ICTP

Institute of Polymer Science and Technology, ICTP, is a Research Institute of the Spanish Council for Scientific Research, CSIC, a public research organisation belonging to the Ministry of Economy and Competitiveness (MINECO).

ICTP

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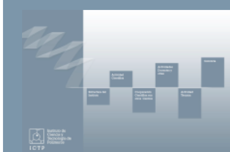
The ICTP is located in the Centre for Organic Chemistry "Manuel Lora-Tamayo", close to the central offices of the CSIC in Madrid.

The **Main Objective** of ICTP is the scientific and technological advancement of polymeric materials through research and development. This objective is pursued through the following activities:

- Research projects and contracts.
- Scientific and technical advice.
- Training of specialist staff on polymer science.
- Promotion of the culture of polymer science.
- Transfer of results to the business sector.

RSS Publications



ICTP annual report 2013

Principal **Research Lines** at ICTP:

- Design and development of new *elastomeric materials* for advanced applications.
- Development of *components for energy conversion and storage* electrochemical devices.
- Design and development of functional *polymeric nanocomposites* based on graphene, carbon nanotubes and inorganic nanoparticles.
- Development of *nanohybrids and interactive polymers* with stimuli-responsive behavior with applications in sensor field, detection systems, drug release, regenerative medicine and other therapies.
- Preparation and development of application of *polymeric nanomaterials.*
- Design and preparation of *biomaterials* for biomedical field.
- Nanostructured polymer and multicomponent systems.
- Heterogeneous polymer systems and organic-inorganic hybrid materials: control of interphases and surfaces, ionic and molecular transport properties, superhydrophobicity and superlipophobicity, optoelectronic properties, etc.
- *Condensation polymers*: membranes for water purification, gas separation and porous materials as catalyst supports.
- Synthesis and modification of polymers with *photochemical and environmental applications.*
- Synthesis and modification of polymers for *technological and biomedical applications.*
- *Heterogeneous materials based on organic polymers*: blends, composites, interfacial agents from chemical modification of polymers, recycling and waste treatment.
- Synthesis and characterization of nanostructured materials developed from well-defined polymers obtained by conventional/controlled polymerization or physical/chemical modification.
- Design, synthesis and characterization of polymer cholesteric liquid crystals (PCLC), twisted nematic, biocompatibles, optoelectronic and multifunctional.

Research organization chart:

ICTP is divided into **five research departments** divided in research groups

Departments	**Groups**
Polymer Physics, Elastomers and Applications Energy	▪ Energy Applications ▪ Elastomers ▪ Polymer Physics
Polymeric Nanomaterials and Biomaterials	▪ Biomaterials ▪ Polymeric Nanomaterials
Polymeric Physical Chemistry	▪ Nanostructured and multicomponent polymer systems ▪ Physical-Chemistry of heterogeneous polymer systems ▪ Nanohybrids and Interactive Polymers
Applied Macromolecular Chemistry	▪ Polymeric Photochemistry ▪ Polymer Functionalization ▪ Polycondensation and Polymer Membranes
Chemistry and Properties of Polymeric Materials	▪ Macromolecular Engineering ▪ Polymer Engineering ▪ Physical-Chemistry and Modelization of Macromolecules

Elastomers Group

Elastomers group is the unique research group in Spain specialized in elastomers. Our group specializes in the study of science and technology of elastomeric materials and has extensive experience in both basic research and applied technology in the industrial sector.

Research lines:

The group's main objective is the design and development of new elastomeric materials for advanced applications.

- Study of fundamental concepts about elastomers science and technology.
- NMR experiments application in time domain for the study of crosslinked networks, charge/ rubber interactions and chain dynamics in elastomeric compounds. Application of low-field NMR (MQ- NMR experiments).
- Development of elastomeric networks with ionic crosslinks and coordination for advanced applications. Shape memory and temperature elastomers (first elastomer with shape memory effect) .
- Development of rubber compounds with advanced properties through the addition of fillers and nanofillers.
- Synthesis and characterization of novel polyurethanes with tailored properties.
- Valuation of recycled elastomers as raw material: regeneration mechanisms/devulcanization optimization and recovery of recycled rubber.
- Knowledge transfer: New technological developments for the degradation and recycling of elastomers.

To perform this objective we carry out studies in the field of relationship structure elastomer properties (including latex), composite and nanocomposite elastomeric, ionic elastomers, thermoplastics and polyurethanes. Recently, we have patented two developments: one related to shape memory elastomers and another related to latex characterization. The group counts with the usual techniques for the study of elastomers, and a low field nuclear magnetic resonance spectrometer.

Our works have generated numerous publications and communications at international and national conferences, patents, PhD Thesis (7 in progress), master's Thesis (3 course) and undergraduate thesis. The close relationship with companies materializes in major research projects (Repsol, Alstom, Tecnilatex, Elastorsa, etc.), technical reports and delivery of training

Elastomers Group

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Elastomers Group

Recent publications:

Local chain deformation and overstrain in reinforced elastomers: An NMR study. Pérez-Aparicio, R., Schiewek, M., Valentín, J.L., Schneider, H., Long, D.R., Saphiannikova, M., Sotta, P., (...), Ott, M. *Macromolecules*, 46, 5549-5560 (2013) Impact factor 5.521

Study on peroxide vulcanization thermodynamics of ethylene-vinyl acetate copolymer rubber using 2,2,6,6,-tetramethylpiperidinyloxyl nitroxide Posadas, P., Fernández-Torres, A., Chamorro, C., Mora-Barrantes, I., Rodríguez, A., González, L., Valentín, J.L. *Polymer International*, 62, 909-918 (2013). Impact factor 2.125

Chain dynamics and strain-induced crystallization of pre- and postvulcanized natural rubber latex using proton multiple quantum NMR and uniaxial deformation by in situ synchrotron X-ray diffraction. Che, J., Toki, S., Valentin, J.L., Brasero, J., Nimpaiboon, A., Rong, L., Hsiao, B.S. *Macromolecules*, 45, 6491-6503 (2012). Impact factor 5.521

Energy applications group

Energy applications group research activity focuses on development of conducting polymers and their application for electric energy storage and generation devices.

Research lines:

Electrodes and electrolytes development for generation and electric power storage devices:

- Rechargeable batteries lithium/lithium ion
- Electrochemical capacitors
- Polymer membrane fuel cells (PEMFC)

Our currently work is focused on the development and characterization of proton exchange hybrid membranes for PEMFC based on perfluorosulfonated ionomers, commercial thermoplastic elastomers and organo-inorganic fillers modified with sulfonic groups. Electrochemical behavior is studied by polarization and durability tests performed on a PEMFC test station. Also analysis the hydrogen diffusion through membranes and determine their proton conductivity at different temperatures and relative humidities.

We also carried out the synthesis, morphological and electrochemistry characterization of polymer gels containing different nature ionic liquids, with application as electrolytes in lithium/lithium ion rechargeable batteries. Study the effect of incorporating interfacial agents in electrochemical behavior both electrolytes as in lithium/lithium ion cells. We also perform the synthesis and characterization of hybrid materials based on graphene modified with electronic conductor polymers to achieve their use as electrodes in supercapacitors.

Energy Applications Group

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Energy Applications Group

Recent publications:

M.A., Torre, M. C.; del Río, E., Morales. Effect of carbon porosity on the electrochemical properties of carbon/polyaniline supercapacitor electrodes. *Journal of New Materials for Electrochemical Systems*, 16, 189-195 (2013) Impact factor 0.532

Escribano, P.G. ; Canovas, M. J.; Ojeda, M. C.; del Río, C., Sánchez, F.; Acosta, J. L. Preparation and characterization of hybrid membranes for fuel cell applications HSBS filled with alkyl, phenyl or tolyl sulfonate. *Polymer International*, 60, 493-499 (2011) Impact factor 5.521

Escribano, P. G.; Del Rio, C.; Acosta J. L. Polymeric Proton Conducting Systems Based on Commercial Polymers: Crossover Analysis and Single Cell Testing. *Journal of Applied Polymer Science* 119, 2386-2392 (2011) Impact factor 1,240

Proceedings of the 9th International Symposium on New Materials and Nanomaterials for Electrochemical Systems Editorial: Sociedad Mexicana del Hidrógeno ISBN: 978-607-7823-13-1 Título del Capítulo: “Effect of carbon porosity on the electrochemiocal properties of carbon/polyaniline supercapacitor electrodes” Authors: M.A. Torre; C. Del Rio; E. Morales

Polymer Physics, Elastomers and Energy **Department**

Polymer physics group

The main activity of the group is fundamental and applied research in polymeric materials, with wide experience in the areas of polymer blends, composites, hybrid and nanocomposite materials.

Research lines:

The group undertakes diverse research lines, and a generic list is provided below:

- Graphene: Synthesis, functionalization and new strategies for incorporation into polymeric nanocomposites.
- Polymer nanocomposites. High performance polymers reinforced with carbon nanotubes: PPS & PEEK. Strategies of incorporation, hierarchical laminates, laminated with Buckypaper.
- Polymer nanocomposites based on fullerenes and inorganic nanotubes. IF-WS2, IF-MoS2 in various matrices, dual charges strategies and ITNs in multiphase systems.
- Polymer blends nanocomposites: green and sustainable nanomaterials. Addressed nanofibers location, modification of the interface and Starbon® nanocomposites.
- IR microspectroscopy using synchrotron radiation (MIRAS).
- Chemical functionalization of polymer and nanoparticles.
- "Click" chemistry for the design of new functional materials.
- New materials from bio-derived waste revalorization.

Our more recent goals are centered on the development of polymer nanocomposites based on carbon nanotubes, graphene, and inorganic fullerene-like nanoparticles with improved performance properties for diverse application areas. In order to do this we incorporate nanomaterials such as carbon nanotubes, graphene, fullerenes, clay and inorganic nanotubes in various polymer matrices, since consumer polymers like polyethylene and polypropylene, to technical polymers like nylon, high performance, such as polyether ketones and polysulfones. Recent achievements of the group that can be highlighted are the development of a new method of chemical functionalization of graphene by "click" chemistry, the preparation of high performance hybrid nanocomposites with tunable properties, and excellent improvements in properties by grafting nanotubes polymer molds.

Other activities of the group include training scientists through Masters and PhD courses, dissemination and scientific-technical assistance to industry.

The group has a broad history of collaborations with major producers enterprises through research projects and contracts, national and international collaborations with recognized centers. Since 2009, the group has published more than 60 SCI papers, 5 patents, and 8 book chapters.

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Recent publications:

Opportunities and challenges in the use of inorganic fullerene-like nanoparticles to produce advanced polymer nanocomposites Naffakh, M., Díez-Pascual, A.M., Marco, C., Ellis, G.J., Gómez-Fatou, M.A. *Progress in Polymer Science*, 38, 1163-1231 (2013) Impact factor 26.383

Comparative study of the covalent diazotization of graphene and carbon nanotubes using thermogravimetric and spectroscopic techniques. Castelaín, M., Shuttleworth, P.S., Marco, C., Ellis, G., Salavagione, H.J. *Physical Chemistry Chemical Physics*, 15, 16806-16811 (2013). Impact factor 3.829

A versatile chemical tool for the preparation of conductive graphene-based polymer nanocomposites. Castelaín, M., Martínez, G., Ellis, G., Salavagione, H.J. *Chemical Communications*, 49, 8967-8969 (2013). Impact factor 6.378

High-performance nanocomposites based on polyetherketones. Díez-Pascual, A.M.; Naffakh, M.; Marco, C.; Ellis, G.; Gómez-Fatou, M.A. *Progress in Materials Science*, 57, 1106-1190 (2012) Impact factor 18,216

Graphene-Based Polymer Nanocomposites. Salavagione, H.J., Martínez, G., Ellis, G.. Physics and Applications of graphene-Experiments (Ed: Mikhailov, Sergey), InTech Publishing, Rijeka, Croacia Vol. 1, Cap. 9, p169-192 (2011).

Polymer Physics Group

Biomaterials group

The activity of biomaterials group focuses on the development of bioactive biomedical devices that offer a positive contribution to the health patients as well as in the design and preparation of polymeric systems with a specific therapeutic action (antithrombogenic, antiinflammatory, antitumor, etc.). This activity, called "Therapy with Polymers" fits into the modern development concept of "Nanomedicine".

Research lines

- Development of bioactive biomedical devices.
- Design and preparation of polymeric systems with a specific therapeutic action.
- Development of new systems for controlled and targeted release of bioactive compounds.

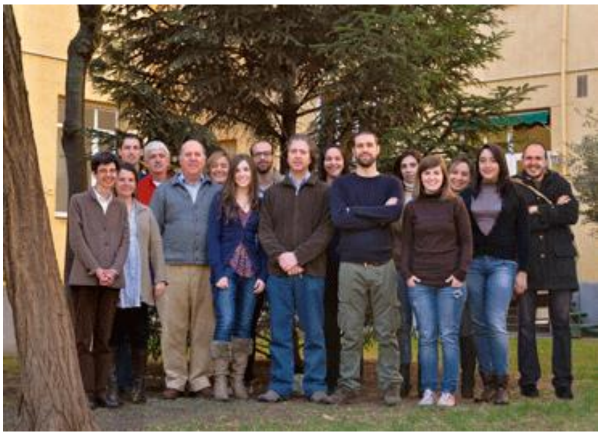
We work on the design of devices to vascular area, having developed new "coronary stents" with antithrombogenic and antiproliferative properties that are on the market with CE mark, devices to ophthalmology area: intrastromal rings or contact lenses with antiproliferative surfaces; membranes for tissue regeneration or abdominal mesh coatings to local antibiotic dosage.

This has been reflected in a several number of European patents, some of which have been transferred to industrial sector, high-impact publications, biomedical and pharmaceutical companies contracts companies, as well as European and national projects.

Aware of the multidisciplinary nature activities, the group is active part of Biomedical Research Networking center in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN) since its establishment in 2006.

Biomaterials Group

Polymeric Nanomaterials and Biomaterials **Department**



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Biomaterials Group

Recent publications:

Smart heparin-based bioconjugates synthesized by a combination of ATRP and click chemistry. Reyes-Ortega, F., Parra-Ruiz, F.J., Averick, S.E., Rodríguez, G., Aguilar, M.R., Matyjaszewski, K., San Román, J. Polymer Chemistry, 4,2800-2814 (2013) Impact factor 5.231

Microstructure and biological activity of sulfonated N-vinylpyrrolidone copolymers. Tardajos, M.G., García-Fernández, L., Reinecke, H., Aguilar, M.R., Gallardo, A., Román, J.S. *Journal of Bioactive and Compatible Polymers*, 27, 453-466 (2012) Impact factor 2.207

Preparation and characterization of hydrogel-nanosilver composites based on copolymers from sodium 2-acrylamido-2-methylpropanesulfonate. Valle, H., Rivas, B.L., Aguilar, M.R., Román, J.S. *Journal of Applied Polymer Science*, 129, 537-548 (2013) Impact factor 1.395

Polymer nanocomposites group

Polymeric nanomaterials group research focuses on the manipulation and the control of materials at "nano" scale, which exhibit very different properties to their corresponding micro scale. Research encompasses both basic and applied science establishing relationships between processing technologies, nanocharge-polymer interactions and properties, in order to design new materials commercially attractive.

The group is divided in two subgroups:

- Polymers and gels nanostructured.

- Polymer nanocomposites.

Research lines:

The group's main objective is the design and development of new elastomeric materials for advanced applications.

- Development of macro, micro and multifunctional nanogels for biomedical applications.
- Manufacture of 1D arranges nanostructured polymers: nanotubes, nanofibers.
- Preparation of new structures by modification of polymeric precursors.
- Characterization of macro-and nanostructured polymers.
- Synthesis and functionalization of nanoparticles (organic, inorganic and carbon nanostructures: carbon nanotubes graphenes, nanocellulose...).
- Development and processing of polymer nanocomposites both solid state or foamed: elastomeric nanocomposites, polymeric foams; bionanocomposites (from tissue engineering to packaging); high performance thermoplastics (i.e. PEEK, PPS, PA) High performance thermosets (i.e. Epoxies for high performance composites); nanostructured block copolymers; enzymatic polymerization.

The group is part of the European Centre for Nanostructured Polymers (ECNP) participates actively in research projects and industry contracts, it should be noted its recent participation in European projects such as Nanofun-Poly, Harcana or Photomat.

In the last three years, it has published 85 SCI articles, 3 book chapters and presented 9 doctoral theses.
in 2006.

Polymer Nanocomposites Group

Research lines (cont.):

- Development of Shape Memory Polymers: copolymers, composites and shape memory nanocomposites and polymer actuators (dielectric elastomers)
- Production of polymer nanofibres by Electrospinning.
- Development of polymer actuators. Dielectric elastomers.
- Synthesis: Functionalization of nanoparticles; synthesis and functionalization of nanocelllulose (i.e. PLA); synthesis of block copolymers PLA-PCL and their PUs; enzimatic polymerization (PLA, PCL, PUs, etc.); self-healing.
- Processing: Chemorheology of thermosets and rheology of thermoplastics; mathematical modelling (composites, nanocomposites); fire retardancy in biopolimers, with IMDEA; availability of special techniques: miniextrusion, calendering three roll mill, electrospinning
- Characterization: Thermal degradation and kinetics; crystallization kinetics; water absorption and kinetics; shape memory behavior.
- Technology transfer.

Polymer Nanocomposites Group

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Polymer Nanocomposites Group

Recent publications:

Multifunctional nanostructured PLA materials for packaging and tissue engineering Progress in *Polymer Science Volume*, 38, 1720-1747 (2013) Impact factor 26.3831

Graphene materials with different structures prepared from the same graphite by the Hummers and Brodie methods. *Carbon*, 65, 156-164 (2013). Impact factor 5.868

Directional crystallization of 20 nm width polymer nanorods by the inducement of heterogeneous nuclei at their tips. Martín, J., Nogales, A., Mijangos, C. *Macromolecules*, 46, 7415-7422 (2013) Impact factor 5.521

One dimensional PMMA nanofibers from AAO templates. evidence of confinement effects by dielectric and raman analysis. Blaszczyk-Lezak, I., Hernández, M., Mijangos, C. *Macromolecules*, 46, 4995-5002 (2013). Impact factor 5.521

Graphene filled polymer nanocomposites. Verdejo, R., Bernal, M.M., Romasanta, L.J., Lopez-Manchado, M.A. *Journal of Materials Chemistry*, 21, 3301-3310 (2011). Impact factor 6.10

Nanostructured and multicomponent polymer systems group (NANOMULPOL)

The nanostructured multicomponent polymeric systems group research has focused on two major areas:

- Synthesis and characterization of nanostructured polymer

- Multicomponent systems with the ability to form mesophases and multicomponent polymeric materials

Research lines:

- Development of macro, micro and multifunctional nanogels for biomedical applications: Liquid crystal polymer (backbone and/or lateral, linear and/or crosslinked with shape memory) and polypropylene derivatives
- Manufacture of 1D arranges nanostructured polymers: nanotubes, nanofibers: polymers mixtures with micro and nanocomposites
- Viscoelasticity, polyolefins, nano-structured polymeric materials and their structural, thermal and mechanical characterization.

Structural evaluation and mechanical rheological properties gives us the opportunity to study in depth the nanoscale arrangement of different materials prepared by the group and the knowledge of final services. This examination is done by combining different techniques individually or simultaneously in real time with X-ray diffraction with synchrotron radiation coupled to a rheometer.

The study of some of our multicomponent systems with specific properties (conductor, gases or biocides transport, etc.) involves collaboration with other recognized national and international groups. Also, the clear commitment of NANOMULPOL for technology transfer to the private sector is evidenced by the numerous R&D projects with polyolefin sector companies and with polymer nanocomposites and polymer liquid crystals producer companies. All this work has resulted in over than 60 SCI publications in the period 2007-2012 confirming our multidisciplinary, dynamism and internationalization.

Environmental sustainability and waste plastics concern is evidenced by our participation and coordination in a network included in the Ibero-American Programme for Science, Technology and Development (CYTED).

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NANOMULPOL Group

Recent publications:

Amphiphilic polymers bearing gluconolactone moieties: synthesis and long side-chain crystalline behavior. Cerrada ML, Bordegé V, Muñoz-Bonilla A, León O, Cuervo-Rodríguez R, Sánchez-Chaves M, Fernández-García M. *Carbohydrate Polymers*, 94, 755-764 (2013). Impact factor 3.479

Lightweight nanocomposites based on poly(vinylidene fluoride) and Al nanoparticles: Structural, thermal and mechanical characterization and EMI shielding capability. Arranz-Andrés, J., Pulido-González, N., Fonseca, C., Pérez, E., Cerrada, M.L. *Materials Chemistry and Physics*, 142, 469-478 (2013). Impact factor 2.072

Tailoring the formation rate of the mesophase in random propylene-co-1-pentene copolymers. Pérez, E., Gómez-Elvira, J.M., Benavente, R., Cerrada, M.L. *Macromolecules*, 45, 6481-6490 (2012) Impact factor 5.521

Physical-chemistry of heterogeneous polymer systems group (HEMPOL)

HEMPOL group main research activity focuses on the design and development of new materials with diverse applications in fields as energy, construction and environment.
The group specializes in the synthesis of organic-inorganic fillers such MOFs and ad-hoc modification of nanoscale fillers (silica, silicates or cellulose, etc.) using new methods developed in our group. Materials obtained this way were studied by themselves or as part of composites or hybrids with polymeric matrix.

Research lines:

- Surface modification (clays, silica, fibers, cellulose…) and preparation of based polymer composites materials.
- Ionic and molecular transport through polymer based membranes: solid electrolytes (Li^+ cell) conductivity, gas separation, mechanical and barrier properties ...)
- Superhydrophobic surfaces based on polymers coatings (water repellency, transparency and mechanical stability).
- Electronics: conductivity, mechanical properties and processability.
- Synthesis and preparation of materials based on conjugated polymers (optoelectronic properties).
- MOF synthesis (Metal Organic Frameworks) and hybrid membranes

Download a brief summarize:

Based on the explained methodology, it has been prepared superhydrophobic hybrids and composites materials based on micro and nano silica and polymeric matrices, which may be also transparent and mechanically stable. These materials are currently matching many applications such as anti-corrosion coatings, supersliding, etc... A particular case of these superhydrophobic compounds are those based on conjugated polymers with electronic properties (luminescence or conductivity), which form the new electronic materials water repellent

Electrolytes pseudosolids have also been developed based on polyethylene oxide and modified sepiolites. Such materials behave microscopically as fluids showing high ion Li conductivities although macroscopically maintain the solid character even at high temperatures.
As a common link to our previous work, there is our work based on ion and molecular transport properties, which is performed by using dielectric spectroscopy and nuclear magnetic resonance for determination of ionic mobility and conductivity; or by absorption and diffusion methods for the study of molecular transport coefficients, especially gases.

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HEMPOL Group

Recent publications:

Polymerization of methyl methacrylate with lithium triflate. A kinetic and structural study. Hermosilla, L., Calle, P., Tiemblo, P., García, N., Garrido, L., Guzmán, J. *Macromolecules*, 46, 5445-5454 (2013) Impact factor 5.521

Confinement and nucleation effects in poly(ethylene oxide) melt-compounded with neat and coated sepiolite nanofibers: Modulation of the structure and semicrystalline morphology. Mejía, A., García, N., Guzmán, J., Tiemblo, P. *European Polymer Journal*, 49, 118-129 (2013) Impact factor 2.562

Triarylamine polymers of bridged phenylenes by (N-heterocyclic carbene)-palladium catalysed C-N coupling. Sprick, R.S., Hoyos, M., Morrison, J.J., Grace, I.M., Lambert, C., Navarro, O., Turner, M.L. *Journal of Materials Chemistry C*, 1, 3327-3336 (2013) Impact factor 6.101

Nanohybrids and interactive polymers group (NyPI)

Our main research activity focuses on the development of nanohybrid and nanostructured materials for applications as sensors, drug delivery and regenerative medicine.

Research lines:

The group's main objective is the design and development of new elastomeric materials for advanced applications.

- Development of polymers responsive to stimuli (smart)
- Development of photoluminescence nanoparticles.
- Development of noble metals nanoparticles
- Development of NPs hybrids
- Development of biodegradable and biocompatible polymers to facilitate the regeneration of the CSN.
- Design polymer surfaces from scratch (polymer synthesis) with: Control surface functionality and its distribution, micro and nanostructures, modify topography.

Download a brief summarize:

ICTP

The optical, electronic, magnetic, catalytic and photothermic conversion properties depend upon size, shape and distance between nanoparticles (NPs) and, consequently, they are very favourable and unique for use in relevant technologies, such as optoelectronics, catalysis and biomedicine.

The use of NPs in these fields requires a control of their interactions with their environment. The functionalization of NPs with polymers would clearly improve current technologies, since their versatility makes them unique for the fabrication of custom-made surfaces. The development of nanostructured polymers funcionalized with bioactive molecules combined with the versatility of NPs for regeneration of the central nervous system (CNS) is other area of group’s work.

NyPI Group

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NyPI Group

Recent publications:

Versatile functional microstructured polystyrene-based platforms for protein patterning and recognition Palacios-Cuesta, M., Cortajarena, A.L., García, O., Rodríguez-Hernández, J. *Biomacromolecules*, 14, 3147-3154 (2013) Impact factor 5.371

Constructing robust and functional micropatterns on polystyrene surfaces by using deep UV irradiation. Palacios, M., García, O., Rodríguez-Hernández, J. *Langmuir*, 29, 2756-2763 (2013) Impact factor 4.187

Surface-Enhanced Raman Trajectories on a Nano-Dumbbell: Transition from Field to Charge Transfer Plasmons as the Spheres Fuse. Banik , N., El-Khoury, P., Nag, A., Rodriguez-Perez, A., Guarrottxena, M., Bazan, G.and Apkarian, V. *ACS Nano*, 6, 10343–10354 (2012). Impact factor 12.062

Functional micropatterned surfaces prepared by simultaneous UV-lithography and surface segregation of fluorinated copolymers . Palacios, M., Liras, M., Labrugère, C., Rodríguez-Hernández, J., García, O. *J. Polym Science. Part A Polym. Chem.* 50, 4902-4910 (2012). Impact factor 3.543

Patent Nr. P201231928 (2012)

Polymeric photochemistry group

Photochemistry group is active in the synthesis and structural or surface modification of polymers and multicomponent systems, which contribute to environmental conservation, from the point of view of non-accumulation in the environment by biodegradation microbial, antimicrobial properties preventing the formation of biofilms and later “biofouling”, as well as detection sensors and bioremediation of pollutants.

Environmental applications of new materials are studied from a biological (nature, biodiversity and microorganisms concentration) and chemical point of view (polymer structure, additives, degradation, etc.).

Research lines:

The group's main objective is the design and development of new elastomeric materials for advanced applications.

- Controlled structures:

  - Block-copolymers.
  - Hiperbranched polymers.
  - Nanocomposites.

- Fluorescent Probes:

  - Analites/process dynamics detection in polymers.
  - Polymer thin films preparation.

- Environmental degradation:

  - New polymeric materials.
  - Commodities polymers.

Aim 1: Study of environmental degradation process and polymer stabilitation. In order to obtain photoselective, photodegrable and bioderadable agricultural thin films, through the incorporation of specific additives. Study of poliolefin films stabilitation, through the additon of antioxidizers. Study of polymers degradation through chemiluminiscence

Aim 2: Fluorescent Probes. Synthesis of novel organic compounds and high fluorescent polymeric structures. Synthesis of “anttena-effect” dendrimers. Evaluation in front of environmental pollutes, organic acids and metallic salts as interest analites. Study of polymer processes detection: crosslinking reactions, adhesives photocure, thermal transitions, molecular compounds absorption. regeneration of the central nervous system (CNS) is other area of group’s work.

Polymeric Photochemistry Group

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Polymeric Photochemistry Group

Recent publications:

Bioinspired actuated adhesive patterns of liquid crystalline elastomers" Cui, J.; Drotlef, D.-M.; Larraza, I.; Fernández-Blázquez, J.P.; Boesel, L.F.; Ohm, C.; Mezger, M.; Zentel, R.; Del Campo, A. *Advanced Materials*, 24, 4601-4604 (2012) Impact factor 13,8771

Photostabilization study of ethylene-butyl acrylate copolymers functionalized in the molten state with hindered amine light stabilizers (HALS). López-Vilanova, L., Espí, E., Martinez, I., Fierro, J.L.G., Corrales, T., Catalina, F. *Polymer Degradation and Stability*, Article in Press, Impact factor 2.770

In vitro biocompatibility and antimicrobial activity of poly(ε-caprolactone)/montmorillonite nanocomposites. Corrales, T., Larraza, I., Catalina, F., Portolés, T., Ramírez-Santillán, C., Matesanz, M., Abrusci, C. *Biomacromolecules*, 13, 4247-4256 (2012) Impact factor 5.371

Polymer functionalization group (FUPOL)

Polymer functionalization group is formed by about 10 researchers, three of them with permanent position in CSIC. The group creates and studies new methodologies to chemically modify polymeric materials. The ultimate aim is to provide to the society significant technological and/or biomedical advances.

To achieve that, the group has experience in organic synthesis, polymer chemistry and in the biological evaluation of polymeric materials, and they perform their activities in close collaboration with complementary groups.

Research lines:

- Preparations and functionalization of new polymeric materials for biomedical and technological applications.
- Supercritical CO_2
- Development of new plasticizers for PVC.
- Multifunctional polymers obtained by a bottom-up approach.

Download a brief summarize:

The group dedicated efforts and resources to develop greenly some of these methodologies by using supercritical CO_2 as a solvent in reactions and polymer processing.

Trying to resolve the problems associated with conventional plasticizer migration. The first generation of 'anchoring' plasticizers developed by the group had a great impact in non-specialized media (TVE, ABC, CSIC website, etc..) And very recently it has been licensed the patent for the second generation of plasticizers (most efficient) to a German company..

Example of polyvinylpyrrolidone. The aim is to prepare unpublished polyvinylpyrrolidone functionalization routes, a polymer with many applications in biomaterials area. We are tuning up functionalization processes of soluble linear in systems water, also preparation of amphiphilic networks, with applications in angiogenesis, gene therapy, transport properties modulation, etc.

FUPOL Group

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FUPOL Group

Recent publications:

Self-structuring in amphiphilic networks prepared by single conventional radical copolymerization of n -butyl methacrylate and vinylpyrrolidone. Tardajos, M.G., Aranaz, I., Pérez, M., López, D., Reinecke, H., Elvira, C., Gallardo, A. Macromolecules, 46, 5018-5025 (2013) Impact factor 5.521

Preparation of surface-attached polymer layers by thermal or photochemical activation of α-diazoester moieties Navarro, R., Pérez Perrino, M., Prucker, O., Rühe, J. *Langmuir*, 29, 10932-10939 (2013). Impact factor 4.187

Water-soluble pendant copolymers bearing proline and permethylated β-cyclodextrin: PH-dependent catalytic nanoreactors. Doyagüez, E.G., Rodríguez-Hernández, J., Corrales, G., Fernández-Mayoralas, A., Gallardo, A. *Macromolecules*, 45, 7676-7683 (2012) Impact factor 5.521

Chlorosulfonation of polystyrene substrates for bioanalytical assays: Distribution of activated groups at the surface Del Prado, A., Briz, N., Navarro, R., Pérez, M., Gallardo, A., Reinecke, H. *Analyst*, 137, 5666-5671 (2012) Impact factor 3.969

Transparent Polystyrene Substrates with Controllable Surface Chlorosulfonation: Stable, Versatile, and Water-Compatible Precursors for Functionalization *Macromolecules*, 2012, 45, 2648–2653 Impact factor 5.521

Polycondensation and polymeric membranes group

The polycondensation and polymeric membranes group is devoted to the preparation and study of new and special condensation polymers.

In the last fifteen years, a major objective of the group is the preparation of polymer membranes with application in several fields such as: ultrafiltration, reverse osmosis and gas separation.

These investigations, which have always been funded by public and private entities, have led to 13 theses defenses, and more than 100 publications in this area. Recently, thanks to the participation in a consolider project, the group has launched a new research line focused in synthesis of porous polymers designed mainly to anchoring catalysts

Research lines:

- Polymeric membranes for gas separation.
- Polymeric membranes for water purification.
- Porous polymer for anchoring catalysts.
- Computational modeling.

The group, led by Prof. Javier de Abajo and Prof. Jose G. de la Campa is constituted by two Research Professors, one Senior Researcher, two Tenured Researcher, one Postdoctoral Researcher and eight Ph.D. students.

Due to the multidisciplinary character of our research activity, several collaborations have been established with other groups of excellence not only in Spain but also in Europe and the United States as the Institute of General Organic Chemistry of CSIC, Seoul Hanyang University, Department of Chemical Engineering from Texas University, as well as with the industry through concerted projects (Acciona, Befesa o Porous Fibers).

Polycondensation and polymeric membranes Group

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Polycondensation and polymeric membranes Group

Recent publications:

Gas separation properties of mixed-matrix membranes containing porous polyimides fillers *Journal of Membrane Science*, 447, 403-412, (2013). Impact factor 4.093

Liquid-liquid displacement porosimetry applied to several MF and UF membranes. Carretero, P., Molina, S., Lozano, A., de Abajo, J., Calvo, J.I., Prádanos, P., Palacio, L., Hernández, A. *Desalination*, 327, 14-23 (2013). Impact factor 3,041

E. Merino, E. Verde-Sesto, E.M. Maya, M. Iglesias, F. Sánchez, A. Corma. *Chemistry of Materials*, 25, 981-988 (2013) Impact factor 8.238

Synthesis, characterization, and evaluation of novel polyhydantoins as gas separation membranes. Tejero, R., Lozano, A.E., Álvarez, C., De Abajo, J. *Journal of Polymer Science, Part A: Polymer Chemistry*, 51, 4052-4060 (2013). Impact factor 3.543

Thermally segregated copolymers with PPO blocks for nitrogen removal from natural gas. Tena, A., Marcos-Fernández, A., Lozano, A.E., De La Campa, J.G., De Abajo, J., Palacio, L., Prádanos, P., Hernández, A. *Industrial and Engineering Chemistry Research*, 52, 4312-4322 (2013) Impact factor 2.206

Chemistry and Properties of Polymeric Material **Department**

Macromolecular engineering group

Macromolecular engineering group performs the synthesis and modification of polymers having well-defined structures and complex nanostructures using conventional/controlled polymerization (classic radical polymerization, ring opening polymerization and chemical modification) and advanced polymerization (living/controlled polymerization, metallocene chemistry, "click" chemistry and physical modification).

Research lines:

- Synthesis and modification of well-defines polymers (controlled polymerization):

  Polymeric micro-nano particles/fibers

  Surface/coatings structure-functionality.

  Hybrid materials and nanocomposites.

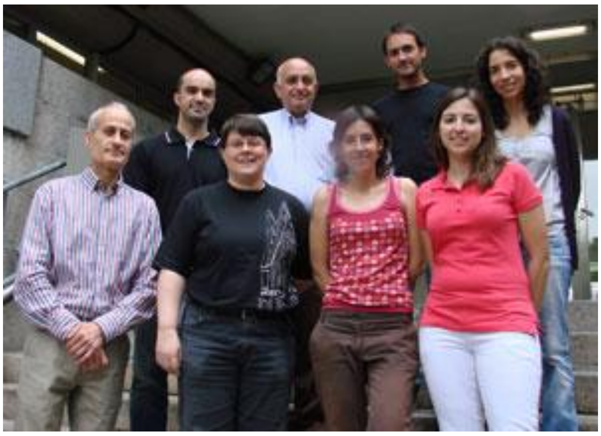
Download a brief summarize:

We are performing the synthesis of novel block copolymers with different characteristics (molecular weight, block type or chemical composition) which results in nanostructured materials with different morphologies in the solid state, in solution and at its surface. Also we are oriented in design of new (glyco) monomers, polymers with a defined functionality, for example, glycopolymers, peptides, fluorine, etc… Also, our efforts are directed towards the synthesis of new polyolefins able to develop the new polymorphic form, trigonal of polypropylene

Finally, we have synthesized inorganic nanoparticles, such as iron oxide and titanium for the following use in magnetic systems and hybrid nanocomposites. Aimed to obtain advanced systems, such as those capable of selectively recognizing specific proteins; superhydrophobic, bioactive compounds transport systems, for hyperthermia or antimicrobial systems among others.

Macromolecular Engineering Group

Chemistry and Properties of Polymeric Material **Department**



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Macromolecular Engineering Group

Recent publications:

Towards hierarchically ordered functional porous polymeric surfaces prepared by the breath figures approach. Muñoz-Bonilla, A., Fernández-García, M., Rodríguez-Hernández, J. *Progress in Polymer Science*, Article in Press (2013) Impact factor 26.383

Honeycomb patterned surfaces functionalized with polypeptide sequences for recognition and selective bacterial adhesion. de León, A.S., Rodríguez-Hernández, J., Cortajarena, A.L. *Biomaterials*, 34, 1453-1460 (2013) Impact factor 7.604

Polymeric materials with antimicrobial activity. Muñoz-Bonilla, A.; Fernández-García, M. *Progress in Polymer Science*, 37, 281-339 (2012) Impact factor 24,1

Synthesis, characterization, and evaluation of novel polyhydantoins as gas separation membranes. Tejero, R., Lozano, A.E., Álvarez, C., De Abajo, J. *Journal of Polymer Science, Part A: Polymer Chemistry*, 51, 4052-4060 (2013). Impact factor 3.543

Synthesis and lectin recognition studies of glycosylated polystyrene microspheres functionalized via thiol-para-fluorine "click" reaction. Álvarez-Paino, M., Muñoz-Bonilla, A., Marcelo, G., Rodríguez-Hernández, J., Fernández-García, M. *Polymer Chemistry*, 3, 3282-3288 (2012) Impact factor 5.231

Polymer engineering group

Polymer engineering group has its origins in the mid-eighties, during the global environmental crisis and the role played in it by the plastic materials, particularly in major solid waste streams. Management has to be effectively combined with knowledge and scientific-technical progress with the rest of the strategic sectors: economic, industrial, social and political.

Research lines:

Study and development of heterogeneous materials based total or partially on organic polymers:

- Blends,
- Composites,
- Interfacial agents from chemical modification of polymers,
- Recycling and waste treatment.

The double perspective: academic and applied that requires addressing the tandem polymers and environment, given the diversity of materials based on them, in all or in part and the crucial role played by the interface between components, explains that the research activity of GIP, consolidated since the nineties, was configured under the general heading of heterogeneous polymer-based materials.

Polymer Engineering Group

Recent publications:

On chemical modified polyolefins by grafting of polar monomers: A survey based on recent patents literature. Collar, E.P., García-Martínez, J.M. *Recent Patents on Materials Science*, 3,76-91 (2010).

Titulo de la obra: 14th European Conference on Composite Materials Editores: Kollár, László; Czigány, Tibor; Karger-Kocsis, József Editorial: ESCM (European Society for Composite materials) Budapest. ISBN: 978-963-313-008-7 "Dynamic-Mechanical Properties of Polypropylene/Mica Composites with modified interphase by a novel p-Phenylen-bis-maleamic acid gfated atactic polypropylene as interfacial agent." García-Martínez, J.Mª.; J.; Collar, E.P. Edición Electrónica. (2010)*aterials*, 34, 1453-1460 (2013) Impact factor 7.604

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Polymer Engineering Group

Physical-chemistry and modelization of macromolecules group

FQMM group's activity focuses on the design, synthesis and characterization of polymer cholesteric liquid crystals (PCLC), twisted nature, biocompatible, optoelectronic, multifunctional and with double thermotropic and lyotropic behavior.

Research lines:

- Structural characterization of PCLC synthesized and their complexes.
- Molecular modeling.

PCLC amphiphilic molecules self-associate by long-range interactions with each other and with active principles and biomacromolecules (providing biotechnological application): a) membrane lipids (neutral and cationic) and b) nucleic acids (non-viral vectors for gene therapy). The complexes conformation varies with the concentration and the solvent. The PCLC also self-associate directly on metallic and semiconductor surfaces with application in the design of surface nano-structured with optoelectronic and magnetic properties.
FQMM group performs structural characterization of PCLC synthesized and their complexes by NMR, DSC, SAXS / WAXS synchrotron radiation (DESY, ALBA, ESRF), SANS (neutron diffraction) (ILL, NIST) Raman, optical and electronic microscopy, Fluorescence, DC and ORD.

Molecular modeling allows us to design new molecules and also their properties using chemical computational programs: ChemBioOffice, Cerius2, Materials Studio, Discovery Studio, Schrödinger Suite (macromolecule-receptor interaction). With the aid of a computerized laboratory reactor it can be controlled polycondensation and crystallization kinetics of PCLCs.

FQMM Group

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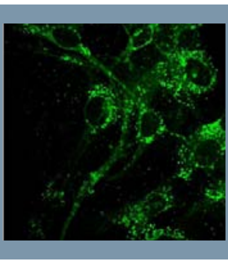
Recent publications:

Trans-cis isomerisation of the carotenoid lycopene upon complexation with cholesteric polyester carriers investigated by Raman spectroscopy and density functional theory. López-Ramírez, M.R., Sanchez-Cortes, S., Pérez-Méndez, M., Blanch, G. *Journal of Raman Spectroscopy*, 41, 1170-1177 (2010) Impact factor 3.137

Adsorption of a cholesteric liquid crystal polyester on silver nanoparticles studied by surface-enhanced Raman scattering and micro Raman spectroscopy. Pérez-Méndez M, Marsal-Berenguel R, Sanchez-Cortes S. *Appl Spectrosc.*, 58, 562-9 (2004) Impact factor 1.848

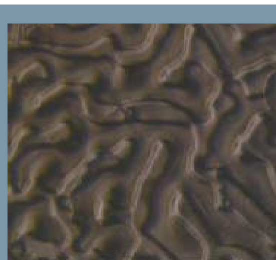
Technological Offer



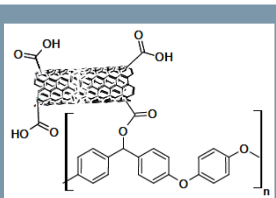
Anticarcinogenic polymer nanoparticles with high selectivity
Particles are based on a family of amphiphilic copolymers that are able to form polymer micelles at nanometric scale.

New industrial procedure for characterization of elastomeric latex in real time
A simple and economical procedure for a complete characterization of latex manufacturing process, from quality control of raw material, following with pre-vulcanization up to post-vulcanization.

New smart elastomeric materials with thermal stimuli response
An elastomeric material formed by interpenetrated ionic and covalent networks with shape memory effect which allows to respond to thermal stimuli.



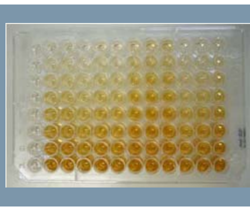
Novel one-step method to create functional wrinkles in polymeric surfaces
A method to produce structured and functional surfaces by sculpting wrinkles on polymeric materials in a controlled manner.



Polymer nanocomposites with high thermal, mechanical and electrical performance for structural applications in aeronautical and aerospace engineering
A polymer nanocomposite with thermal, mechanical and electrical properties drastically improved due to excellent filler dispersion in polymer matrix and to an optimal filler-matrix interface adhesion.

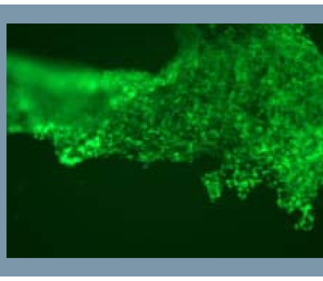
Technological Offer

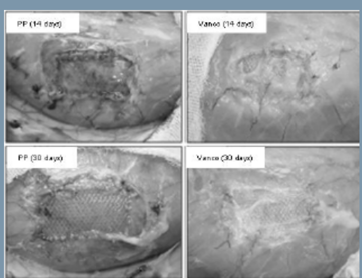
Functionalization of polystyrene surfaces in a low cost and controlled way, maintaining its transparency, for applications in biomedicine and pharmacy
Method to functionalize polystyrene surfaces in a controlled way.



Ionic liquids with low viscosity as electrolytes in electrochemical devices for energy storage
A new family of Ionic Liquids (ILs) with tiazole-like core structure, which possess high ionic conductivity, thermic & electrochemical stability, low viscosity and no inflammability.

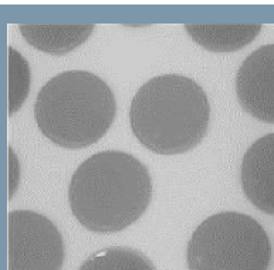
Multicomponent hydrogels for in vitro cell manipulation
A new generation of multicomponent hydrogels based on vinylpyrrolidone that can be obtained in a simplistic one step process.



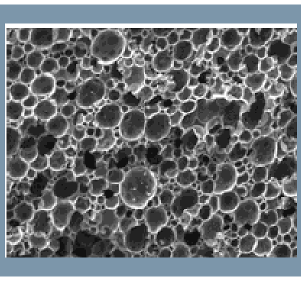


Novel polymeric coating for bioactive agents release in prosthetic meshes that avoids post-operative infections
A multilayer dressing that
improves compromised wound and ulcers healing, in particular this dressing is suitable to treat
patients with diabetes, elderly patients and/or people with reduced blood flow

Novel multilayer dressing for compromised wound healing
Polymeric foams based on epoxy resin filled with nanostructured carbon materials. These foams exhibit higher conductivities and permittivities than conventional foams.



Technological Offer



Rigid polymer foams with good electrical conductivity
Polymeric foams based on epoxy resin filled with nanostructured carbon materials. These foams exhibit higher conductivities and permittivities than conventional foams.