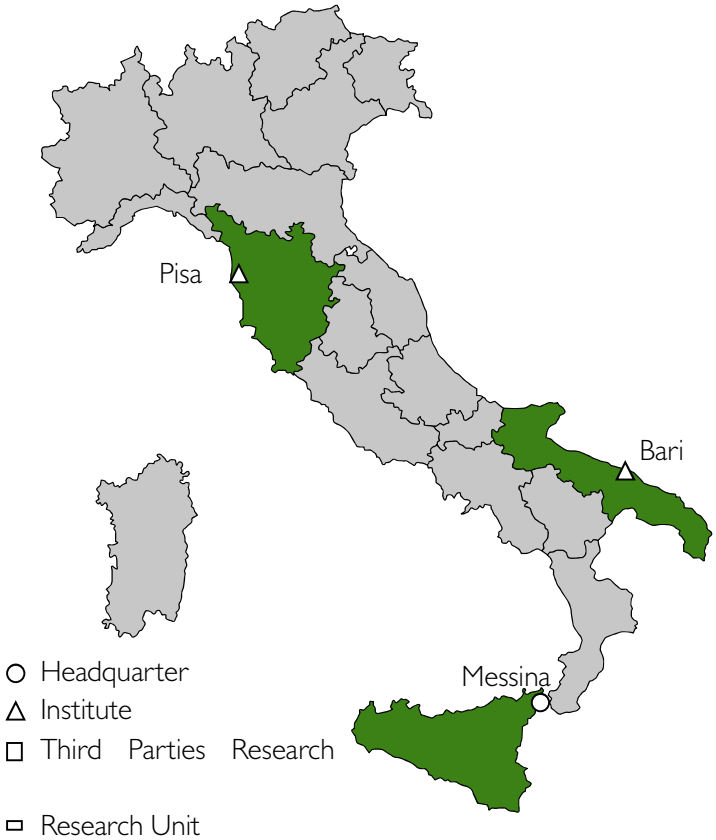
Institute of Chemical and Physical Processes

Director: **Dr. ONOFRIO M. MARAGO'**

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, cultural heritage with major technological implications, such as: development of organic nanostructures and semiconductors for electronic and photovoltaic applications, development of sensors with plasmonic nanomaterials (SERS, TERS, TERS imaging, etc.), creation of materials with predetermined properties (mechanical, thermal, optical, magnetic, electrical).

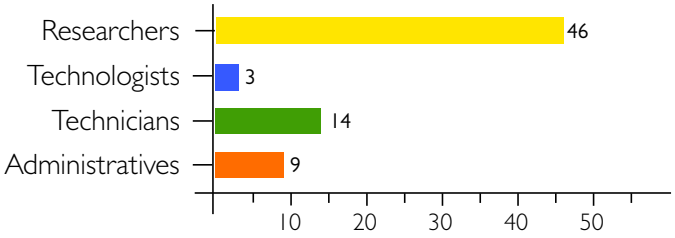


What We Are Doing

Research activities carried on at IPCF are intrinsically inter-disciplinary, spanning chemical, physical, life science topics, and their interrelation with key assets for materials, energy, cultural heritage, health, and environment. Different areas in soft and condensed matter are covered:

- Life Science, for isolation, reconstitution and investigation of biomaterials for energy conversion, molecular recognition and tissue interaction;
- Materials science, for synthesis of nanostructured materials, both inorganic and organic, 2D materials, and their manipulation and self-organization for optoelectronic, biomedical, energy, cultural heritage, 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 advanced analytical tools and methodology with ultrahigh sensitivity;
- Environmental acoustics for the evaluation of environmental noise exposure from anthropogenic sources, for comparisons with normative limits or for health-effects evaluations, acoustic modelling of transport infrastructures, wind farms, industries, strategic planning of innovative mitigation solutions, acoustic beamforming;
- Multi-scale computational modelling of molecules, supramolecular systems, and hybrid interfaces for applications in medicine, (bio-)optoelectronics, and catalysis.

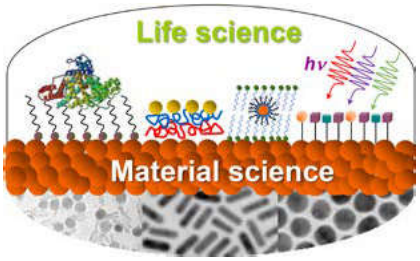
Human Resources

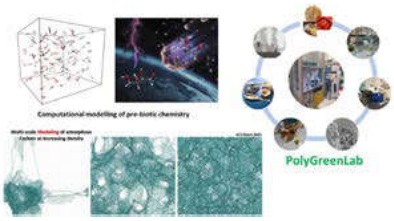


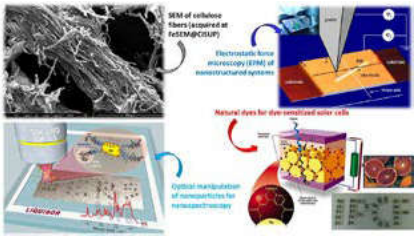
Patent

- US Patent App. 16/754,449, 2020 - Compound for the preparation of rubber products. P Stra'', G Cossu, MC Palumbi, R Comparelli
- US Patent App. 16/652,456, 2020 - Silica based nanomaterials as substituted for ZnO in rubber compouunds and preparation thereof. G Cossu, MC Palumbi, R Comparelli, V Margiotta

DSCTM
Department of Chemical Sciences and Materials Technology





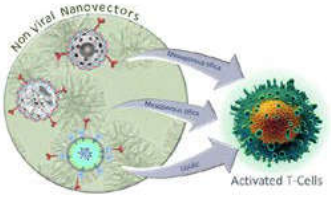


Our Projects

PON TITAN

Project manager
DR. N. DEPALO

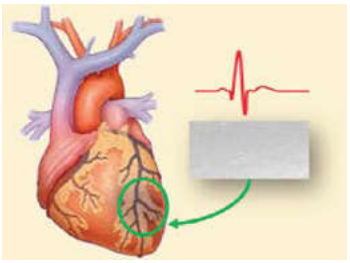
Immunotherapy with genetically modified T cells (CAR-T) has obtained important results bringing its use to the commercialization of its therapy and its use to treat different types of tumors and diseases, etc., but is still very expensive. TITAN project aims at making cancer immunotherapy with safe, efficient and easily accessible CAR-T by developing: i.) a fully automated platform for in-process monitoring of cultures of the engineered T throughout the production phase and ii.) novel synthetic vectors for the transduction of primary T cells as safer alternative to the current viral vectors. Within the latter scope, the role of CNR IPCF Bari in the project is the development of lipid or mesoporous silica nanoparticles as targeted non-viral nanovectors, for promoting T-cells activation and nucleic acid transduction. TITAN outcomes are expected to access a radically new and sustainable treatment for cancer.



INCIPIT

Project manager
DR. C. CRISTALLINI

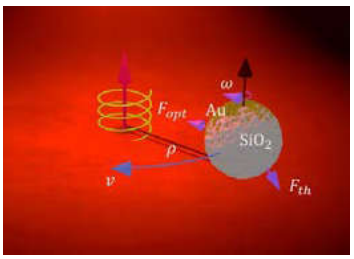
The aim of the project is the implementation of bioartificial scaffolds with the potential to serve as acellular patches for in vivo cardiac regeneration. In particular, electroconductive polymers will be tested in order to improve cardiac commitment. The protection against ventricular remodelling and 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.



ACTIVEMATTER ITN

Project manager
DR. M. A. IATI'

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).



Excellence of the Institute

ADVANCED SPECTROSCOPIC TECHNIQUES: we use advanced spectroscopic techniques for environmental and cultural heritage applications. We combine Raman/Photoluminescence spectroscopy with optical and acoustic trapping to develop unique tools for micro/nanoplastics analysis in liquid and dust particles in air/vacuum, overcoming the technological gaps in environmental sciences and space applications. Furthermore, SERS active substrates combined with advanced spectroscopic techniques are crucial for analytical characterization of paintings, mosaics and artifacts for cultural heritage applications (Projects PNRR_SAMOTHRACE, MICROPLASTIQUE, and PNRR Space-It-Up).

ENERGY & ENVIRONMENT: PNRR NEST and H2 projects deal with the synthesis and investigation of advanced nanostructured materials for solar energy conversion and with biomass valorisation. IPCF is also involved in monitoring and remediation activities related to environmental pollution. Recyclable agri-food waste based adsorbents are synthetized to purify treated water from emerging pollutants, and photocatalytic nanomaterials are successful applied in the degradation of atmospheric and water pollutants and in the conservation and protection of cultural heritage. IPCF is also exploiting microorganism for bio-remediation of water and soil. IPCF is also involved in "In-Pair" (INvestigation of Plastics And bIoplastics degRadation) on the study of the behavior of microplastics in marine environments with the aim to follow the aging/degradation with time of commercial plastic pellets and items by morphological, spectroscopic and thermal investigation. Moreover, IPCF collaborates in "SeaCleaner Pellets Watch" for monitoring, mapping, and characterizing the physical-chemical properties of aged plastic pellets collected on Italian beaches.

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. Advanced supercomputing techniques are routinely employed to investigate the behavior of condensed matter under extreme conditions as well as to shed light on the chemical origins of life (i.e., prebiotic/astrochemistry).

Website: http://www.ipcf.cnr.it
Address: Viale Ferdinando Stagno d'Alcontres, 37
98158 - Messina
Tel: +39 090 39762 200 Fax: +39 090 39762 252