The scientific interests of IPCF center around the study of condensed matter with particular attention to the thermodynamics of the collective processes responsible for the behavior and properties of materials on a mesoscopic scale. Such an intrinsically interdisciplinary activity is characterized by strong international competitiveness, touching aspects relevant to physics, chemistry and materials engineering. Research objectives move from interests purely motivated by scientific curiosity, such as the understanding of the general mechanisms underlying phenomena of self-aggregation and self-organization responsible for the macroscopic properties of complex systems, and then turn to the design and characterization of materials for specific applications and technology transfer in strategic areas as sensors, environment, energy, health, aerospace, with major technological implications, such as: development of organic nanostructures and semiconductors for electronic and photovoltaic applications, development of sensors in guided optics (SERS, TERS, TERS imaging, etc.), creation of materials with predetermined properties (mechanical, thermal, optical, magnetic, electrical). In addition, IPCF is engaged in the design and construction of experimental lines in large scale neutron facilities.

What We Are Doing

Research activities carried on at IPCF are intrinsically inter-disciplinary, spanning chemical, physical and life science topics, and their interrelation. Different areas in soft and condensed matter are covered:

- Life Science, for isolation, reconstitution and investigation of biomaterials for energy conversion and molecular recognition;
- Materials science, for synthesis of nanostructured materials, both inorganic and organic, and their manipulation and self-organization for optoelectronic, biomedical and environmental applications;
- Design and optical characterization of nanoaggregates, interfaces and hybrid systems of photochemical interest, for sustainable energy generation and catalysis;
- Physico-chemical characterization of thermal, electrical, and optical properties of materials and systems of interest by dedicated development of measurement tools and methods with specific sensitivity;
- Multi-scale computational modelling of molecules, supramolecular systems, and hybrid interfaces for applications in medicine, (bio-)optoelectronics, and catalysis.

Human Resources

Researchers: 13
Technologists: 11
Technicians: 1
Administratives: 1

Patents

PON TARANTO

The project TARANTO aims at the development of an ensemble of technologies suitable to generate renewable energy, and consequently achieve remediation effects in the polluted environmental compartments, thus favouring circular economy and decarbonization practices. The proposed innovative technologies intend to promote efficiency, transforming wastes ((waste water, sludge, biomass from remediaation) in renewable energy sources, stimulating a profound reconsideration of how to produce and use energy and doing business.

INCIPIT

The aim of the project is the implementation of bioartificial scaffolds with the potential to serve as acellular patches for in vivo cardiac regeneration. In particular, electroconductive polymers will be tested in order to improve cardiac commitment. The protection against ventricular remodelling and recruitment of stem cells in situ will be pursued using advanced nanotechnologies. The therapeutic product will be validated in vitro using stem and precursor cells, cardiomyocytes derived from induced pluripotent stem cells, cell-sheet technology and in vivo using a small animal model. The INCIPIT cardiac patch technology will move this material-based product closer to the market of smart therapies in the cardiovascular field.

ACTIVE MATTER ITN

This is an MSCA ITN project composed by 14 Beneficiaries and 9 Partner Organisations from 9 different countries, and focuses on experimental, theoretical and computational aspects of active matter. The aim of the network is to train a new generation of physicists and engineers with the scientific insight and managerial skills to harness active matter at mesoscopic and nanoscopic length-scales and to exploit it in high-impact applications (e.g. the design and fabrication of biomimetic materials, the targeted localization, pick-up and transport of nanoscopic cargoes, drug delivery, bioremediation and chemical sensing).

ADVANCED MATERIALS: disordered optical media are an emerging class of materials useful to investigate light transport phenomena and for applications in imaging, sensing and energy storage. @IPCF it has been possible to image Rayleigh scattering, photoluminescence and weakly localized Raman light from a random network of silicon nanowires via real-space microscopy and Fourier imaging.

GREEN CHEMISTRY: within the European Project Life “Clean up” (LIFE 16 ENV/ES/000169), aiming at finding sustainable, low cost and efficient processes of “Green Chemistry” and “Green Economy”. IPCF synthesized and deeply characterized recyclable cyclodextrin-based nanosponges suitable to purify treated water from emerging pollutants.

COMPUTATIONAL MODELLING: we highlight an original multiscale computational approach to predict the morphology of carbonaceous materials via dynamic reactive massaging of the potential energy surface (DynReaxMas), which uses the ReaxFF reactive force field in a simulation protocol that combines potential energy surface transformations with global optimization within a multidescriptor representation.