9:00-9:15 Registration
9:15-9:45 General view and future perspectives of the BCMaterials. (Senentxu Lanceros-Mendez)

Morning Session 1 – Advanced multifunctional materials and devices

9:45-10:15 Lecture 1-2 – Nanostructured materials

Stefan Wuttke (BCMaterials)

"Plenty of Room at the Top"

Abstract

The maturation of synthetic methodologies over the past century has transformed chemistry from a largely empirical to a rational science. Following this golden era of chemical synthesis, any thermodynamically stable molecule can be synthesized given enough resources and time. At this point in time, an apparent lack of major challenges in the field has been proclaimed, with many stating that all major challenges of synthetic chemistry have been solved.

In material chemistry the control on the molecular and nano-levels has led to the impactful field of nanotechnology, the distinction of matter into molecular, nano, and extended solids. In contrast, building macroscopic structures while still maintaining the atomic precision at the heart of chemical synthesis has received little to no attention.

In this talk, we wish to reflect reflecting different aspects of reticular chemistry and how this chemistry could be used to close the hug ′design cap′ between the macroscopic world of visible objects and the microscopic world of molecules. Further, we wish to raise awareness on the importance of reticular materials′ morphology on their functional properties, and ultimately shift the attention from crystal structures towards their macroscopic characteristics.

Oscar Castillo (UPV/EHU)

"Working on the building units for the development of porous metal-organic materials"

Abstract

Metal-organic porous materials, including MOFs, are built up on a basis of combining nodes (metal centers) and linkers (organic molecules) usually through coordination bonds. This approach provides some degree of predictability on the resulting structures, but hinders the development of other approaches to this challenge. There are some other systems build up from more reversible supramolecular interactions, in which the node/linker concept is disregarded in favour of tecton/synthons concept, that also afford porous materials but also incorporate a reversibility on the assembly-dissambly process of the crystal structure. The latter allows an active capture capability towards the guest molecules that do not present the more conventional MOFs which rely on the passive diffusion of the guess molecules into the pores for their capture.

10:15-10:45 Lecture 3-4 – Functional surfaces and coatings

Rafael Morales (UPV/EHU)

"Magnetic thin films and nanostructures: from fundamentals to applications"

Abstract

In this presentation, I will briefly describe our research lines in magnetism, from conventional topics to emerging fields in spintronics. Magnetic properties of ferromagnetic and antiferromagnetic materials in thin-film heterostructures and new properties of these materials when patterned into nanostructures will be highlighted. A vortex spin configuration is a clear example of a patterning effect. Nanostructures exhibiting this magnetic state can be exploited in novel biomedical applications for diagnostics and therapy, our second research topic. Finally, a recently discovered phenomenon on all optical switching is also revised. This phenomenon allows the magnetization switching by ultrashort laser pulses in absence of external magnetic fields and offers new routes for future spintronic applications. Ongoing collaborations in these topics and lab facilities will be presented to inspire further BCMaterials-UPV/EHU collaborations.

Jose Luis Endrino (BCMaterials)

"Functional surfaces and coatings at BCMaterials: from nothing to something?"

Abstract

Multi-functional surfaces and coatings can enable a wide variety of technological solutions. In the Basque Country alone, over one thousand companies are directly or indirectly related to this important technological field. Despite the fact that surfaces and coatings have been traditionally designed to enhance the mechanical performance of the underlying substrates in a broad range of applications, whether they be high load, low friction or other high-demanding environments. Today, surfaces and coatings can be designed to simultaneously protect, intelligently monitor and even control the degradation of high-value added components such as gas turbine engines, storage tanks and machine tools. If successful, this area will clearly play an important role in the digital transformation to industry 4.0. This brief presentation will introduce the challenges, mission and vision, of this research line in its early days, and will summarize some of the efforts done at BCMaterials for its establishment in the last year.

10:45-11:15 Lecture 5-6 – Active and smart materials

Senentxu Lanceros-Mendez (BCMaterials)

"From the smart use of materials… to actually smart materials!"

Abstract

Smart and multifunctional materials are a key driving force for the development of sustainable and interconnected responsive systems. In fact, they are essential players in the EU-Digitalization and Green Deal scientific policies. Further, their implementation by additive manufacturing allows simpler integration into devices and possibility of obtaining multifunctional materials over large and flexible areas.

The talk will summarize the main features, achievements and challenges associated with the most relevant smart materials that are being developed, ranging from their smart development, use and implementation …. to the development of a new generation of actually smart materials, which represent one the next big challenges in materials science

José Luis Vilas (UPV/EHU)

"Polymers for sensors and actuators"

Abstract

Polymers can be classified in many different ways, being the most common attending to their molecular structure, obtaining thermoplastics, elastomers and thermosets. Nowadays, polymer-related research is mainly focused on obtaining new polymeric materials, being the great majority designed and synthesized for a determined application.

Related to the evolution in materials and technology, as well as the highly extended introduction of information technologies in manufacturing processes, concepts as the Industry 4.0 and Internet of Things (IoT) have emerged. These new concepts require of new developments in electronics, software, sensors, actuators, and connectivity, which enables the connection among things and the exchange data.

In this framework, lot of these sensors and actuators related with the IoT concept are based on polymers and polymer composites that can be fabricated by conventional techniques, but which are increasingly being produced by additive techniques, such as 3D printing.

11:15-11:30 Lecture 7 – Micro and nano-devices

Francisco Javier del Campo (BCMaterials)

"Miniaturisation: from materials to devices"

Abstract

Miniaturisation enables the integration of multiple functions in a single device, and to improve the overall performance of current systems in terms of lower energy consumption, faster responses, improved reliability, and higher sensitivities.

Successful miniaturisation requires a deep understanding of the application as well as the right mix of materials and manufacturing processes. Thus, the research activities focus on three goals:

(i) to ensure that new active and functional materials are compatible with mass manufacturing processes,
(ii) to apply miniaturisation techniques to the development of advanced tools and techniques for the study of new materials, and
(iii) to develop novel devices that demonstrate the ability of multi-responsive materials to simplify device construction and integration through multi-functional components.

This brief presentation will give an overview of the current status and near term goals of the micro- and nanodevices area of BCMaterials.)

11:30-12:00 Lecture 8-9 – Advanced functional materials

Shahzada Ahmad (BCMaterials)

"Innovative materials for energy applications"

Abstract

The pressure to move towards renewable energy has inspired researchers to develop new ideas for materials that can lead to breakthrough. In the conference of parties (COP21), 195 countries took an oath to cut emission as much as possible to keep global warming <2o Celsius. This can only be achieved by increasing the share of renewable energy in our percentage mix of

electricity generation. The renewable sources, such as hydroelectric, wind, wave, biomass, geothermal, and photovoltaic are vital for the sustainability of our planet. Solar energy are potentially attractive to provide energy, at a competitive price. Recently the use of perovskites as a light harvester has made stunning progress. The power conversion efficiency in perovskite solar cells is now approaching parity with that of the established technology. In this talk, strategies to overcome instability in perovskite solar cells and materials for battery will be discussed.

Volodymyr Chernenko (UPV/EHU)

"Magnetic shape memory materials"

Abstract

Group is engaged in the research and development of new class of intelligent multifunctional materials: Heusler-type ferromagnetic and metamagnetic shape memory alloys, FSMAs and MetaMSMAs, respectively. The former materials, e.g., NiMnGa or NiFeGa, exhibit giant magnetostrain effect used for novel actuation and sensing, the latter ones, usually, NiMnX(X=Sn,In,Sb), show giant inverse magnetocaloric effect suitable for solid state refrigeration. Some of the research goals are:

- high temperature FSMAs for automotive and aerospace applications
- FSMAs for magnetic actuation on micro(nano)scale: micropillars, thin films, double beam cantilevers, surface patterning (smart surfaces), microwires;
- Ni-Mn-Ga particles/polymer composites for magnetic actuation, magnetoelecrics, magnetically controlled mechanical damping, haptic applications;
- superelasticity effect for vibration energy harvesting and its hysteresisless behavior in postcritical region for elastocaloric applications;
- advanced magnetocaloric MetaMSMAs and technology of 3D printing of active magnetic regenerators.

12:00-12:20	Coffee & Networking and Poster Session

Poster Session 1– Best Poster Presentations and Awards – PhD Students	
12:20-12:25	Poster 1 - Best ongoing research works at the BCMaterials (PhD Students)
12:25-12:30	Poster 2 - Best ongoing research works at the BCMaterials (PhD Students)

Welcoming to the new Ikerbasque Researchers	
12:50-13:00	Lecture 10 – **Qi Zhang** (BCMaterials).

"Ferroelectric materials for energy storage. Corrosion prevention of offshore structures"

Abstract

Present energy-storage devices mainly consist of electrochemical capacitors, batteries, dielectric capacitors and fuel cells. In all these energy-storage devices, dielectric capacitors have faster charge-discharge rate (< 1μs), more excellent fatigue endurance, and lower energy loss, and thus are widely used in electromagnetic guns, particle beam accelerators, laser technology, and hybrid electrical vehicles, which require a rapid and gigantic energy release so as to acquire large pulsed power.

Corrosion has been a serious threat to both economy and society. One-third of the total output of metal was rejected from technical application because of corrosion. Up to 8% of Gross National Product of industrialized nation was lost as a result of corrosion. In corrosion, Fe is

oxidised into Fe^{2+} in water. This reaction becomes more rapidly in salt water. Anything that can stop this chemical reaction is welcome

~~13:00-13:10 Lecture 11 – Unai Silvan (BCMaterials).~~

~~*"Evaluation of the biological response of cells to active materials"*~~

~~Abstract~~

~~In their physiological niche cells are exposed to a number of stimuli that regulate processes such as cell adhesion, proliferation and differentiation. In addition to their importance for maintaining tissue homeostasis, these stimuli play a central role in tissue regeneration and repair, and are crucial for the host's appropriate response to implanted biomaterials [Schoenenberger et al., 2020; Razafiarison et al., 2018]. Since the protein interface, that is the protein layer deposited on the material either *in vitro* or by adhering cells, is central to these biological events, our research aims to describe the impact of biophysical stimuli of different nature, ranging from electric charges and magnetic fields [Ribeiro et al., 2020] of varying strength and frequency to topographical cues, on the cell-mediated deposition of proteins and on the subsequent cell behaviour.~~

Morning Session 2 – Ongoing BCMaterials-UPV/EHU research projects

13:10-13:20 Lecture 12 – Advanced nano-biomaterials

Javier Reguera/Erlantz Lizundia.

"Plasmonic photocatalysts incorporated into renewable materials for environmental remediation"

Abstract

The development of patchy, multicomponent, and multifunctional nanoparticles represents a remarkable advance in nanomaterial science. The combination of nanoscale-related properties such as magnetic, optic, electronic, or catalytic, allows the design of more complex and specialized applications. Here we present examples of multicomponent and Janus nanoparticles, with a focus on novel plasmonic photocatalytic nanomaterials.

The importance of the support of those nanoparticles, to offer a long-standing and reusable catalyst, will be described with the incorporation of photocatalysts into a cellulose host. A continuous flow reactor with a customized holder has been designed to allowing the pollutant to pass through the active material. The combination of the tuneable nanoparticles, together with the highly porous structure, hydrophilic character, and stability of the cellulose framework will ensure in long-term in-flow water purification system efficiently working under solar illumination.

13:20-13:30 Lecture 13 – Multi-responsive materials for printing technologies

Carmen Rial-Rubio /Nikola Perinka

"All-printed devices based on multi-responsive materials"

Abstract

The area of smart and active materials has recently extended its use from the response to just one stimulus to react to several complementary stimuli simultaneously, or to incorporate

different active functionalities. The application of such materials is dependent on their processability and therefore a new area of investigation focused on their applicability by solution- or melt-process based techniques is emerging. Solution-processing includes 2D and 3D printing techniques, such as screen printing, inkjet printing, spray coating or direct ink writing. The development and applicability of different advance composite inks based on multi-responsive materials is discussed and demonstrated on printed functional devices including sensors and actuators.

13:30-13:40 Lecture 14 – Neutron based characterization of multifunctional materials

José María Porro / Viktor Petrenko

"Neutron scattering research at BCMaterials: current state and future prospects"

Abstract

The most widely used neutron scattering techniques are Neutron Imaging, Neutron Diffraction (ND), Small-Angle Neutron Scattering (SANS), Neutron Reflectometry (NR), and Inelastic (INS)/Quasielastic (QENS) Neutron Scattering. BCMaterials is actively participating in neutron scattering experiments in different systems and with different techniques. In this talk, the current and prospective neutron scattering experiments being developed at BCMaterials will be briefly introduced. In particular, ND experiments in magnetic shape memory alloys and perovskite solar cells; NR in aqueous ferrofluids and perovskite solar cells; SANS for complexes of protein with bicelles and the impact of nanoparticles on the protein amyloids aggregates; and INS on MOF adsorption and functionalization processes will be discussed. Prospects for further development of the neutron scattering program at BCMaterials and participation in international collaborations at large scale facilities will also be considered.

13:40-13:50 Lecture 15 – Magnetic responsive materials

Daniel Salazar/Karla Merazzo

"Advanced manufacturing of ceramic and metallic compounds with multifunctional properties"

Abstract

The processing of ceramic and metallic compounds is a sequence of tasks used in the transformation of raw materials into a functional product, part or device. At BCMaterials, we can produce different types of novel devices or materials on a lab-scale. Some multi-scale studies, from single-crystalline to amorphous state materials including nano and submicron sizes, will be described in order to give an insight of the facilities and experimental processes that we can make in the metallurgy laboratory for the development of novel functional materials.

As part of the portfolio we have available here at BCMaterials, we will show different magnetic nanostructures and magnetic nanodevices, their advanced fabrication methods and different magnetic behavior. By manipulating their geometric properties, materials and configurations, we can obtain different magnetic signals, behavior or properties, which dictates on which kind of device can be applied to. Currently, magnetic inks are being developed, with different materials and different magnetic properties. All these with the aim to apply them in different devices, such as caloric materials, magnetic-based sensors, permanent magnets, spintronic elements and other sustainable materials and strategies will also be discussed.

13:50-14:00 Lecture 16 – Energy storage materials and devices

Arkaitz Fidalgo/Idoia Larramendi

"Ongoing and future perspectives on new materials for energy storage systems."

Abstract

An increasingly technological society resulting from the growth of electronic miniaturization and the appearance of new gadgets has led to a growing demand for smaller and lighter energy storage systems with improved safety, energy and power characteristics. One of the most efficient technologies for energy storage are lithium-ion batteries, which are expected to become increasingly relevant for the next-generation rechargeable batteries. In this sense, the separator membrane is one of the key components of the batteries, and our work focuses on the development and characterization of new polymeric membranes.

For the near future we focused our work on the development of new materials with potential applications as electrolytes in all-solid-state batteries. Today, the next generation of batteries is considered to be based on the use of solid-state electrolytes, both inorganic and polymeric materials, so this research is expected to have a great impact on the development of new battery designs.

14:10-14:20 Lecture 17 – Environmental remediation

Roberto Fernández/Maribel Arriortua

"Metal-Organic Framework Materials for environmental remediation, prevention and monitoring: from the active materials to their integration in final devices"

Abstract

Metal-Organic Framework (MOF) are highly versatile porous materials formed from the ordered assembly of inorganic and organic building blocks. The outstanding plasticity of these ordered materials allows decorating both their inorganic and organic building blocks, as well as their pore space to endow them of specific sorption properties towards inorganic and organic pollutants. In this talk we will describe how the MOFs can be encoded with specific groups to boost their adsorption specificity towards target inorganic and organic pollutants and in parallel to couple the adsorption process to a measurable physicochemical property. Giving a step forward, the integration of MOF active nano-particles in different polymeric and metallic membranes and transductor systems will be described, a key advance to achieve a real applicable air or water depollution or sensing devices.

14:20-14:40 Best Poster awards

14:40-15:00 Closing and farewell