Generation of Spin and Spin Current.*
- VII. *LUDWIG SCHULTZ: (IEEE Distinguished Lecturer) Interaction of ferromagnetic and superconducting permanent magnets - superconducting levitation.*
- VIII. *CATARINA LOPES: Electroactive Polymers and applications.*
- IX. *NEERAJ SHARMA: The future is in your hands. What will you make of it?*
- X. *RUSSEL COWBURN: (IEEE Distinguished Lecturer) Perpendicular magnetic anisotropy: from ultralow power spintronics to cancer therapy.*
- XI. *MIGUEL ALARIO: Óxidos superconductores.*
- XII. *MANUEL VÁZQUEZ: Magnetic Nanowires.*

In addition, about 20 internal seminars (BCMATERIALS fortnightly seminars) have been developed by PhD and postdoc researchers, with large audience.

## Organization of conferences

The traditional ONE DAY WORKSHOP ON "NEW MATERIALS FOR A BETTER LIFE" was devoted this year to: Materials for Energy, and held on Friday, 20th November 2015 at the Paraninfo, Faculty of Science and Technology, Leioa Campus, UPV/EHU.

Over 100 delegates registered for the event.

Invited speakers were:

- I. *ALODIA ORERA: Instituto de Ciencia de Materiales de Aragón, CSIC, Zaragoza (New Materials for Fuel Cells).*
- II. *JUAN CARLOS JIMENO: Instituto de Microelectrónica, UPV/EHU, Bilbao (New Photovoltaic materials).*
- III. *LILIANE GUERLOU-DEMOURGUES: Institut de Chimie de la Matière Condensée de Bordeaux CNRS (New cobalt based materials for asymmetric supercapacitors).*
- IV. *SANTIAGO CUESTA: Universidad de Burgos e ICCRAM (Radiation Resistant materials for nuclear and aerospace applications).*
- V. *ALBERTO BOLLERO: IMDEA, Nanociencia; Madrid (New Permanent Magnets for Energy Applications).*
- VI. *GURPREET SINGH: CIC Energigune (Rechargeable batteries: Past, Present and Future).*

#### “NEW MATERIALS FOR A BETTER LIFE” PROGRAM

9:00-9:15	Registration
9:15-9:30	Welcome and opening
	<i>Estibaliz Hernáez (Deputy Minister for Technology, Innovation and Competitiveness, Basque Government)</i>
	<i>Esther Domínguez (Dean of the Faculty of Science and Technology)</i>
	<i>Amaia Esquisabel (Director of Scientific Policy, Basque Government)</i>
9:30-10:15	Lecture 1
	<i>Alodia Orera (CSIC, Zaragoza)</i>
10:15-11:00	Lecture 2
	<i>Juan Carlos Jimeno (University of the Basque Country)</i>
11:00-11:30	Coffee
11:30-12:15	Lecture 3
	<i>Liliane Guerlou-Demourgues (CNRS Bordeaux)</i>
12:15-13:00	Lecture 4
	<i>Santiago Cuesta (University of Burgos)</i>
13:00-14:30	Networking lunch /posters/ brookerage
14:30-15:15	Lecture 5
	<i>Alberto Bollero (IMDEA)</i>
15:15-16:00	Lecture 6
	<i>Gurpreet Singh (CIC Energigune)</i>
16:00-16:30	Teófilo Rojo:
	<i>(The CIC Energigune and the Basque Research in Energy)</i>
16:30-17:00	Round table with speakers and conclusions
17:00	Closing and Farwell

# 2015 IN PICTURES



Prof. Kouzudis



Dr. Lopes



Dr. Siriguri



Prof. Schuler



Dr. Florez-Zúñiga



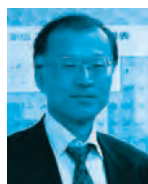
Dr. Schultz



Dr. Sharma



Prof. Cowburn



Prof. Maekawa



Prof. Alario



Prof. Vázquez



**Right image:**  
Preparing the  
NOVAMAG project  
during August 2015.  
On the left, Profs.  
George Hadjipanayis  
and Dimitris Niarchos.



**Right image:** Attending  
an internal seminar.





**Left image:** Master opening. Left, Estibaliz Herraiz (Vice Minister of Innovation, Basque Government), center, Esther Dominguez (Dean of the Faculty of Science and Technology).



**Left image:** Master late registration.



**Right image:** Dr Alodia Orera discussing a point with a delegate.



**Left image:** Posters.

**Right image:** Dr. Gurpreet Singh answering a question.



**Left image:** Final round table with speakers.



# HIGH LEVEL EDUCATION AND OTHER ACTIVITIES



# HIGH EDUCATION

## Spring Schools

1. *Professional development workshop: Characterization techniques for Magnetic Materials. Held at the TMS 2015, 144th annual meeting and exhibition, Orlando (Florida) March 15th.*
2. *Spring school: Data analysis and processing for Powder and single crystal diffraction. Facultad de Ciencia y Tecnología UPV/EHU. 11-15th May 2015. Organizers and speakers: Irene Urcelay, Pablo Alonso and Roberto Fernández.*

## Master

The **MASTER ON NEW MATERIALS** opened a new academic course 2015-16 under the direction of Prof. Maria Luisa Fernandez Gubieda. There were 54 preregistrations at the UPV/EHU. 23 were selected and 16 started the course in October. Another 4 students joined from the University of Cantabria.

That makes a **TOTAL** of 20 students in the Master, a figure that remains steady during the last 5 years.

Master thesis successfully defended in **BCMATERIALS** during 2015

- 📦 *OMAR RUIZ: "Ferritas de FE y ZN: Síntesis, Caracterización y Propiedades Magnéticas".*
- 📦 *JANIRE MATAS: "Superficies poliméricas biocompatibles".*
- 📦 *ANDER GARCÍA: "Biomedical application of magnetic nanoparticles synthesized by bacteria".*
- 📦 *ANDRÉS MARTÍN: "Development of Dy-free, high coercivity Nd-Fe-B magnets".*
- 📦 *IÑIGO GOYASTUA: "Elección de capas aislantes para la microfabricación de sensores".*

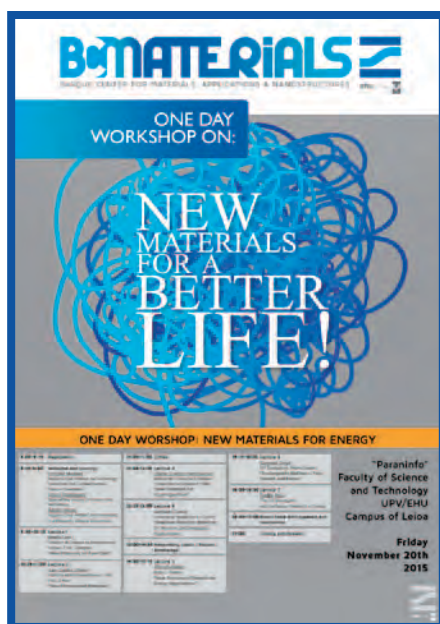
## Doctorate

The new PhD program: Science and Technology of Materials is headed by Prof. L Lezama.

It started September 2014, with 20 pre-registered students, 17 were accepted and, finally, a **TOTAL** of 12 students registered and are developing their PhD studies. Three of them belong to **BCMATERIALS**

PhD thesis successfully defended in **BCMATERIALS** during 2015:



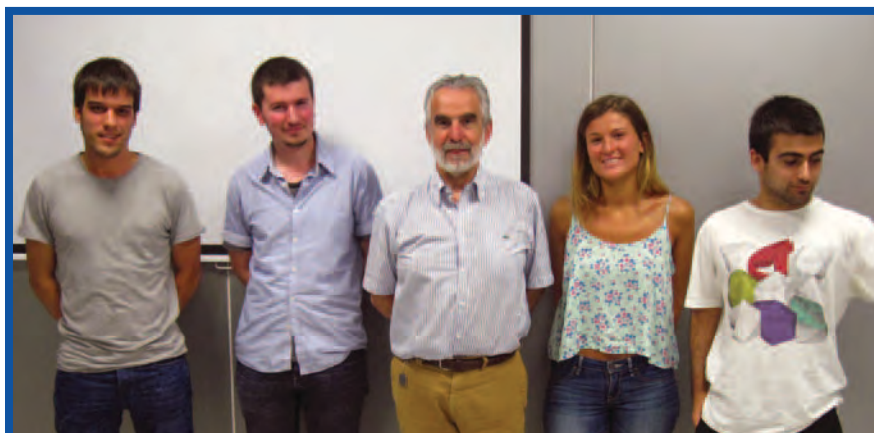


Left image: 2015 Master's poster.

- ⊠ ENEKO GARAIO: "Development of experimental techniques for magnetic hyperthermia therapy", March 2015, International PhD.
- ⊠ AROA MORÁN: "Development of contact coatings for SOFC", June 2015 International PhD.
- ⊠ ENEKO AXPE: "Uncovering the role of free volume in biomaterials and biological matter", October 2015, International PhD.
- ⊠ OIHANE KISTIÑE ARRIORTUA: "Nanopartículas de Pd, PdFe y Fe<sub>3</sub>O<sub>4</sub> ; Agentes Inductores de Hipertermia Magnética", December 2015.

## Summer internships

Were started this year. 4 students of 3rd year in Physics, Chemistry and Biology were selected and spent 8 weeks with us , working in advanced research lines: Mikel Perez (Grado Física), Mikel Rouco (Grado Física), Erik Garica (Grado Física), Nerea Andino (Grado Biología).



Left image: Students of the summer internship with BCMaterials' director.

Right image: Organizers of the TMS Workshop: Bob Schull (NIST), Victorino Franco (U. Sevilla) and José Manuel Barandiarán (BCMaterials).



Right image: Spring school advertising.



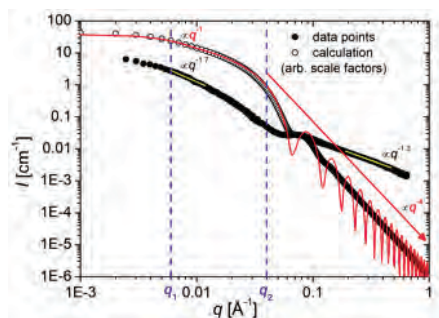
Right image: Visit to USF, March 2015.



# OTHER ACTIVITIES

## Large Facilities approved proposals

- ILL (GRENOBLE) D22: "Formation of coated bcc-Fe magnetic nanoparticles".
- ESRF (GRENOBLE) BM25A: Silver vanadium oxide hydrogels: synthesis conditions influence on the silver and vanadium oxidation states and coordination environments.
- ESRF (GRENOBLE) BM25A: "XANES study on monodisperse  $M_xFe_{3-x}O_4$  nanoparticles obtained by synthetic and biological routes".
- ALBA (BARCELONA) BL04 - MSPD: "Effect of the A cation size disorder and synthesis conditions on the properties of an iron perovskite series".
- ALBA (BARCELONA) BL22 - CLAESS: "XANES study on monodisperse  $M_xFe_{3-x}O_4$  nanoparticles obtained by synthetic and biological routes".
- CERN (GENÈVE) ISOLDE IS576: "Magnetic and Structural Properties of Manganese Doped (Al,Ga)N Studied with emission Mössbauer Spectroscopy".



Left image: Small Angle Neutron Scattering (SANS) in magnetite nanorods, measured at D22, ILL, Grenoble.

## Visits to international laboratories

- V.A. Chernenko: Visit to Tokyo Institute of Technology (Japan).
- Rafa Morales: University of California San Diego (USA).
- Jon Gutiérrez: University of Braga and International Nanotechnology Laboratory (Portugal).
- Daniel Salazar: University of Delaware (USA).
- José Manuel Barandiarán: University of South Florida (USA) and University of Campinas (Brazil).



# MAIN RESEARCH PRODUCTION IN 2015





MAIN RESEARCH  
PRODUCTION IN  
2015



## Invited contributions to Conferences

**M<sup>a</sup> LUISA FERNÁNDEZ-GUBIEDA**

- ① “Magnetic nanoparticles from magnetotactic bacteria: the process of biomineralization”. ZING CONFERENCE ON NANOBIO MATERIALS, 6-9 April, Carvoeiro Algarve (Portugal).

**RAFAEL MORALES**

- ① “Exchange bias of spring-like domain walls”. 20TH INTERNATIONAL CONFERENCE ON MAGNETISM. July 5-10, Barcelona (Spain).

**GALINA KURLYANDSKAYA**

- ① “Flexible thin film magnetoimpedance sensoric”, BALTIC CONFERENCE ON MAGNETISM, August 30 - September 3, Svetlogorsk (Russia).

**MARIBEL ARRIORTUA**

- ① “Transformación estructural reversible en una red sólida de coordinación de CuII con piridin-2,5-dicarboxilato y di-2-pirirdilcetona: Análisis con radiación sincrotrón”, XXXV Reunión Bienal de la RSEQ, July 19-23, A Coruña (Spain).

**VLADIMYR CHERNENKO**

- ① “Recent advances in magnetic shape memory materials”, FIMPART 2015, June 12-15 Hyderabad, India.
- ① “Fundamental aspects of deformation and magnetism of magnetic shape memory alloys”, ESOMAT 2015, September 14-17, Antwerp, (Belgium).

**JOSÉ MANUEL BARANDIARÁN**

- ① “Neutron and synchrotron studies in Magnetic Shape Memory Alloys”. TMS 2015, March, 15-19, Orlando, Florida (USA).
- ① “Magnetite in the rat’s brain”. ZING CONFERENCE ON NANOBIO MATERIALS, 6-9 April, Carvoeiro Algarve (Portugal).
- ① “Thin films of Magnetic Shape Memory Alloys”, INTERNATIONAL CONFERENCE ON MAGNETISM (SEMI PLENARY), July 5-10, Barcelona (Spain).
- ① “Magnetic Shape Memory Alloys Thin films and nanostructures”, INTERNATIONAL WORKSHOP ON ENERGY MATERIALS AND NANOTECHNOLOGY, September 1-4, San Sebastián (Spain).
- ① “Optimizing Magneto Impedance sensors for detecting magnetic nanoparticles”, 22TH SOFT MAGNETIC MATERIALS CONFERENCE, 14-16 September, Sao Paulo (Brazil).

**DANIEL SALAZAR**

- ① “Coercivity enhancement of nanostructured NdFeB magnets by grain boundary engineering”, TMS 2015, March, 15-19, Orlando, Florida (USA).

## Publications

1. Functionalization of Krebs-Type Polyoxometalates with N,O-Chelating Ligands: A Systematic Study; *Beñat Artetxe; Santiago Reinoso; Leire San Felices; Pablo Vitoria; Aroa Pache; Jagoba Martin; Juan M. Gutiérrez-Zorrilla*. ACS INORGANIC CHEMISTRY, 54 (1), 241–252 (2015).
2. Rearrangement of a Krebs-Type Polyoxometalate upon Coordination of N,O-Bis(bidentate) Ligands; *Beñat Artetxe; Santiago Reinoso; Leire San Felices; Luis Lezama; Aroa Pache; Cristian Vicent; Juan M. Gutiérrez-Zorrilla*. ACS INORGANIC CHEMISTRY, 54 (2), 409–411 (2015).
3. High-Voltage Cathode Materials for Lithium-Ion Batteries: Freeze-Dried  $\text{LiMn}_{0.8}\text{Fe}_{0.1}\text{M}_{0.1}\text{PO}_4/\text{C}$  (M = Fe, Co, Ni, Cu) Nanocomposites; *Amaia Iturrondobeitia; Aintzane Goñi; Izaskun Gil de Muro; Luis Lezama; Chunjoong Kim; Marca Doeff; Jordi Cabana; Teófilo Rojo*. ACS INORGANIC CHEMISTRY, 54 (6), 2671–2678 (2015).
4. Effect of Carbon Coating on the Physicochemical and Electrochemical Properties of  $\text{Fe}_2\text{O}_3$  Nanoparticles for Anode Application in High Performance Lithium Ion Batteries; *Amaia Iturrondobeitia; Aintzane Goñi; I. Orue; Izaskun Gil de Muro; Luis Lezama; Marca Doeff; Teófilo Rojo*. ACS INORGANIC CHEMISTRY, 54, 5239–5248 (2015).
5. Dielectric relaxation dynamics of high-temperature piezoelectric polyimide copolymers; *Alberto Maceiras; C. M. Costa; A. C. Lopes; María San Sebastián; J.M. Laza; José L. Vilas; J. L. Gómez Ribelles; R. Sabater i Serra; A. Andrio Balado; S. Lanceros-Méndez; Luis M. León*. APPLIED PHYSICS A, 120:731–743 (2015).
6. Giant magnetoimpedance biosensor for ferrogel detection: Model system to evaluate properties of natural tissue; *Galina V. Kurllyandskaya; Eduardo Fernández; A. P. Safronov; Andrey Svalov; I. Beketov; A. Burgoa Beitia; Alfredo García-Arribas; F. A. Blyakhman*. APPLIED PHYSICS LETTERS, 106, 193702 (2015).
7. Detection of in-depth helical spin structures by planar Hall effect; *Ali C. Basaran; Rafael Morales; S. Guénon; Ivan K. Schuller*. APPLIED PHYSICS LETTERS, 106, 252404 (2015).
8. Harmonic phases of the nanoparticle magnetization: An intrinsic temperature probe; *Eneko Garaio; Juan-Mari Collantes; José Ángel García; Fernando Plazaola; Olivier Sandre*. APPLIED PHYSICS LETTERS, 107, 123103 (2015).
9. Crystallization, structural relaxation and thermal degradation in Poly(L-lactide)/cellulose nanocrystal renewable nanocomposites; *Erlantz Lizundia; José L. Vilas; Luis M. León*. CARBOHYDRATE POLYMERS, 123, 256–265 (2015).
10. Increased functional properties and thermal stability of flexible cellulose nanocrystal/ZnO films; *Erlantz Lizundia; A. Urruchi; José L. Vilas; Luis M. León*. CARBOHYDRATE POLYMERS, 136, 250–258 (2015).
11. Anti-thyroid and antifungal activities, BSA interaction and acid phosphatase inhibition of methimazole copper(II) complexes; *Nora M. Urquiza; María S. Islas; Santiago T. Ariza; Nadir Jori; Juan J. Martínez*

- Medina; Martín J. Lavecchia; Leonor L. López Tévez; Luis Lezama; Teófilo Rojo; Patricia A. M. Williams; Evelina G. Ferrer. CHEMICO-BIOLOGICAL INTERACTIONS, 229, 64-72 (2015).*
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  13. Influence of  $\alpha$ -methyl substitutions on interpolymer complexes formation between poly(meth)acrylic acids and poly(N-isopropyl(meth)acrylamide)s; *Leire Ruiz-Rubio; Verónica Álvarez; Erlantz Lizundia; José L. Vilas; Matilde Rodríguez; Luis M. León. COLLOID AND POLYMER SCIENCE, 293 (5), pp 1447-1455 (2015).*
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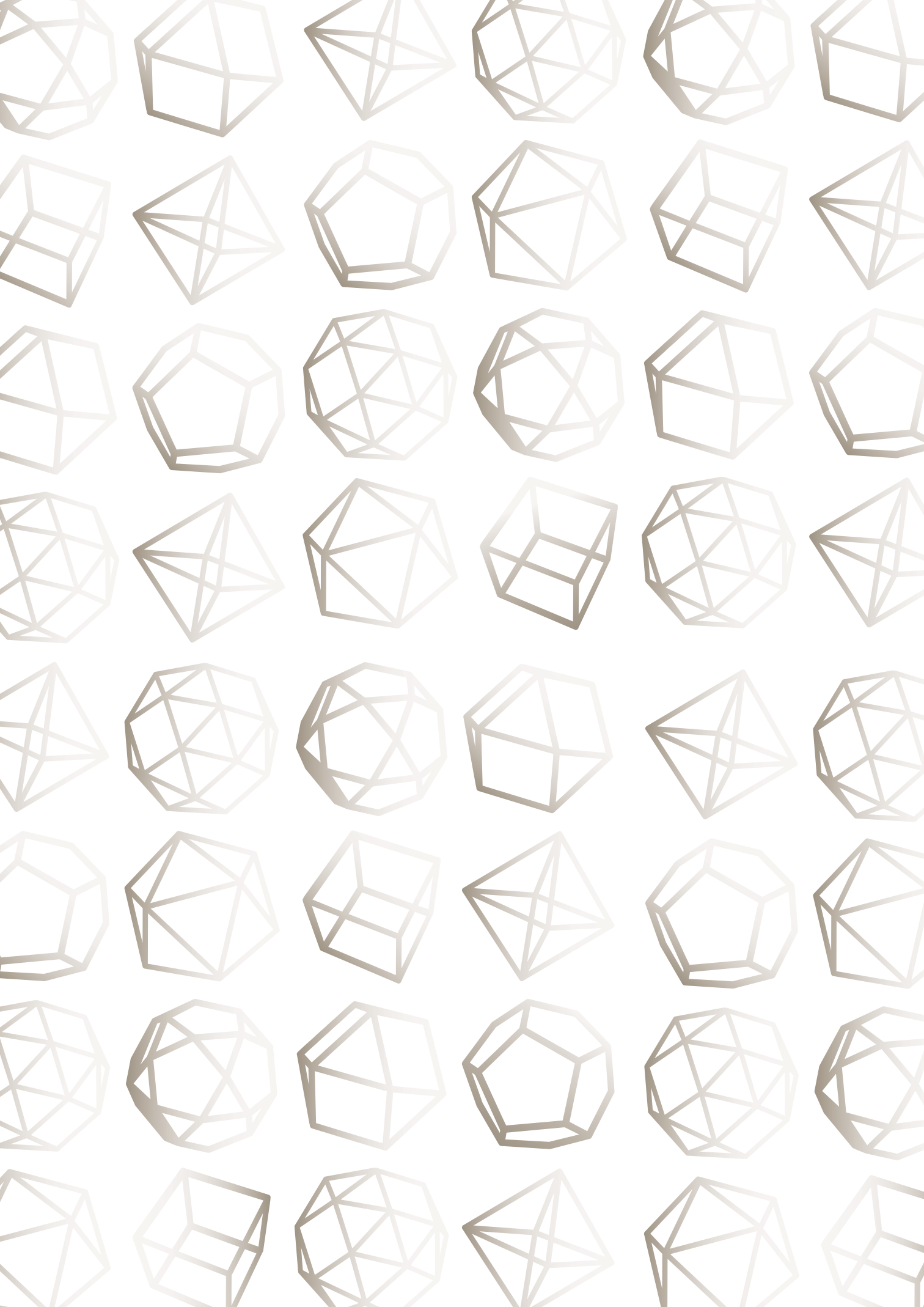
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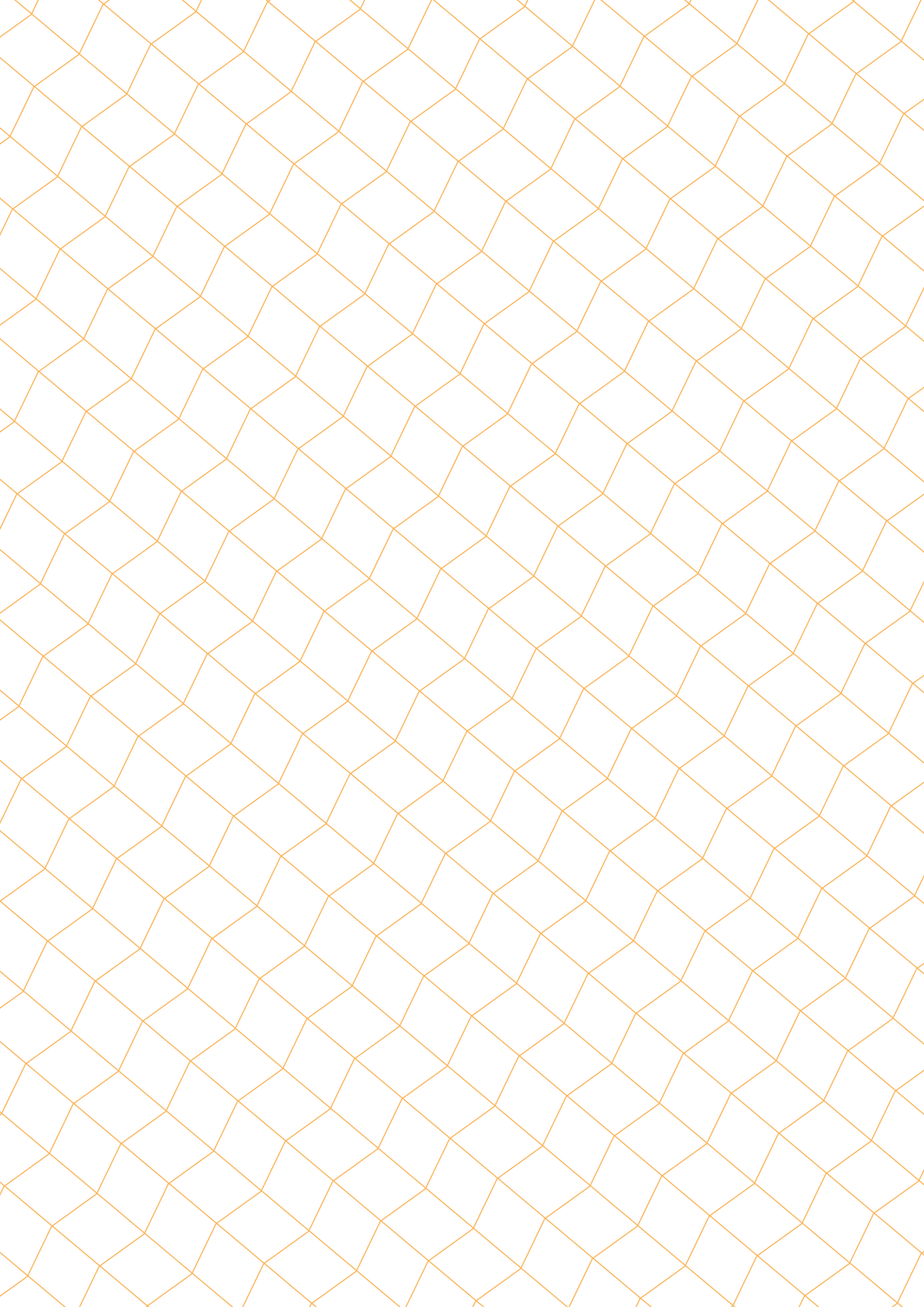


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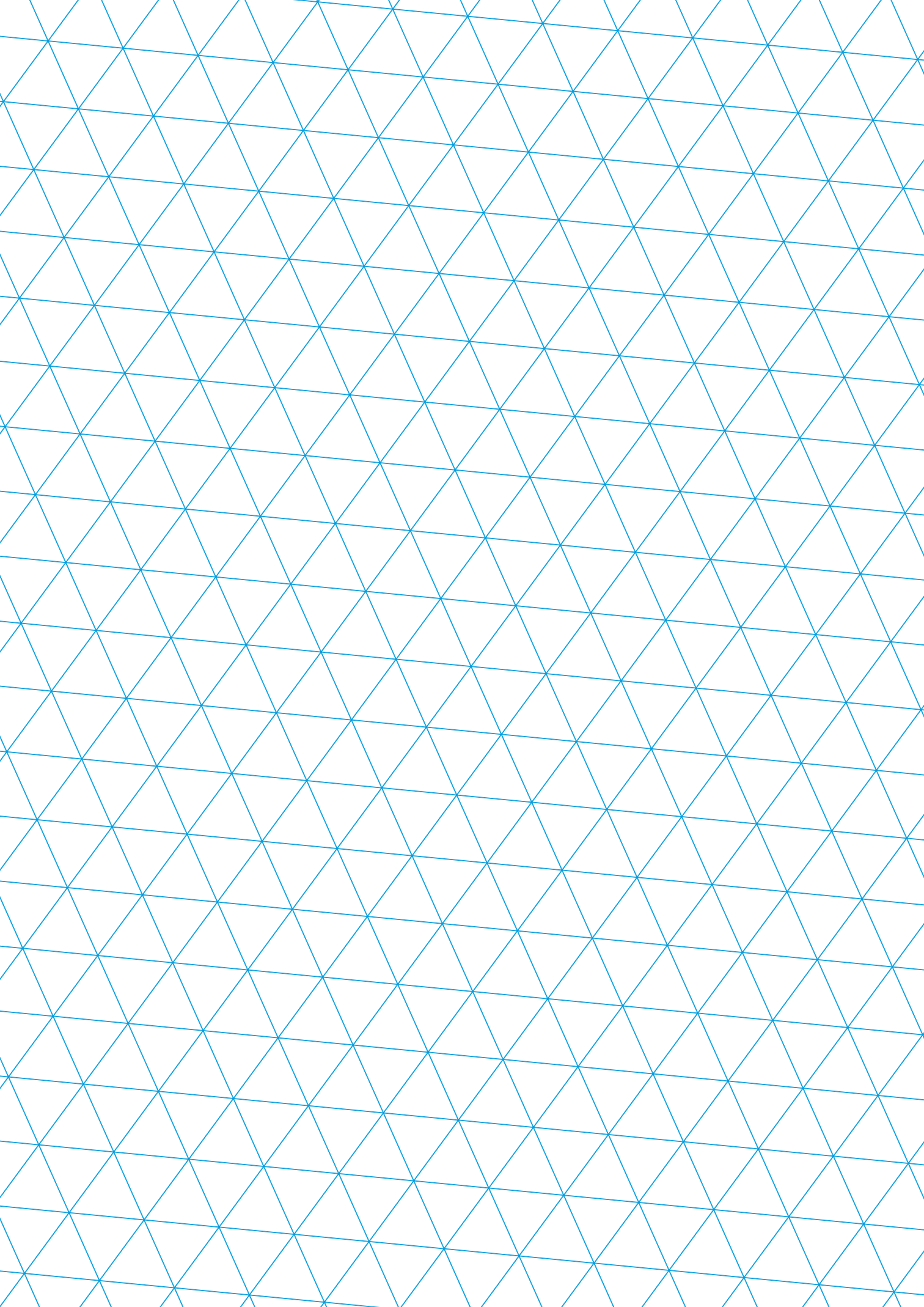
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