National Research Council of Italy

Department of Chemical Sciences and Materials Technologies

Director: Prof. Lidia Armelao

DSCTM
Department of Chemical Sciences and Materials Technology

Department

Director: **Prof. LIDIA ARMELAO**

DSCTM carries out strategic and applied research in every field of chemistry, molecular sciences and advanced materials playing a key role in promoting, coordinating and designing a wide range of interdisciplinary projects. Scientific excellence, size and capacity for collaborative research at both national and international levels, make DSCTM one of the most important Italian scientific centers for chemical sciences and materials technology.

The Department activities tackle primary scientific and social challenges that distinguish the first part of the 21st century: the health, care and well-being of people throughout their lives, the design of new materials and the exploitation of renewable energy resources, the development of green and sustainable solutions to build economic growth according to the principles of circular economy.

Inspired by the Sustainable Development Goals of Agenda 2030, aim of DSCTM is to promote prosperity while protecting the planet, and to address a range of social needs including health and job opportunities, while facing climate change and environmental preservation.

DSCTM, with 11 research Institutes and about 1000 researchers, technologists and technicians, is able to develop multidisciplinary coordinated projects, combining blue-sky scientific research with technology transfer and process innovation.

Research Areas

GREEN CHEMISTRY

CHEMISTRY FOR LIFE SCIENCES

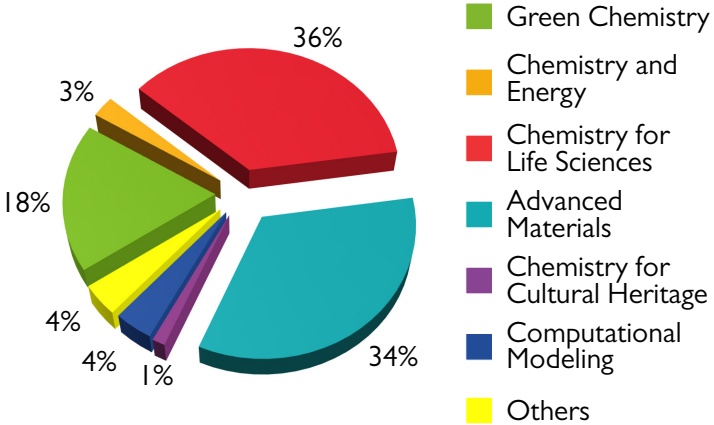
CULTURAL HERITAGE

CHEMISTRY AND ENERGY

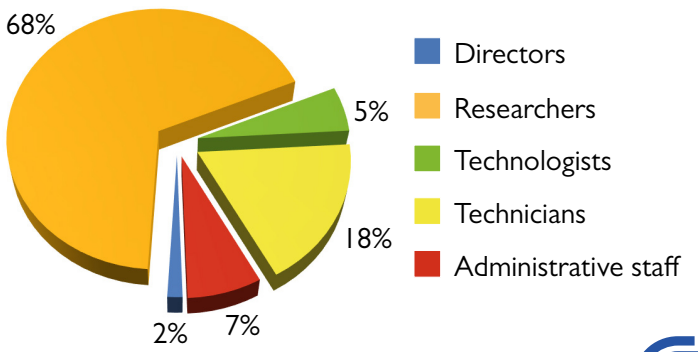
ADVANCED MATERIALS

COMPUTATIONAL MODELING

Patents



Human Resources



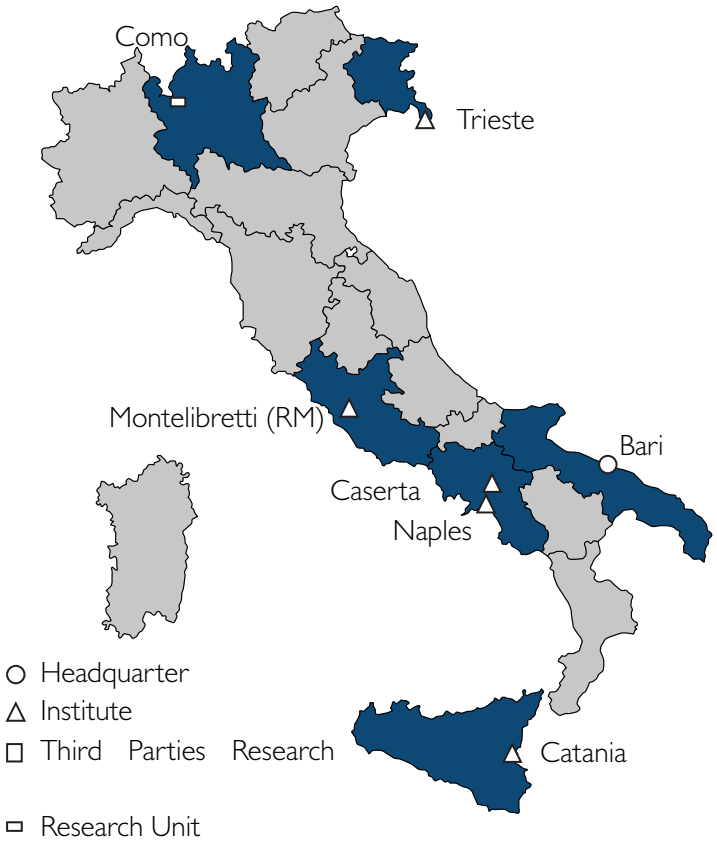
Institutes

11 institutes are within the department (IC - Institute of Crystallography; ICB - Institute of Molecular Chemistry; ICCOM - Institute of Chemistry of Organometallic Compound; ICMATE - Institute of Condensed Matter Chemistry and Technologies for Energy; IPCB - Institute of Polymers, Composites and Biomaterials; IPCF - Institute of Chemical and Physical Processes; ISMN - Institute of Nanostructured Materials; ISOF - Institute of Organic Synthesis and Photoreactivity; ISTEC - Institute of Science and Technology for Ceramics; ITM - Institute on Membrane Technology; SCITEC - Institute of Chemical Sciences and Technologies). These institutes, spread all over the wole country, carry out advanced research activity and are distinguished for competences, experimental facilities and the excellence of it's researchers.

Institute of Crystallography

Director: **Dr. CINZIA GIANNINI**

The Institute of Crystallography (IC), officially active since 2002, with headquarters in the CNR Research Area in Bari, is also in Trieste (Elettra synchrotron in the Science Park Area of Basovizza), Como (Department of Science and High Technology of the University of Insubria), Rome-Monterotondo (Research Area of Rome 1, Montelibretti), Caserta (Vanvitelli University, Department of Pharmacy), Napoli (Santobono-Pausilipon Hospital), Catania (Research Area of Catania). The IC, through the Trieste unit, co-manages (50%) the X-Ray Diffraction 1 (XRD1) beamline at the Elettra synchrotron, for macromolecular crystallography and material science studies.

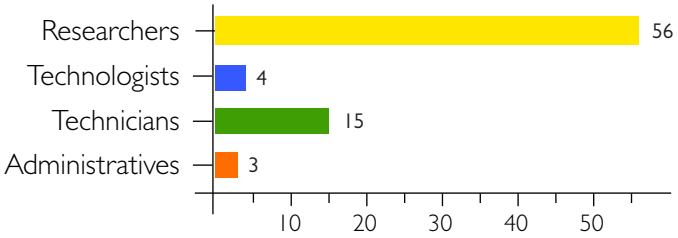


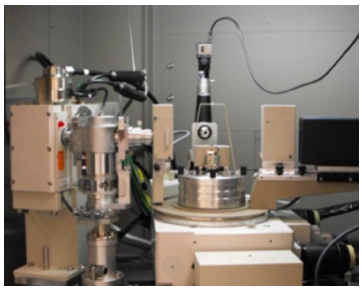
What We Are Doing

The Institute of Crystallography operates at international levels of excellence in three main application areas: Health, Materials, Environment in a systemic approach (one-health oriented). Precisely, it deals with research in the field of chemistry, physics, structural and functional biology, with studies in human and animal health, in the health of ecosystems, and in new materials with applications in energy, environment, medicine, covering the following list of activities:

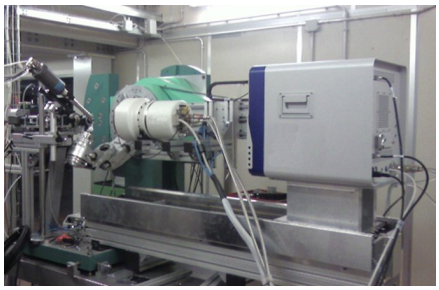
- Development of innovative, theoretical, computational, and experimental crystallographic methodologies, and their applications for the study of crystalline and non-crystalline matter through X-rays, electrons, and neutrons.
- Development of instrumentation, methods, and dedicated set-up for experimental applications of X-ray scattering from conventional sources, synchrotron, and neutron light.
- Structural and microstructural studies of nanomaterials and biomaterials of scientific and technological interest.
- Synthesis and study of the structure-activity-function relationships of inorganic, organic, bioinorganic, and pharmaceutical compounds.
- Molecular design, synthesis, production, crystallization, structural and functional characterization of biomolecules, in solid or liquid phase, also in interaction with ligands and / or metals, for biotechnological and / or pharmaceutical applications.
- Studies of processes and products of biotechnological interest and development of innovative biosensors and sensors.
- Development of imaging approaches for multidisciplinary research.

Human Resources





X-ray Powder Diffractometer (RINT2500).



X-Ray Diffraction 1 (XRD1) beamline at the Elettra synchrotron.

Computational tools for structural investigations of biomolecules and materials.

Our Projects

E-CROME

Project manager
DR.
V. SCOGNAMIGLIO

E-CROME proposes the development of biosensors for measuring blood counts and electrolytes to support cancer patients. The goal is to create a new research group of excellence for the development of integrated biosensors for telemedicine in the oncology field by responding to the priority topics included in S3 such as oncology, in vitro devices, biosensors and telemedicine with a strong social and economic impact. In this context, the IC proposes the development of an electrochemical biosensor for the measurement of hemoglobin, by means of the immobilization of antibodies with the electrospray ionization technique.

ITACA.SB

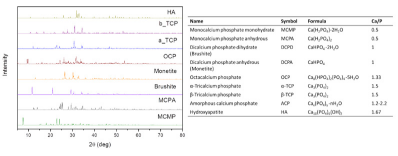
Project manager
DR. M. SAVIANO

ITACA.SB project aims to enhance the Italian pole of the Instruct-ERIC European infrastructure, present in the ESFRI Roadmap since 2006 and Landmark of ESFRI, based at the CERM in Florence, and to implement distributed platforms dedicated to the structural biology of CNR in Italy. This action aims to facilitate researchers' access to cutting-edge instrumentation and expertise in structural biology to support scientific research excellence.
The main objectives of the ITACA.SB project are: to maintain the excellence of the Italian Instruct-ERIC center in the world; support the competitiveness of the Italian scientific community at European and international level and strengthen synergies with the other IRs of the ESFRI Roadmap in the Health and Food sector. The project also includes numerous training activities aimed at expanding the use of structural biology technologies by the Italian scientific community, as well as ensuring a high level of competence of the personnel involved in providing the service.
ITACA.SB will allow access to the infrastructural structures to scientists from European universities and research centers, but also to personnel from companies interested in the development of new technologies.

BONE++

Project manager
DR. F. ATTANASIO

BONE++ aims at the development of Micro and Nanotechnologies for the Prediction, Diagnosis, Therapy and Regenerative Treatments of Pathological Changes of Bone and Osteo-Joints. The project will have as its objective the development of advanced technological demonstrators based on micro and nano systems around 4 main topics related to bone and osteoarticular pathologies: molecular diagnosis and genetic predictivity; therapy; osteochondrial regeneration; bone implants.
The results of the optimization of the formulations will be evaluated in terms of increased tissue bioavailability of the active ingredient. Derivatization of 3D hydroxyapatite-based scaffolds by systems inorganic compounds that can improve both regeneration osteochondral (Cu chelators) will be studied.



Excellence of the Institute

The main and promising research lines covers the following relevant scientific area:
Crystallographic methods. IC is one of the world leaders in the development of innovative crystallographic methods. The developed packages for structural resolution (SIR, EXPO), crystalline phase identification (QUALX), X-ray scanning microscopy (SUNBIM), multivariate analysis of unidimensional profiles (ROOTPROF), for searching and analyzing crystal-chemical information (OChemDb), for nanomaterials characterization with total scattering methods (DEBUSSY) are well known in the international scenario and downloaded by hundreds of thousands of users worldwide.
Structural Chemistry. More promising research on new ligands is performed by X-ray powder and single crystal diffraction with application in medicinal chemistry, cultural heritage materials and minerals.
Material Science. IC offers excellent scientific competences and state-of-the-art instrumentation to image structure and morphology of smart nano/bio/materials at the nano and atomic scale, encompassing diverse disciplines.
Biotechnology for agri-food field. Biosensors are developed to detect environmental pollutants, and address food quality and safety issues.
Structural Biology. High impact research is in progress on proteins or oligonucleotides and their complexes with biological molecules, with the aim to drive the design of new molecules with application in early diagnosis and in therapy.

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Institute of Biomolecular Chemistry

Director: **Prof. ANGELO FONTANA**

The Institute of Biomolecular Chemistry (ICB) fosters the chemical study in any sector of life science and sustainable use of natural resources, occupying a multi-disciplinary area in which the methods and approaches of organic and bio-organic chemistry are applied to biology, medicine, and environmental protection. The mission of the Institute concerns the research and development of chemical reactions and organic molecules of interest in biology and sustainability, intending to understand their function and explore their applications. The ICB was born on 15th February 2002 from the union of 3 former Institutes and 3 Centers of CNR but the original core dates back to the late sixties. In the present form, the Institute is composed of more than 100 units of personnel distributed in four sites including the institutional headquarters in Pozzuoli at the north of Naples and 3 branches in Catania, Padua, and Sassari.

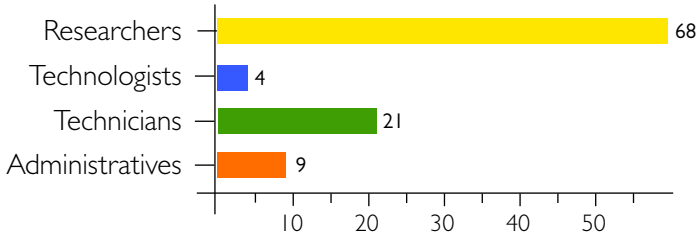
The Institute promotes basic and applied research through national and international projects with public and private collaborators in favor of scientific and social progress in human well-being (therapeutics, diagnostics, food ingredients, nutraceuticals, and cosmeceuticals), bio-based and eco-friendly technology, green chemistry, marine and extreme environment exploration. The ICB also offers research infrastructures for the analysis of single metabolites (marker analysis) and molecular pools (metabolomics, glycomics and lipidomics), the structural characterization of small molecules, the identification of biological and pharmacological properties, the study of the mechanism of action of bioactive compounds, the synthesis and functionalization of organic chemicals, the extraction and purification of natural molecules, fermentation and biomass production.

What We Are Doing

The ICB copes with R&D in the bio-medical, agro-food, biotechnology, and green-economy sectors by virtue of experience in chemical synthesis, supramolecular chemistry, pharmacology, cellular biology, chemical and enzymatic catalysis, biosynthesis and metabolism, biochemistry, extraction techniques, chromatography, nuclear magnetic resonance and other spectroscopic methods, mass spectrometry and related techniques (MS cytometry, GC- and LC-MS/MS analysis), NMR- and MS-based metabolomics and lipidomics, fluorescent and isotope-labeled probes, microscopy, whole-cell transformation and fermentation from laboratory scale to large industrial reactors. This expertise contributes to the formation of five major research platforms committed to innovative programs in:

1) Human Health: drug discovery, medicinal chemistry, neuroscience, cancer research, molecular immunology, preclinical development of drug candidates, microbiome, ex vivo and in vivo model;
2) Sustainable Energy: biofuels, hydrogen from catalytic and biological processes;
3) Environment: chemical ecology, biological invasion, recycling of potentially polluting industrial waste products;
4) Agriculture and Food: novel foods, amelioration of species with nutritional value, active natural ingredients for the nutraceutical, cosmetic and veterinary use;
5) Biotechnology: valorization of agro-food residues, biotransformation by extremophilic bacteria and enzymes, CO_2-capture and valorization, biomass and bioproducts from marine microalgae.

Human Resources



Patent

- Nanostructured formulations for the delivery of silibinin and other active ingredients for treating ocular diseases, EP3203989A1
- Use and preparation of beta-glycolipids as adjuvants in vaccines, WO2014199297-A1; CN105307680-A; EP3007725-A1; US2016151483-A1; US2018344843-A1.
- Process for the sequestration of carbon dioxide and the fermentative production of organic compounds, EP2948556B1
- Peptidi e peptidomimetici inibitori delle interazioni proteina-proteina della fosfatasi SHP2 come farmaci nella terapia del cancro e di malattie rare (RASopatie) PCTEP2021055624

Fractionation of small organic molecules. The ICB has a well-established expertise in the synthesis and extraction from natural sources of bioactive molecules that are studied for their pharmacological and functional activities.

Analysis of volatile organic compounds (VOCs) by gas chromatography (GC). The ICB offers an updated array of instrumental resources for the structural characterization and analysis of organic molecules for studies in medicine, food, agriculture, and ecology.

Collection of unicellular microorganisms in liquid cultures. The ICB fosters the study of cell biology, from prokaryotes to eukaryotes, in order to address physiological or pathological issues especially related to human health, as well as to elucidate central metabolic pathways and to implement biotechnological processes.

Our Projects

Joint International Research Unit (UMI)

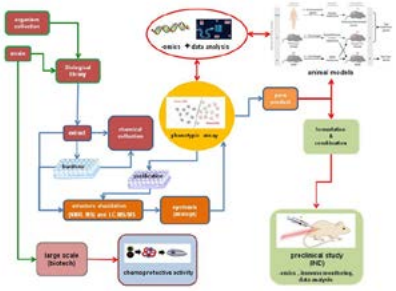
Project manager
DR. V. DI MARZO

Joint international research unit for chemical and biomolecular research on the microbiome and its impact on metabolic health and nutrition.
https://www.umilaval.cnr.it/en/
The Joint International Research Unit (UMI) is a bilateral research unit between the CNR and the Université Laval of Quebec. The UMI has among its proposed ambitious goals the development of research projects, and the innovation, education and knowledge transfer in the biomolecular study of the intestinal microbiome. Among others, the project aims at the identification of microbiome-derived bioactive metabolites and -omic characterization of the oral and gut microbiome of healthy individuals as compared to individuals with high cardiometabolic risk.

ADViSE

Project manager
DR. A. FONTANA

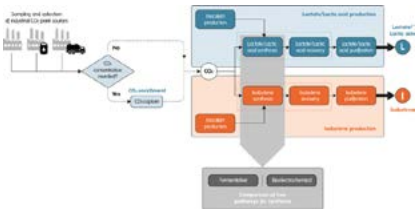
Antitumor Drugs and Vaccines from the Sea
https://www.advise.campania.it/
The project pursue the implementation of a drug discovery platform for marine natural products with chemotherapeutic and immunomodulating activity. The high-level goals are the development of anti-tumor vaccine models, taking advantage from the discovery of the molecular adjuvant called SULFAVANT, and (ii) the identification of new immunotherapeutic molecules of natural origin, (iii) chemopreventive agents. As a proof of concept, ADViSE targets neoplasms chosen from chronic forms and without validated biological markers of lung cancer, melanoma and multiple myeloma.



BioRECO$_2$VER

Project manager
DR. G. D'IPPOLITO

Biological routes for CO_2 conversion into chemical building blocks
https://bioreco2ver.eu/
The goal of this H2020 project (No. 760431) is to demonstrate the technical feasibility of non-photosynthetic anaerobic biotechnological processes for the capture and conversion of CO_2 from industrial point sources into isobutene or lactate. To this end, three hybrid enzymatic processes, including the Capnophilic Lactic Fermentation, are investigated for conversion of off gas CO_2 into the targeted end-products by fermentation and bioelectrochemical systems. The BioRECO$_2$VER project provides a further step in valorizing CO_2 and manufacturing chemicals in an alternative way.



Excellence of the Institute

The ICB is an updated technological hub for the research and development of small molecules and biotechnological processes. For the pharmaceutical sector, the activities dedicated to the analysis, synthesis and biological evaluation of small bioactive organic molecules are able to support studies of lead compounds and preclinical development of lipids, natural products, peptides, and biomarkers for oncology, immunology, and neuroscience. In this frame, an emerging point of excellence is the research of vaccine adjuvants by the activation of the innate immune system through pattern recognition receptors (PRRs) and small molecules and glyco-conjugates.

The Institute makes available a collection of molecules and extracts, and a database with information on molecules discovered in our laboratories. The ICB also harbors impactful research on the endocannabinoid signaling system and on the pharmacological potential of cannabis. In biotechnology the Institute conducts research in the development and implementation of processes based on extremophilic and whole-cell enzymes for the biological mitigation of CO_2 and for the production of biofuels, hydrogen, food ingredients and functional and / or bioactive compounds from the conversion of natural matrices and agro-food residues.

Website: www.icb.cnr.it
Address: Via Campi Flegrei, 34
80078 - Pozzuoli (NA) - Italy
Tel: +39 081 8675026 - Fax: +39 081 8041770

Institute of Chemistry of Organometallic Compound

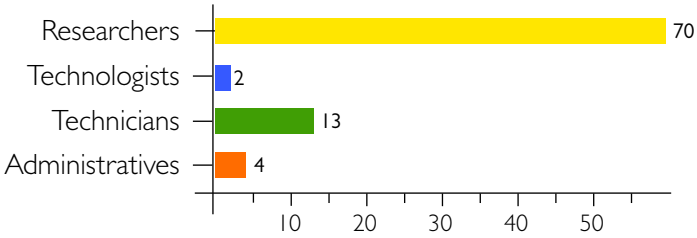
Director: **Dr. CLAUDIO SANGREGORIO**

The Institute of Chemistry of Organometallic Compounds (ICCOM) was founded in 2001, merging former ISSECC (Institute for the Study of Stereochemistry and Energetics of Coordination Compounds), founded by Luigi Sacconi in Florence in the 1970s, with three CNR Centers located in Florence, Pisa and Bari, to create a CNR chemistry institute initially mainly focused on organometallic chemistry, homogeneous and heterogeneous catalysis. Since 2006, ICCOM manages the Center for Electronic Microscopy (Ce.M.E.), located within the CNR Florence Research Area, a reference laboratory in the field of electronic microscopy available to CNR Researchers, Universities and the manufacturing and industrial world. In 2011, the expertise in analytical chemistry, spectroscopy methods for health, materials science and cultural heritage, and theoretical chemistry were enhanced by the arrival of more CNR researchers, who joined the ICCOM Secondary Site in Pisa. A Third Party Research Unit (URT) of ICCOM is located at the Department of Chemistry of the University of Trieste, collaborating on research in nanotechnologies, heterogeneous catalysis and new materials for production of energy from renewables. In 2023 ICCOM has 89 staff units, of which 70 researchers, 2 technologists, 13 technicians and 4 administration personnels. Moreover, the Institute also had a large number of University associates (30) and many young scientists among PhD students and postdocs (30). ICCOM has established over the years a large number of collaborations in Italy and abroad, spanning from universities, to public institutions, research centers, companies, NPOs, consortia and foundations, across many countries in Europe and worldwide.

What We Are Doing

The mission of the Institute is to develop fundamental and applied research together with advanced training in the following fields of chemistry and materials sciences:
- Green chemistry and sustainable processes: toward high efficiency and selectivity by catalytic and stoichiometric processes optimisation and use of renewables;
- Catalysis, electrocatalysis and photocatalysis for the production of energy;
- Photovoltaic solar cells: organic and organometallic compounds for new generation solar cells;
- Hydrogen chemistry and technology: production, storage and use in fuel cells;
- CO_2 chemistry and technology: valorisation (CCU) and capture (CCS);
- Organic, inorganic and hybrid polymeric materials with tailored functional properties;
- Organic chemistry and magnetic materials for pharmaceutical and medical applications;
- Advanced analytical and spectroscopic techniques for the environment, health and conservation of the artistic and cultural heritage;
- Theoretical and computational chemistry for predictive modeling.

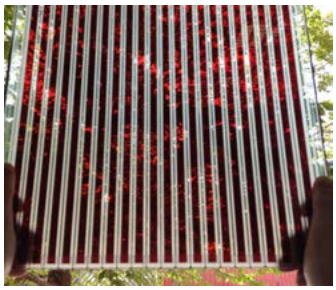
Human Resources



Patent

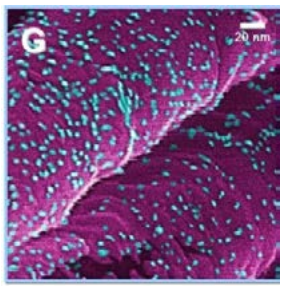
- Coating material for producing an adsorbent, porous, flexible coating for a heat exchanger and method for producing said coating material, World Patent No. WO2020120142A1, 2020.
- Use of exfoliated black phosphorus for the treatment of bone cancers, World Patent No. WO2020049475A1, 2020.
- Hydrometallurgical process for the treatment of lithium batteries and recovery of the metals contained therein, European Patent No. PCT/IT2019/050013, 2019.

DSCTM
Department of Chemical Sciences and Materials Technology



DSSC photovoltaic module containing the SB2 photosensitizer synthesized at ICCOM, manufactured in collaboration with the University of Peloponnese (Patras, Greece).

Dual beam Gaia Tescan avaialble at Ce.M.E.



Scanning Electron Microscopy (SEM) image of titanium-web substrate nanotubes photocatalyst with the addition of Pd (0.26 wt.%).

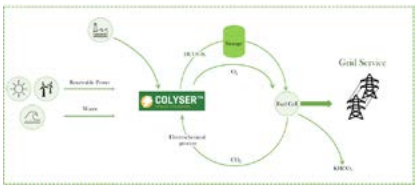
Our Projects

HORIZON-RIA "FRESH" (2022-2025)

FRESH

Project manager
DR. H. A. MILLER

FRESH aims to reducing the EU's dependence on fossil fuels for power generation, providing a cushion for the intermittent character of renewable electricity generation leading to stable, more predictable prices for renewable electricity. The project will achieve this through the development, construction and validation at TRL 4, of an integrated, cost competitive process for conversion of CO_2 to potassium formate using an electrocatalytic process powered by renewable electricity and its subsequent conversion to electricity on demand by a direct fuel cell system. (http://www.iccom.cnr.it/horizon-eu-fresh/)



EU- EIT Raw Materials "INSPIRES" (2021-2024)

INSPIRES

Project manager
DR. C. SANGREGORIO

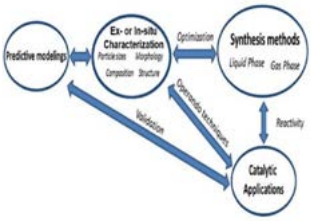
The EU-EIT Raw Materials Project INSPIRES aims at recovering and supplying Rare-Earths within the EU through radical innovations in the recycling of permanent magnets, focusing on one of the most readily available sources: home appliances. INSPIRES will optimize methods at industrial scale for sustainable extraction and recycling and use of recycled magnets in new motors. The consortium, led by CSIC (Spain), includes CNR, German and Danish universities, Slovenian research centres and companies. (https://www.inspires-magnet.eu/)

H2020-MSCA-ITN-2018 "BIKE" (2019-2023)

BIKE

Project manager
DR. A. FORTUNELLI
DR. C. EVANGELISTI

Combining two metals is an effective method of tuning the performance of a catalyst; its properties can be superior to those of either of the constituent elements. Funded by the MSC Actions programme, BIKE will introduce a holistic method for developing next-generation bimetallic catalysts for use in the production of either green or blue hydrogen. BIKE will provide 14 early-stage researchers with international and interdisciplinary training in the field, spanning the entire spectrum of catalyst development, including synthesis and characterisation, modelling, industrial applications and marketing activities.



Excellence of the Institute

The Institute is a Center of Excellence, principally but not only in the fields of "Green Chemistry and Sustainable Processes" and "Renewable Energy". The research activities carried out at ICCOM cover aspects of the hydrogen economy, such as production from renewable resources (e.g. biomass), storage and utilization. Innovative photovoltaic devices are developed, focusing on organic dyes design, and engineered for energy and hydrogen production, the latter from photochemical water splitting. Catalytic, photo- and electrocatalytic processes that convert carbon dioxide with high efficiency into fuels or chemical compounds are also studied. Excellence at ICCOM can also be found in other research fields such as catalysis for green chemistry, environmental technology, conservation of cultural heritage, advanced polymers, analytical chemistry and nanomaterials for biomedical and energy applications. ICCOM has also a highly qualified group of computational chemists that brings expertise and top scientific contributions to the institute and DSCTM. The Electron Microscopy Centre of the CNR Research Area of Florence, associated to ICCOM, represents a laboratory of excellence for advanced characterization of various materials, attracting interest and financing opportunities from both public and private sectors.

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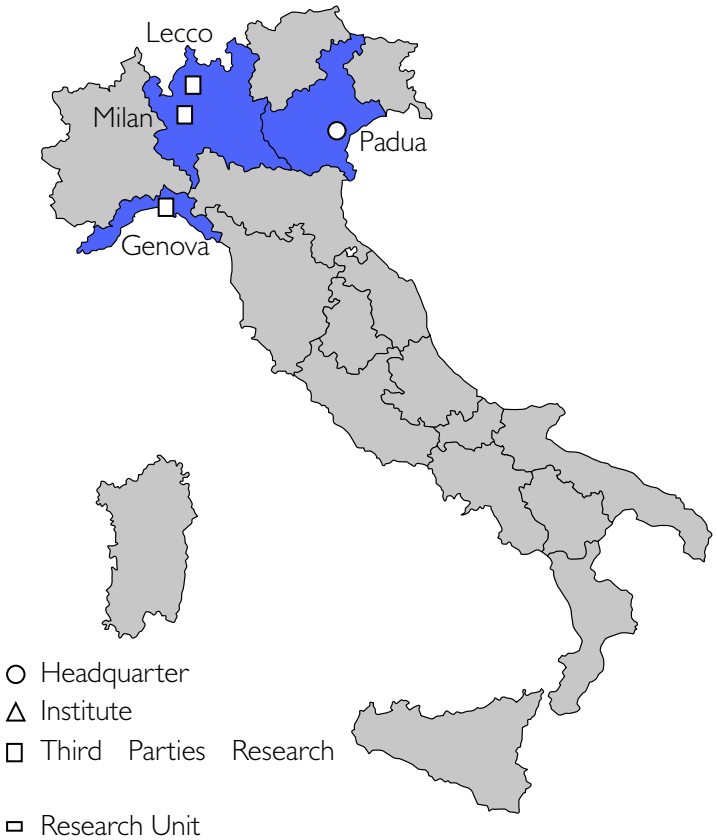
Institute of Condensed Matter Chemistry and Technologies for Energy

Director: **Dr. MARIA LOSURDO**

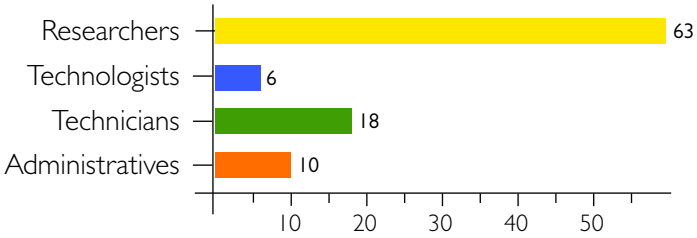
The Institute of Condensed Matter Chemistry and Technologies for Energy (ICMATE), founded in 2016, is a multidisciplinary institute involved in several aspects of materials research with special attention to applications in the field of sustainable energy and growth.
With four units (Genova, Lecco, Milano, Padova) in three Italian regions (Liguria, Lombardia, Veneto), ICMATE is a distributed and interconnected network of laboratories, present also at the University of Padova, operating under the stimulus of different, though converging, viewpoints of chemists, physicists and engineers, with the aim to solve complex problems facing society today and in the future.
The Institute has a consolidated background on the design and synthesis of complex molecules, theoretical modeling at different scale lengths, understanding and prediction of composition-structure-property relationships in materials of different dimensionality, impact of microstructure and surface functionalization on properties.
Research at ICMATE is devoted to the development of innovative molecular systems, soft matter, functional surfaces and interfaces, inorganic, metallic and hybrid materials for applications in emerging technologies for energy sustainability and efficiency, advanced manufacturing and the biomedical field.
ICMATE coordinates many national and international research projects. Owing to its geographical spreading, the institute actively participates in regional networks, innovation clusters and actions in collaboration with universities, other research centers and companies.
It is actively involved in technological transfer processes from the lab-scale to the industrial level providing a technical-scientific support to enterprises. This fosters consulting activities to public institutions and business, and transfer of knowledge to relevant stakeholders.
ICMATE promotes science to students and citizens, giving an important contribution to educational and professional programs.



What We Are Doing

The research is focused on the strategic areas of renewable energy, energy harvesting and efficiency, reduction of carbon footprint, advanced manufacturing, and nanomedicine.
We combine advanced characterization techniques with theoretical and experimental expertise to predict and correlate the compositional and structural characteristics of compounds, nanoscale systems and materials to their functional micro- and macroproperties, and performances.
The activities include the innovative synthesis of molecular systems and inorganic materials including films, nanostructures and colloids, the fabrication of bulk alloys, ceramics and composites, the design and control of their surfaces and interfaces, the development of prototype instruments and new methods of analysis, the study of functional surfaces, (photo)catalysts and coatings for innovative technologies of interest in sustainable energy, hydrogen production and separation, advanced metallurgy, cultural heritage, biomaterials and nanomedicine.

Human Resources



Patent

Over the years, ICMATE researchers have deposited several patents ranging from advanced manufacturing, functional surfaces and interfaces and sustainable materials. The most recent example is a patent on a composite made by a geopolymer and construction and demolition waste material mixture, suitable for building and design elements such as ventilated facades or for buildings hydronic heating/cooling. The patent is now under international extension.

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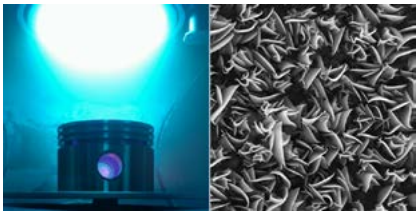
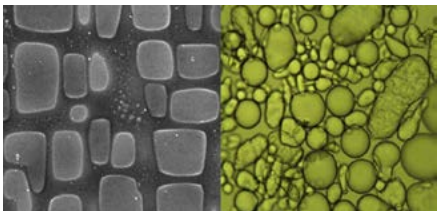
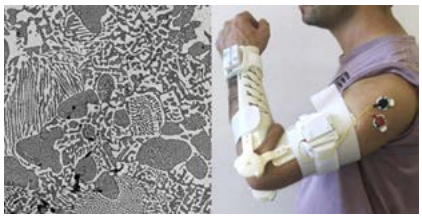


Vapor phase deposition is used for applications such as protective coatings (left) and photocatalytic films (right).



Biphasic systems can be fabricated at both the solid state (left) and the liquid state (right, emulsion).



Complex alloys find application, for example, in thermoelectric devices (left) or orthoses (right).

Our Projects

ADJOINT

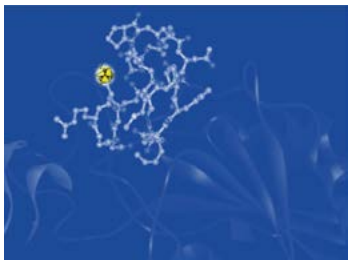
Project manager
DR. A.TUISSI

Additive manufacturing by binder jetting of sintered metallic components for osseointegration.
The ADJOINT project is funded by Istituto Nazionale Assicurazione Infortuni sul Lavoro (INAIL) and is focused on developing osseointegrated prostheses for the treatment of finger amputations. The project activities are based on the use of Additive Manufacturing technologies for the production of new implantable metal devices "fixtures" with improved osseointegration and antibacterial response tuned on the specific needs of the patient.

TARATA

Project manager
DR. C. BOLZATI

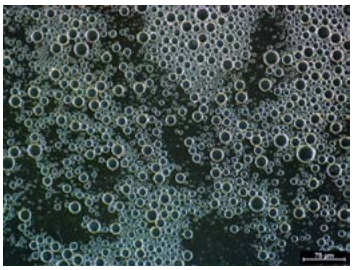
Targeting high malignant tumors with new αvβ3-selective radiopharmaceuticals for imaging and theranostic applications.
The development of highly selective αvβ3-targeting RadioPharmaceuticals (RPs) provides a new opportunity to efficiently image highly malignant tumors (e.g. melanoma and metastatic triple negative breast cancer) and their associated metastases by single-photon-emission-computed-tomography and positron-emission-tomography (SPECT/PET) along with an accurate prognostic stratification of patients. In parallel, RPs offer the unique opportunity to design a theranostic strategy in treatment of cancer of epithelial origin, especially those refractory to conventional therapy. Using the highly selective αvβ3 RGDechi peptide, a new class of RPs will be designed and developed for SPECT or PET-imaging and subsequent therapeutic applications. Results of TARATA, a project funded by Associazione Italiana per la Ricerca sul Cancro (AIRC), will have a definite impact on detection and therapy of highly aggressive tumors.



EDDI - Emulsion Dynamics and Droplet Interfaces

Project manager
DR. L. LIGGERI

EDDI is a Microgravity Application project of the European Space Agency (ESA) coordinated by ICMATE involving 14 academic and industrial partners from Europe, Japan, Russia and USA.
The project aims at increasing the comprehension of the influence of equilibrium and dynamic properties of the interfaces between surfactant solutions and oils on the dynamic and structural features of the corresponding emulsions. Experiments are planned on board the International Space Station, utilizing a facility developed by ESA for the study of emulsion aging and droplets dynamics. Within the perspective of a sustainable growth, the results of the research will support the development of models and numerical tools useful for an "on-demand" formulation of emulsion-related products (foods, pharmaceutics, cosmetics, chemistry, materials), using an optimal resource utilization (energy, surfactants, chemicals) and conjugating economical and societal benefits.



Excellence of the Institute

ICMATE operates in multiple research fields, from chemistry to materials science and engineering. Its long-term expertise on the synthesis and investigation of functional molecules, colloids, engineered surfaces and interfaces, multifunctional nanostructures, innovative materials, new architectures and devices is internationally recognized.
ICMATE balances basic and applied research to both increase knowledge and provide innovative technological solutions to both public and private sectors. It is actively involved in the transition to a lower carbon footprint society, in green hydrogen technologies, energy efficiency, water purification, advanced manufacturing, waste recycling, nanomedicine and advanced characterization of materials and interfaces.
The multidisciplinary competences in ICMATE favours its consolidated links with leading national and international research centers, remaining at the forefront of their fields. Our scientists are active in national and international communities, as editors of international journals, presidents and appointed members of scientific societies, experts in international committees for standardization, science officers at the CNR Brussels Liaison Office and as CNR representatives in European initiatives (e.g. ERA, EERA). ICMATE leads and participates to international, national and local projects and is part of technological clusters.

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Institute of Polymers, Composites and Biomaterials

Director: Dr. EUGENIO AMENDOLA

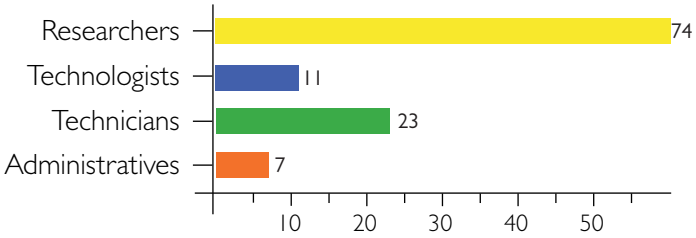
The Institute for Polymers, Composites and Biomaterials (IPCB) was founded in March 2014 by merging the Institute of Chemistry and Technology of Polymers (ICTP) and the Institute for Composite and Biomedical Materials (IMCB).
The headquarter of the Institute is in Pozzuoli and supporting units are in Napoli/Portici, Catania, Lecco and, as Third Research Unit, in Lecce at the University of Salento. The IPCB with 115 employees (85 researchers and technologists, 30 technicians and administrative, several post-docs and PhD students and 25 university associates) is the largest CNR Italian institute performing research on polymers, composite materials and related advanced technologies. The research activities, developed within the area of the Key Enabling Technologies are mainly focused on synthesis and design of advanced polymer-based materials, composites materials for functional and structural aerospace applications, development of personalized solutions in nanomedicine and health, application of chemistry and materials science for the environment and energy, storage, transport, packaging and cultural heritage. Strong partnerships are running with many institutions such as universities, inter-university research's consortium, research centres, technological districts &clusters, SMEs, both at national and international level, operating in different sectors with a focus on societal challenges.

○ Headquarter
△ Institute
□ Third Parties Research
▭ Research Unit

What We Are Doing

The research activities, based on the unique and excellent personnel competences, gained in more than 50 years, organized in the four main research platforms, named Sustainability, Advanced Materials, Health and Nanomedicine, Space&Aerospace materials and technologies, are synthetized as it follows:
– Polymers, composites and nanostructures (bio- and synthetic) with multifunctional, sensing properties and with tailored resistance to extreme temperatures; flexible polymer-based composite multilayers for critical environmental conditions; ablative materials for space re-entry;
– Advanced and sustainable processing technologies of polymers, biopolymers, composites and nanostructures; additive technologies; polymer-based films for new packaging concepts and multisensorial design;
– Synthesis, functionalization and modelling of polymer-based materials. Structural and functional characterization of macromolecules and polymer-based materials and advanced characterization techniques;
– Multiphase polymer-based materials, nanomaterials and nanostructures (synthetic and natural) for tissue engineering and regenerative/therapeutic medicine including cancer; bio-interfaces; bio-printing;
– Development of innovative nanocarriers stimuli responsive for tailored and local drug delivery;
– Structural characterization of glycoproteins for biomarkers identification;
– Knowledge and technology transfer. Outreaching.

Human Resources



Patent

- WO 2017/025829 A1. PCT/IB2016/05430. Device for fluids infusion. Carbone D.C., Recca G.R.M., Maravigna A.
- WO2021013596A1. PCT/EP2020/069695 N-alkyl-D-glucamine based macroporous polymeric cryogel for sequestering and/or removing toxic contaminants. Carroccio S.C., Cunsolo F., Mecca T, Privitera V, Ussia M, Caretti D., Scurti S.
- WO/2020/049475. PCT/IB2019/057444. Use of exfoliated black phosphorus for the treatment of bone cancers''. Raucci M.G., Ambrosio L., Fasolino I., Caporali M., Serrano Ruiz M., Peruzzini M.
- WO 2017/017610 A1. PCTIB2016/O54459. A biocomposites of biomineralized graphene oxide and its use for bone tissue engineering. Ambrosio L., Raucci M.G., Longo A., Carotenuto G., Giugliano D.

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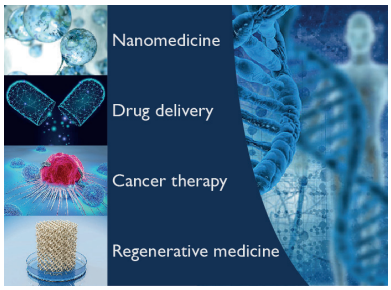
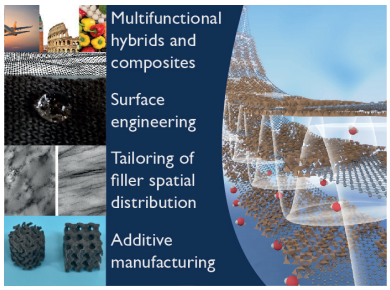
Sustainability.



Health & Nanomedicine.



Advanced Materials.

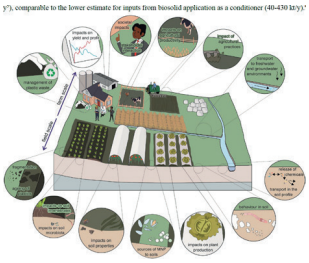
Our Projects

PAPILLONS

papillons

Project manager
DR. P. CERRUTI

Agricultural Plastics (APs) are essential in farming, but can release chemicals and micro- and nanoplastics (MNPs) that accumulate in soil during use and end-of-life. The long-term impact of this pollution is unknown. PAPILLONS addresses the release of chemicals and MNPs and their impacts on soils, filling the knowledge gap on sources, behaviour and long-term ecological and socioeconomic impacts of MNPs in European soils, providing the background to enable policy, agricultural and industrial innovation to sustainable farm production systems.

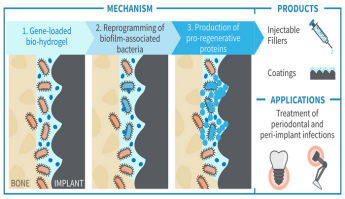


Bacteria biofilm as bio-factory for tissue regeneration

BIOACTION

Project manager
DR. L. AMBROSIO

The BIOACTION project, awarded by HORIZON-EIC-2022-PATHFINDEROPEN-01 programme, aims at developing a new methodology in implant technology based on functionalized bio-hydrogels that will convert the negative occurrence of biofilm-associated infections, the primary cause of implant infections and failure, into a positive resource. The main goal of BIOACTION is to use implant-associated bacteria found in the oral cavity or around percutaneous devices to produce programmable proteins for in vivo cell recruitment and tissue regeneration. BIOACTION would drastically advance the future of infection therapy by changing traditional methods, resulting in improved state of care, health outcomes, and significant socioeconomic benefits.

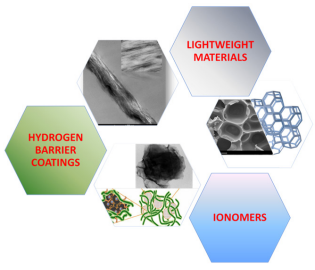


iENTRANCE@ENL

iENTRANCE

Project manager
DR.M. LAVORGNA

Project funded under the National Recovery and Resilience Plan (NRRP), Mission 04 Component 2 Investment 3.1 – NextGenerationEU, Call for tender n. 3264 dated 28/12/2021, Award Number: 128 dated 21/06/2022 – Project Code: IR0000027 - iENTRANCE@ENL "Infrastructure for Energy TRAnsition aNd Circular Economy @ EuroNanoLab". The aim of the project is to realize a distributed, integrated, and fully interoperable Technological Research Infrastructure of European excellence in Italy devoted to Clean Energy Transition Research. In this context IPCB-CNR activities will be addressed to design, development and structural-functional characterization of polymer-based composite materials, with specific focus on hydrogen barrier coatings for transportation/storage, lightweight materials and polymer-based ionomers for fuel cells, development of porous lightweight materials, complex metamaterials and systems by additive manufacturing, for enhanced energy efficient systems and structures.



Excellence of the Institute

IPCB is an international excellence research institute focused on frontier polymeric materials and composites. This position is determined by the IPCB multidisciplinary approach that is realized through the integration of diversified competences, from molecular designing up to the validation of innovative materials, developed to face the most relevant "societal challenges". The IPCB research strategy well-fits the objectives of the National Research Plan, the National Recovery and Resilience Plan (PNRR) and the challenging targets of the Horizon Europe programme, addressed to increase the sustainable competitiveness of the post-Covid society. Among the worldwide recognized results of the IPCB researchers and technologists, it is worth mentioning the highly standard level of their scientific production, their involvement in several national and international projects, committee and platforms and their strong innovation capability that, based on the integration of fundamental and applied research, has allowed the set-up several spin-off companies with primary focuses in biomaterials, structural and functional materials and polymeric-based sensors. Finally, internationalization activities represent a further IPBC excellence, as demonstrated by the existing initiatives in Europe, China and USA and the coming in Japan.

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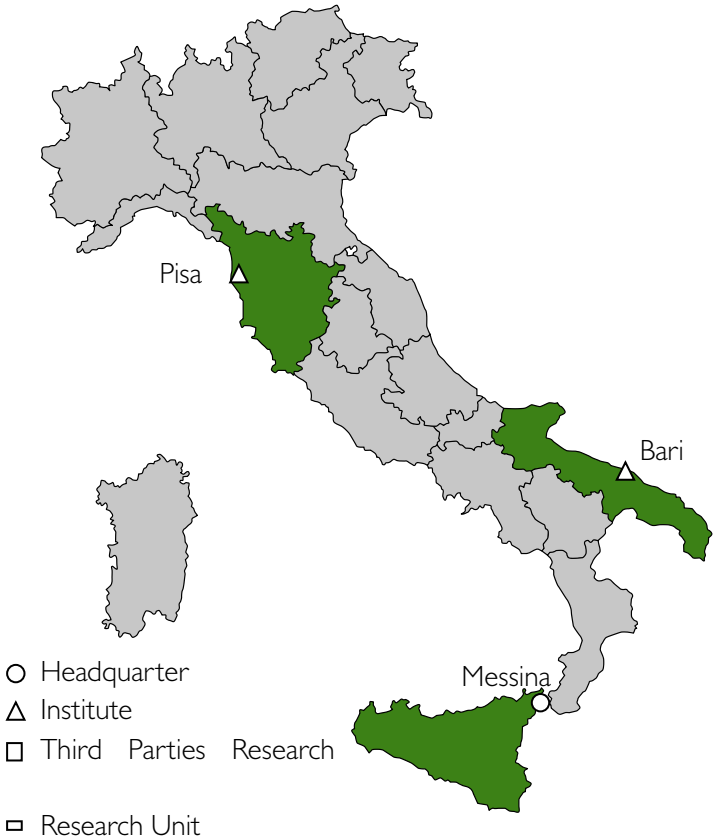
Institute of Chemical and Physical Processes

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).

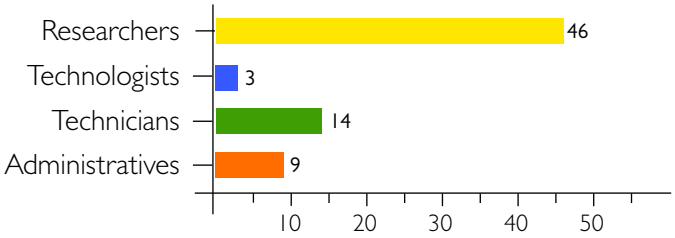


What We Are Doing

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

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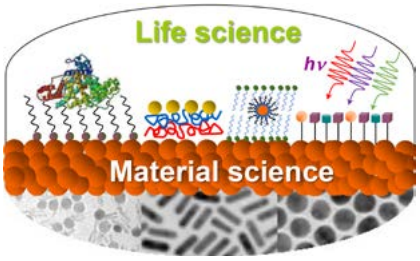
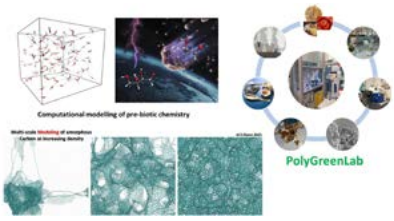
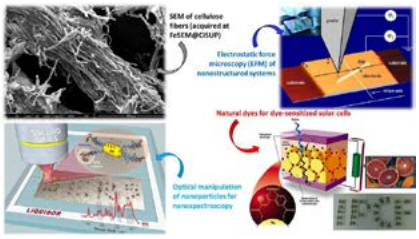




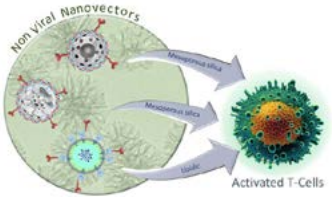


Our Projects

PON TITAN

Project manager
DR. N. DEPALO

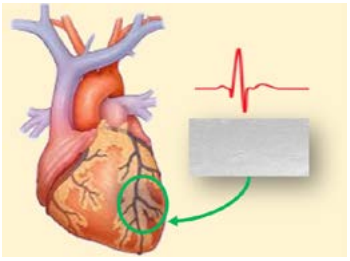
Immunotherapy with genetically modified T cells (CAR-T) has obtained important results bringing its use to the commercialization of its therapy and its use to treat different types of tumors and diseases, etc., but is still very expensive. TITAN project aims at making cancer immunotherapy with safe, 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

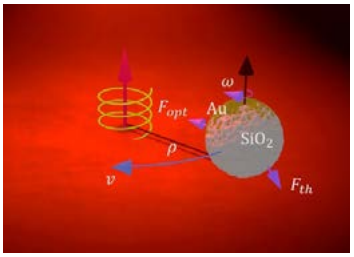
The aim of the project is the implementation of bioartificial scaffolds with the potential to serve as acellular patches for in vivo cardiac regeneration. In particular, electroconductive polymers will be tested in order to improve cardiac commitment. The protection against ventricular remodelling and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

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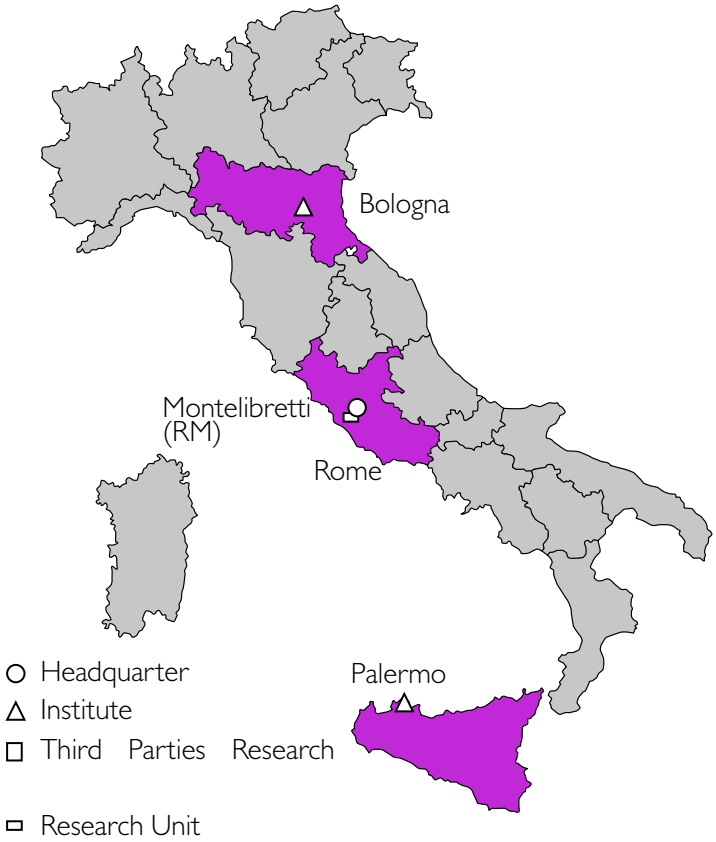
Institute of Nanostructured Materials

Director: **Dr. VITTORIO MORANDI**

CNR ISMN
ISTITUTO PER LO STUDIO DEI MATERIALI NANOSTRUTTURATI

ISMN is a CNR research institute internationally renowned for its multidisciplinary activities in the field of nanostructured materials and enabling processes and technologies. The institute aims at generating state of the art knowledge in the field of Chemical Manufacturing and Science and Technology of Materials, and at exploiting the research results through the relationship with the industrial and business world. In a stimulating and dynamic environment, thanks to the presence of many young researchers and PhDs from various countries of the world, ISMN has a prestigious scientific track record and regularly performs industrial research programs focussed on specific applications.

ISMN is present throughout the country with its four locations. The headquarter of the Institute is at the Research area of Montelibretti Roma 1, while the other locations are in Bologna, Palermo and at the University of Rome Sapienza. In order to reach its objectives, ISMN integrates transversal key enabling technologies, which include advanced materials, photonics, nanotechnology, biotechnology, advanced chemical and manufacturing processes. These technologies are part of the ISMN assets thanks to its advanced research infrastrutures and state-of-the-art scientific and technological equipment.



What We Are Doing

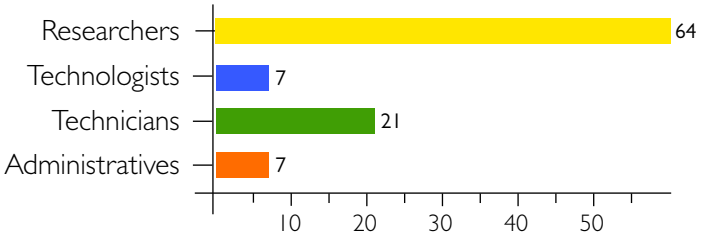
ISMN has a recognized great experience and competences in the development, fabrication and modelling of advanced functional nanomaterials and innovative technological methodologies. This expertise permits to ISMN to be strongly involved in the framework of the following research areas:

- Energy
- Health
- Food, Bio-economy and Environment
- Preservation and Protection of Cultural Heritage
- Circular Economy and Manufacturing 5.0

Patent

ISMN has a significant patent portfolio formed by a number of national and international patents in various technological sectors, including chemistry and materials science, optoelectronics and photonics, lighting, environment and bioremediation, circular economy and agrifood, biotechnologies, catalysis, green chemistry, renewable energy. Batches of correlated patent families are transferred into start up initiatives to create value from the generated knowledge and the related technologies.

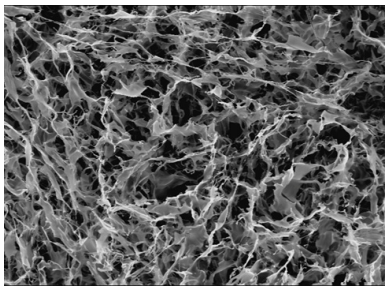
Human Resources



DSCTM
Department of Chemical Sciences and Materials Technology

Research on materials devices for human health.

Sustainable technologies and nanomaterials for the environmental preservation and protection.



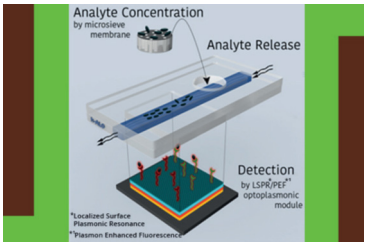
Highly porous materials purposely designed and developed for the capture of atmospheric pollutants in a museum environment as to inhibit the degradation of the artifacts.

Our Projects

h-ALO Project

Project manager
DR. S. TOFFANIN

(photonic system for Adaptable muLtiple-analyte Monitoring of fOod quality, GA n. 101016706, https://h-alo.eu/)
The EU-funded research and innovation project h-ALO aims to develop a cutting-edge bio-chemical photonic-based sensor enabling the on-site early detection of microbiological and chemical contaminants in the farm-to-fork local food chains. h-ALO combines micro-nanotechnologies for optical sensing based on nanoplasmonics, advanced biorecognition, micro-engineered surfaces and microfluidics for the realization of an ICT monitoring analytical instrumentation that aims at outperforming current commercially available portable tools for contamination detection.
The h-ALO sensor will offer unique advantages in terms of sensitivity, portability, and multiplex capabilities and its adoption will help local food producers and small retailers to assess quality and safety of their products in a fast, reliable, simple and cost-effective way. The h-ALO sensor is a tool to bridge the gap between local food production chains (such as aquaponics, organic honey, craft-beer, and raw milk) and food safety/quality monitoring.



The EU H2020 APACHE project (G.A. n. 814496)

Project manager
DR. G. DI CARLO

Aimed at the development of active/intelligent packaging materials and display cases for the preventive conservation of cultural heritage. Efforts are addressed to the preparation and validation of new nanostructured materials for the highly efficient adsorption of atmospheric degrading pollutants, dangerous for the museum collection. Nanostructured multisensors are also developed for the early detections of these volatile compounds. All these activities are aimed at the creation of a stable microenvironment for the storage and exhibition of works of art.
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814496.

THALASSA

Project manager
DR. L. F. LIOTTA

TecHnology And materials for safe Low consumption And low life cycle cost veSSels And crafts.
The aim of the THALASSA project is to study and to develop innovative and advanced materials technologies that can be used in the shipbuilding process in order to meet the needs of company partners and the challenges posed by national, regional programs concerning smart, green and integrated maritime transport. The approach is based on innovation, sustainability, related to performances, and life cycle. These key points come into play for the development of new coatings and paints able to protect metallic surfaces but also to minimize biofouling, which induces a significant increase in friction in navigation with increased fuel consumption and need for more frequent maintenance, through an anti-fouling or a fouling release approach.

Excellence of the Institute

- Innovative Organic Optoelectronics based on advanced materials, architecture and new concept systems represents a distinguishing and broadly recognised experties of ISMN at international level. Over the last 20 years ISMN has pursued and consolidated the activity on low-consumption, wide area, flexible and integrated optoelectronic devices and system through numerous national and international projects. ISMN has invented the planar electroluminescent transistor (OLET) that was at the basis of a startup worth 10 M euros investment.
- A worldwide excellence is represented by hybrid nanostruactured magnetic materials, interfaces and devices for applications in the field of micro-nano electronics (ICT), sensors for biomedical and environmental monitoring, tissue regeneration and other innovative applications in nano medicine.
- ISMN has solid and recognized knowledge on advanced chemical, physical, morphological and structural characterization of Cultural Heritage artifacts. Innovative synthesis and validation of low toxic and environmentally-friend materials are successfully employed to develop and implement sustainable conservation methods.

Website: http://www.ismn.cnr.it
Address: Via Salaria Km 29,300
00015 - Monterotondo Stazione (Roma) - Italy
Tel: +39 06 90 672 484 Fax: +39 06 90 672 372

Institute of Organic Synthesis and Photoreactivity

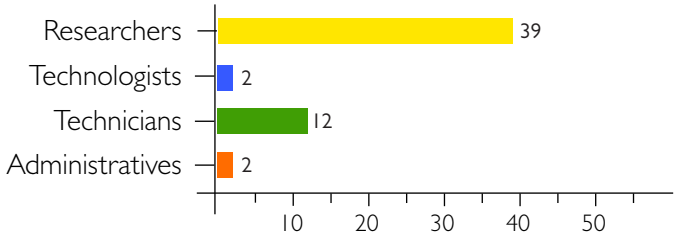
Director: **Dr. VINCENZO PALERMO**

At ISOF we use chemistry, materials and light to develop new technologies to improve our life and our world. In particular, we create new molecules and materials to treat diseases like cancer, to monitor our health, to reduce or remove CO_2 from the atmosphere, or to purify the air and water around us.
ISOF was established in 2002 and is currently the largest institute of CNR located in Bologna with a permanent staff of 65 units, including 44 full-time researchers.

Besides this, ISOF hosts an average of ≈60 among additional researchers, postdoc and ph.d. students paid by external projects. The Institute has ≈7000 m^2 of laboratories equipped with state-of-the-art instrumentation; it is currently performing ca. 26 research projects funded by the EU, the Italian government, the Emilia Romagna Region and different no profit organisations and industrial partners.

○ Headquarter
△ Institute
□ Third Parties Research
▭ Research Unit

Human Resources



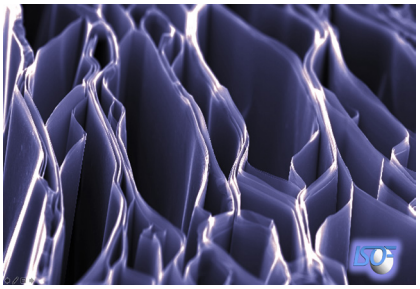
What We Are Doing

We use synthetic chemistry to create a wide range of organic molecules with building blocks such as thiophenes, graphenes, anthracenes, porphyrins, metal-organic complexes, rotaxanes and many others.
We can produce tailored polymers with specific functionalities able as example to convert light into electricity and vice-versa or to act as biomedical scaffolds, using their self-assembling properties to form micelles as delivery and/or diagnostic agents.
Using supramolecular chemistry, we then assemble such nanoscopic objects into innovative materials able as example to deliver drugs in specific parts of the body, to purify water, to interact with the membranes of living cells, to be used in composites for airplanes and cars.
We study the interaction between light and molecules both for fundamental research and for applications, to develop original molecular architectures and nano-machines to be used in light-emitting diodes, or in solar-to-fuel or solar-to-electricity conversion.
We also disseminate the scientific results obtained at ISOF to a wide range of audience, spanning from scientific seminars to students and general public, to industrial contracts with large multinationals or SME.

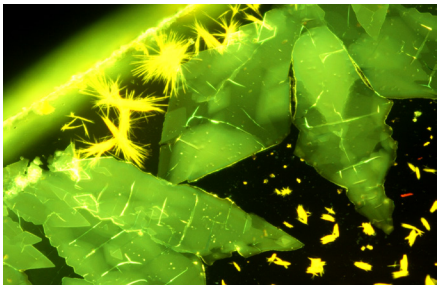
Patent

ISOF has authored ca. 48 patents since its creation. Some examples of patents are:
1. Nanoparticles as drug-delivery vehicles.
2. Production of all-carbon conductive paths attached on flexible substrate in order to obtain RFID antennas, or interconnects, or other applications.
3. Production of water-based solutions of PLA for alogen-free packaging.
4. Purification of bee wax using UV light and radicals.
5. Microfiltration in fibers for removal of contaminants of water.
6. Microfluidic patch for separating specific species in biological fluids and related electrochemical sensing device.

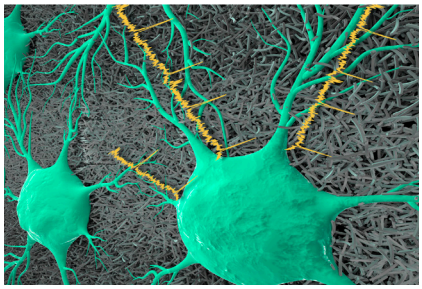
More details can be found on the CNR patent catalogue online: https://www.cnr.it/it/catalogo-brevetti



Electron microscopy image of graphene structures used for energy storage or composites.



Fluorescent microcrystals of oligothiophene; conformational polymorphism leads to yellow or green emission and different morphologies.



Artwork of brain cells (astrocytes) growing on a nanostructured material.

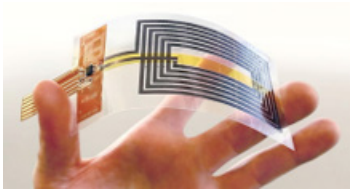
Our Projects

The Graphene Flagship

GRAPHENE FLAGSHIP

Project manager
DR. V. PALERMO

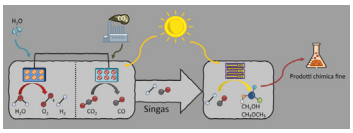
The Flagship is one of most ambitious research project ever launched by the European Commission, with a planned duration of ten years and a target budget of one billion euros. Its objective is to translate the technology of graphene and related 2-dimensional materials from the lab to the European industries for applications in the sectors of composites, electronics, energy, sensors, photonics and biomedical. The Graphene Flagship currently includes >1200 researchers and >140 partners, including key industries like Airbus, BASF, STELLANTIS (former FIAT), Leonardo or Nokia, with a strong participation of Italian academia and industry partners.



CONDOR - COmbined suN-Driven Oxidation and CO2 Reduction for renewable energy storage

CO2NDOR

Project manager
DR. N. ARMAROLI



Conversion of sunlight into fuels and mitigation of anthropogenic climate change are big scientific challenges. CONDOR addresses both of them by developing highly efficient solar-driven conversion of CO2 into fuels and added-value chemicals. The final target is a full photosynthetic device with 8% solar-to-syngas and 6% solar-to-DME efficiencies with three-months continuous outdoor operation. This represents a large progress with respect to the state of the art and requires an international collaboration and a multidisciplinary approach, which integrates expertise in nanomaterials preparation and characterisation by operando microscopy and spectroscopy, homogeneous and heterogeneous catalysis, photochemistry/photoelectrochemistry, PEC engineering and assessment of the environmental and socio-economic impact of the proposed technology, including life cycle assessment.

Il Linguaggio della Ricerca (language of research)

Project manager
DR. A. TORREGGIANI

The main activity of the project is to give a series of lectures in different high schools of in the area of Bologna. The project is running since 2003 and has involved some thousands of students; in 2013 it has been selected as a case-study for the EU project "Science Teaching European Network for Creativity and Innovation in Learning" (STENCIL).
The lectures are directly selected from an online catalogue by the high school teachers, and are given in Italian and English. The scientific topic presented in the selected lecture is then elaborated by the high-school students during the academic year and presented in a dedicated conference held at CNR with the participation of all teacher and students of the schools involved.

Excellence of the Institute

The scientific results obtained at ISOF have been published in more than 1800 scientific articles on peer-reviewed international journals, totaling on average 90 articles/year, with a citation h-index =103 (Source: SCOPUS; June 2021). Besides dissemination to the scientific community, ISOF has an excellent track record of technology transfer to industries, with long-lasting research contracts and collaborations with key industries like ENI, FIAT, AIRBUS, LEONARDO etc.
ISOF has a key role in promoting and coordinating CNR activities in projects like the Graphene Flagship and the KIC Raw Materials which are strategic projects for our Department and for CNR as a whole, involving several other institutes and departments. The activity in fundamental and applied research has also fostered the creation, in the last 20 years, of several spin-off dedicated to lipidomic analysis of cell membrane for personalized medicine (Lipinutragen), production of new polymers (APM), synthesis of fluorescent dyes (Mediteknology) or sustainable bio-materials (Kerline).
Another excellence of ISOF is related to scientific dissemination to the general public. ISOF researchers have ideated and promoted several successful projects focused on the younger generations, also publishing throughout the last 20 years several books and articles on magazines to increase the awareness of the general public on key problems of our age like energy production, energy usage or plastic pollution. Such publications have collected several awards.
In the last years, the vocation of ISOF for research on sustainability has been strengthened, developing new types of materials for water purification, environmental protection, sustainable plastic and solar energy conversion, while keeping also a strong research activity in the fields of new materials to improve human health, with the final goal of supporting the transition of our country and our society to a healthier and more ecological way of life.

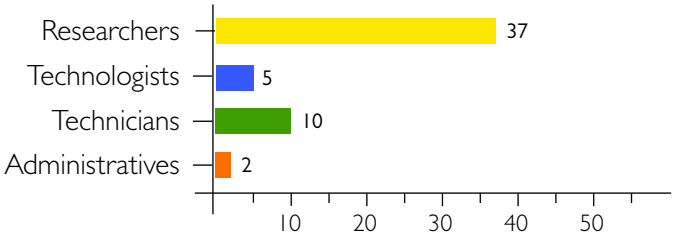
Website: http://www.isof.cnr.it/
Address: CNR-ISOF, Area della Ricerca del CNR via P. Gobetti, 101
Bologna - 40129
Tel: +39 051 639 9773 Fax: +39 051 639 9990

Institute of Science and Technology for Ceramics

Director: **Dr. ALESSANDRA SANSON**

ISTEC is an interdisciplinary Institute entirely devoted to the scientific research, technology transfer and education on ceramics-based materials. Beside traditional and ancient ceramics, it has unique and renowned international expertise on the study and development of structural & functional ceramics, as well as hybrid materials for application in health, nanotechnology & nanosafety, aerospace, mechatronics, energy and environment. ISTEC researches cover basic science, materials design and prototyping, and full characterization from the nano- to the macro-scale with distinguished experience on the synthesis of inorganic materials, set-up of ceramic and biomineralization processes, optimization of consolidation and functionalization techniques. Ameliorative approaches are driven by renowned mastery in the establishment of the relationships between process, microstructure and properties while state of the art instrumentations are coupled with pre-pilot ones able to cope with different industrial needs. The intense activity of research and development in the frame of projects with companies in different industrial sectors is in fact another peculiarity of the ISTEC activity. Other than that, the institute has a long-lasting coordination experience in major collaborative European and international projects (as for example with USA), as well as national and regional ones, which has driven the improvement and implementation of many existing lines and enable the development of new ones. Finally, in the last 10 years, ISTEC has generated several patents, many of them licensed within technological transfer activities and generated innovative start-ups and internationally renowned spin-off companies.

Human Resources



What We Are Doing

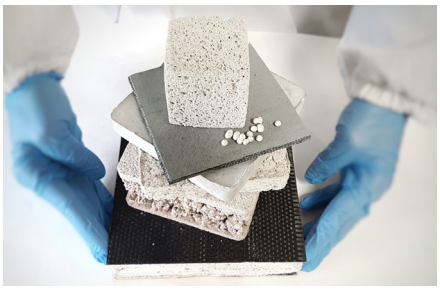
The research in ISTEC is mainly focused on tailoring the properties and performance of ceramic devices by controlling the process conditions and by engineering materials addressed to specific applications. Different solutions are also offered to impart new advanced features and performances to traditional products. ISTEC has developed expertise on the development of new nature-inspired processes overcoming the limitations of the current processing methods in the generation of smart nanoceramics and hybrids as well as processes of additive manufacturing to satisfy an increase demand of materials and devices complexity. The engineering of materials is approached considering the different aspects involved: from the starting raw materials to the processes involved in their production, up to the integration in the final device and the functional validation.

Patent

EP3253369A1; US10,525,432 B2: Process for the preparation of nanoparticles of noble metals in hydrogel and nanoparticles thus obtained (2016).
102016000023614: Physical solar filter consisting of substituted hydroxyapatite in an organic matrix (2016).
WO2017130134(A1): Composite material based o C/SiC fibers with ultra-refractory, high tenacity and ablation resistant matrix (2017).
IT201800010441(A1): Procedimento per ottenere ceramici ultra-refrattari compositi rinforzati con fibre (2020).

DSCTM
Department of Chemical Sciences and Materials Technology

Prototype of historical wall with embedded sensors for pH and chlorides detection.



Geopolymer based materials and composites for high temperature applications, chemical engineering and circular economy.

Prototype of Dye Sensitized Solar Cells (DSSC) for building integrated photovoltaics.

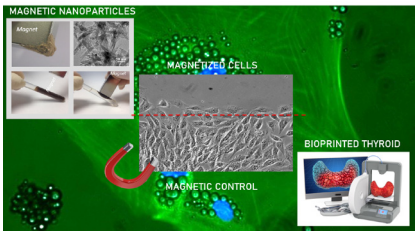
Our Projects

SCREENED

SCREENED
SCREENING FOR ENDOCRINE DISRUPTORS

Project manager
Dr. M.SANDRI

(H2020-SC1-BHC-27-2018-20): Screening for the influence of endocrine disruptors.
SCREENED is part of the EU Cluster EURION, comprises 9 partners and is focused on the study of a multistage model of thyroid gland for screening endocrine-disrupting chemicals (EDC) that strongly interfere with its functioning. ISTEC contributes with the development of biomimetic Fe-doped hydroxyapatite nanoparticles endowed with magnetic properties which are already the topic of a worldwide patent. Internalized by cells they allow to obtain magnetically labelled cells that can be driven by a remote magnetic field, that is strategic to achieve fully colonized 3D thyroid bioconstructs.

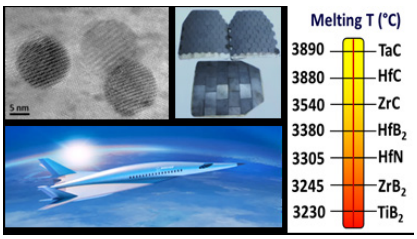


SUSPENCE

NATO OTAN
SUSPENCE

Project manager
DR. L. SILVESTRONI

(NATO SPS –MYP G5767, 2020-23): Super Strong ceramics for Protection in harsh environment &Defence.
SUSPENCE is a 3-y NATO funded project within the Science for Peace and Security Programme, involving Italy, Serbia and the USA. The aim is to develop new ceramics with unprecedented strength from room temperature up to at least 2000°C for use in severe environments, like body armour protection and hypersonic aerospace vehicles that can be used for defence against terrorist attacks. The scientific goal is to achieve enhanced strength retention, impact resistance and ablation resistance in nano-textured ceramics in the form of plates and a sharp cone for testing in relevant environments.

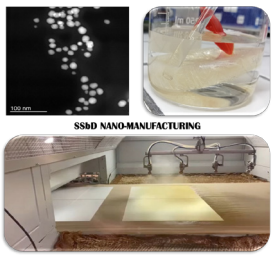


ASINA

ASiNA

Project manager
Dr. A. L. COSTA

H2020-NMBP-15-2018-2020- 862444, 2020-2023 Safe & Sustainable-by-design nano-manufacturing.
ASINA project has the ambition to promote Safe & Sustainable-by-design (SSbD) nano-manufacturing practices. Nanofabrication facilities are available through research and industrial partners of ASINA consortium, in order to optimise products and processes and match technical specifications and safety requirements, referring to the whole nano-enabled product (NEP) life cycle. A multicriteria analysis tool (ASINA Expert System) will use suitable algorithms for the minimization or maximization of response functions and identification of the most efficient SSbD solutions. Due to ASINA target NEPs (anti-microbial coatings and nano-capsules) ASINA has been officially included within the cluster of European projects that are tackling the battle against Corona Virus. The project involves 21 partners from academia, industrial innovators, standardisation bodies, 6M Euro total budget.



Excellence of the Institute

Hi-tech Ceramics for Severe Environments such as carbides, borides and nitrides find applications in high temperature engineering, aerospace, energy and automotive.
Biomimetic, bioactive and bio-resorbable 3D structures and nanoparticles able to exert therapeutic or diagnostic functions as well a as nature-inspired approaches generate innovative Bioceramics and Biohybrid Composites capable of unpreceded performances that can also be implemented with mechanisms of remote, on-demand, activation for smart personalized medicine. These activities are complemented with studies on cell-biomaterial interaction. Nano-products for application in clean technology, health and environment protection are coupled with Safety-by-Product Design approaches to prevent and control potentially adverse effects generated by nano-objects handling. Strategies and processes to enhance static and dynamic repellence of various materials against water and oils, for applications in anti-soiling, drag and friction reduction, anti-fouling, de-frost and anti-icing properties characterized the research on Smart Surfaces while the activities on Geopolymers are focused on environmental-friendly net-shaped ceramics as refractories, insulators and catalysts. New materials and devices able to shift the fossil fuel economy towards eco-sustainable energy sources like batteries, solar and fuel cells and electrolyzers are the focus of the activities on the Energy field.

Website: http://www.istec.cnr.it
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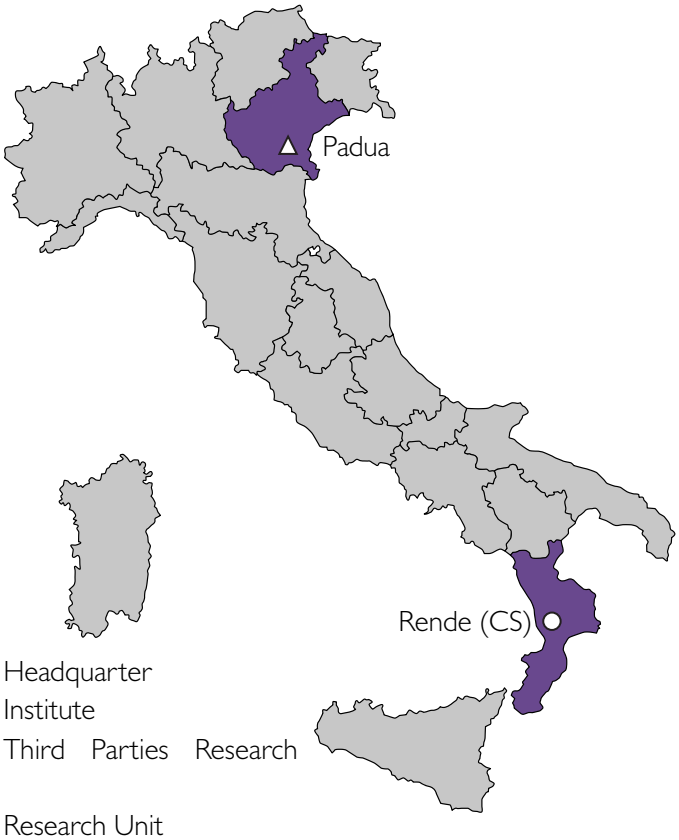
48018 - Faenza - Italy
Tel: +39 0546 699 725 - Fax: +39 0546 46 381

Institute on Membrane Technology

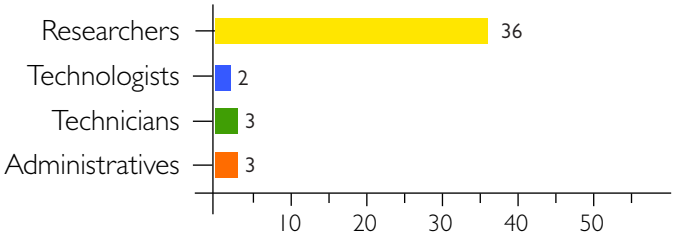
Director: **Dr. ALBERTO FIGOLI**

Mission of the Institute on Membrane Technology (ITM) is the research and development in the field of science and engineering of membranes. The research activities aim to promote knowledge, innovation and high-level training in the field of membranes and their application in water treatment, gas separation, energy, bioartificial organs, biotechnology, food and agriculture. With more than 110 people (including 44 permanent staff, 16 research contracts, 5 associated professors, 22 PhD students, 20 foreign visiting scientists, 20 master students, 12 trainees), ITM is one of the major critical mass in the world specialized in membrane technology. It is internationally recognized for its peculiar skills in the preparation and characterization of membranes (organic, inorganic, mixed matrix, biohybrid, ion exchange); transport phenomena through membranes; molecular selective membrane separations; development of catalytic membranes, catalytic membrane reactors, membranes for electrolysers and reverse electrodyalisis, membrane contactors (including crystallizers, condensers and emulsifiers); development of integrated membrane processes; development of membranes in biotechnology, regenerative medicine and tissue engineering. Membrane technologies have achieved a leading role with a more than 20% annual growth. ITM has established collaborations with various Research Institutes, Universities and Companies located in Italy, Europe, Middle East, China, South Korea, Vietnam, Mexico, Argentina, India, United States and Australia. This reflects a remarkable ability to attract funds for research, development and high education, affecting the socio-economic and cultural environment. ITM attracts many researchers from renowned foreign Universities and Research Institutions, generating a dynamic and multicultural environment that enriches and stimulates further the activities of the Institute.



- ○ Headquarter
- △ Institute
- □ Third Parties Research
- ▭ Research Unit

Human Resources

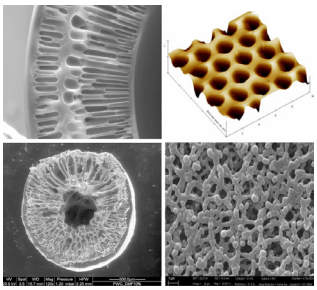


What We Are Doing

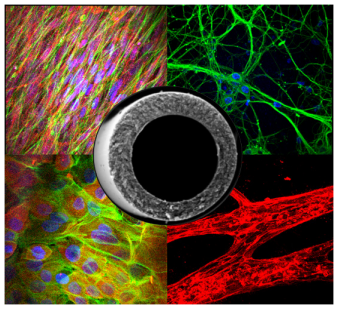
The main research activities of ITM are focused on:
- Development of advanced membranes, including polymeric, inorganic, mixed matrix, imprinted, ion exchange, bioinspired and (bio)catalytic membranes
- Innovative Membranes for desalination, water, wastewater treatment and energy production
-Nanostructured and nanocomposite polymeric membranes for gas and vapor separation
- Catalytic membrane reactors in green fuels, including hydrogen, methanol, bioethanol
- Membrane contactors, membrane crystalizers, membrane condenser, membrane emulsification
- Multiscale modelling and simulation of transport phenomena in membranes
- Study and development of membrane operations and integrated systems in water, agro-food, energy and industrial gas
- Membranes and membrane operations for bioartificial organs, regenerative medicine and tissue engineeering
- Membrane and membrane operations in biotechnology, membrane bioreactors and biosensors.

Patent

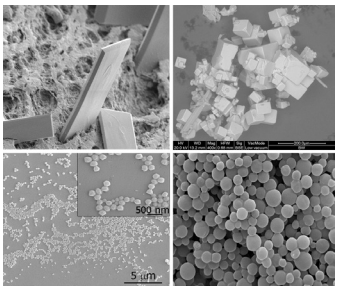
- A. Figoli, J.C Jansen, E. Fontananova, E. Esposito, R. Jerace, M. Longo, A. Minotti, Dispositivo elettrochimico atto a funzionare da elettrolizzatore e da cella a combustibile, Italian Patent n. 102022000011999, filed on 07/06/2022.
- A. Figoli, F. Galiano, G. Barbieri, L. Giorno, B. Gabriele, R. Mancuso, C.S. Pomelli, C. Chiappe, Innovative polymerised ionic liquid membranes for gas separation, Italian Patent n.: 102018000003374 (08/03/2018) extended to PCT/IT2019/050050 and WO/2019/171409 on 12/09/2019. 25/02 2021: US Patent 11,517,860,, 2022.
- A. Figoli, J. Hoinkis, B. Gabriele, G. De Luca, F. Galiano, S.A. Deowan. Bicontinuous microemulsion polymerized coating for water treatment. PCT/EP2014/070603 = WO2014/EP070603 (2014).
- E. Curcio, E. Drioli, G. Di Profio, E. Fontananova. Direct crystallization of enantiomers by heterogeneous stereoselective nucleation on a membrane. WO2013/160926 A1 (2013).



Membranes with different structure, morphology and configuration.



Dermis, epidermis vascular and neuronal constructs on polymeric membranes.



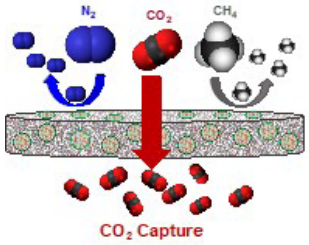
Crystal of proteins, salts and Capsules formed by membrane crystallisation.

Our Projects

doMino

Project manager
DR. A. FUOCO

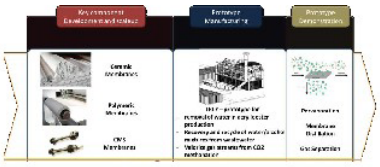
doMino (PRIN - 2020P9KBKZ) is an interdisciplinary project aimed to develop efficient mixed matrix membranes (MMMs) based on purposely synthesized (per-)fluorinated metal organic frameworks for the treatment of large amounts of CO2 for the reduction of green gas house emission and a sustainable development of industrial processes. The research activities of doMino span from the modeling, synthesis and characterization of highly innovative materials to their exploitation for the preparation of MMMs for gas separation.
The consortium, led by CNR-ITM and with CNR-ICCOM as partner, involves also the Univ. of Perugia, Univ. of Pisa and Univ. of Torino.
Website: http://www.prin-domino.it/



MEASURED

Project manager
DR. A. CRISCUOLI

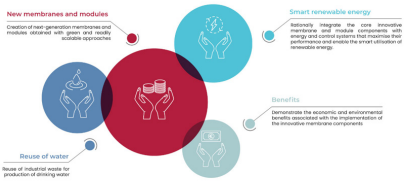
MEASURED - Membrane Scale Up for Chemical Industries, funded by the EU Horizon Europe research and innovation programme (G.A. n. 101091887) is aimed at developing and demonstrating advanced membrane materials for Pervaporation (PV), Membrane Distillation (MD) and Gas Separation (GS) to be applied in industrial operative conditions (up to TRL 7). ITM leads the production of more sustainable and highly hydrophobic MD membranes for wastewater treatment coming from the coagulation baths of an industrial membrane preparation line. The work is in cooperation with ISSMC for the inorganic coating of the new polymeric membranes produced by ITM.
Website: https://cordis.europa.eu/project/id/101091887



MELODIZER

Project manager
DR. F. MACEDONIO

MELoDIZER - The "Sustainable Membrane Distillation for industrial water reuse and decentralised Desalination approaching ZERo waste" (G.A. n. 101091915) aims to implement high-performance membranes and modules in strategic membrane distillation (MD) applications. The membranes and modules will be installed as core components of four MD pilot systems and implemented at four different demonstration sites, in Greece, Spain, and Israel. MEloDIZER.
CNR-ITM coordinates the activities of fabrication/functionalization/characterisation/testing of the new green membranes and modules and acts as Project Manager of the whole project.
Website: https://www.melodizer.eu/



Excellence of the Institute

ITM is internationally recognized as a centre of excellence in the field of membrane science and technology. ITM is leader in the development of novel membrane operations such as membrane crystallizers, membrane condenser, membrane emulsification, membrane dryer. Unique skills and expertise are in the development of membranes and membrane operations for agro-food and water treatment, preparation and characterization of highly selective membranes for gas separation using mixed gases and in presence of contaminants, membrane bioartificial organs and biocatalytic membrane systems,.

The scientific achievements are published in the leading journals in the field of membrane science, engineering, related subject areas and in the most prestigious journals, such as Advance Material, Energy Enviromental Science, Nature Materials, Science.
ITM international reputation is also testified by the involvement of researchers in the editorial board of ISI journals, editing of encyclopedia and books published by Wiley, Elsevier, De Gruyter, Springer etc. ITM is partner and coordinator of European, transnational, international and national projects.

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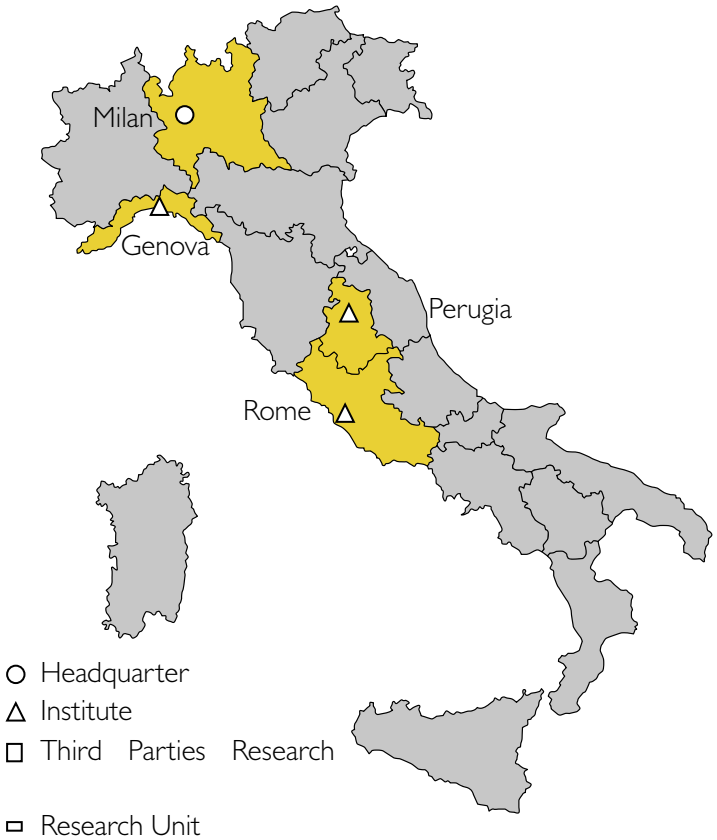
Institute of Chemical Sciences and Technologies

Director: **Dr. SALVATORE IANNACE**

SCITEC was founded in 2019 by merging the Institute of Macromolecular Studies (ISMAC), the Institute of Molecular Recognition Chemistry (ICRM), and the Institute of Molecular Science and Technology (ISTM) with the objective of converging the multidisciplinary competences of the three institutes towards the current research challenges in the fields of Advanced Materials and Technologies, Health and Sustainable Processes. SCITEC headquarter is in Milan and the activities are performed in eight distinct operative units (5 in Milano, Genova, Perugia and Roma).
SCITEC possesses unique expertise in the field of molecular and macromolecular chemistry, biochemistry, physics, computational modelling and processing technologies covering basic science, materials design, prototyping and characterization at the nano, micro and macroscale. It covers the most relevant fields of chemical sciences and technologies by developing and exploiting new approaches to design and prepare molecules, supramolecular structures and nanosystems with tailored specific functions and properties for different applications in the areas of biorefineries and agri-food, novel (bio)polymeric systems, pharmaceuticals and diagnostic, photonics and optoelectronics, hydrogen production, cultural heritage.
The Institute is currently running about 50 research projects and has many interactions with national and international research Institutions both on fundamental and applied research activities. Technology transfer and support to national and international industries are provided by several laboratories dedicated to the analysis and solution of industrial problems.



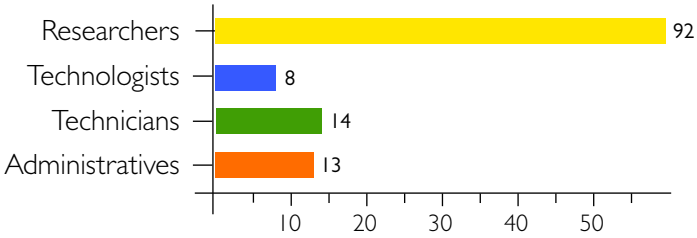
What We Are Doing

- Optimization of chemical processes and reactions according to the Green Chemistry paradigms.
- Synthesis and processing technologies of novel (bio) polymeric materials and composites.
- (Predictive) modeling and synthesis of molecules, nanosystems and materials for DSSC, PSCs, OLEDs, and optoelectronic devices
- Processes for the production of sustainable energy vectors for decarbonization, for the valorization of byproducts/waste of the agri-food industry and waste water treatments according to the water, energy and food security nexus.
- Design, synthesis, engineering and characterization of organic, inorganic and hybrid nanostructures for medical devices, bio-nanoparticles and for the development of novel platforms for personalized medicine care.
- Rational design of small molecules and molecules of peptide nature for the identification and care of pathological molecular processes. Virtual screening of molecules and/or drugs to discover and select antitumoral and antiviral compounds able to fight neurodegenerative diseases.
- In-situ non-destructive measurements on artworks.

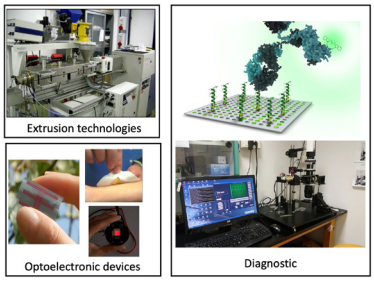
Patent

Many patents have been licensed or sold to industrial companies. Selected active patents are:
- EP 3805759, US20210102191 (A1) Method for the isolation of intact extracellular vesicles
- IT201900006590, WO2020/229965 (A1) Process for preparing polypropylene carbonate
- IT 2018800005276, WO2019/215313 (A1) Elastomeric copolymers with a high sulfur content and process for their preparation

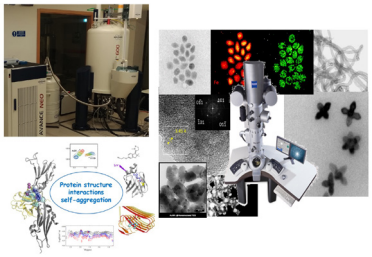
Human Resources



DSCTM
Department of Chemical Sciences and Materials Technology



Prototyping and processing labs include thermoplastic polymers (extrusion, fibers, films, compression and rotational moulding), diagnostic in medicine (microarrays) and optoelectronic devices (Oled, PVC, sensors).



Large infrastructures (NMR and TEM): a series of updated equipments for the morphological, structural and chemical characterization in the field of Advanced Materials, Health and Agri-food Metabolomics.

The "Polittico di Sant'Antonio" by Piero della Francesca at the Galleria Nazionale dell'Umbria is investigated by the researchers of the MObile LABoratory (MOLAB) team of CNR supported by the European Research Infrastructure for Heritage Science – E-RIHS.

Our Projects

BIO-PLASTIC EUROPE

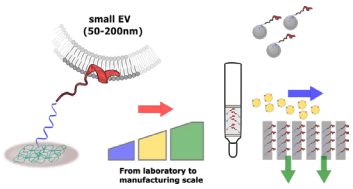
Project manager
DR. P. STAGNARO

BIO-PLASTICS EUROPE aims to develop sustainable strategies and solutions for bio-based plastic production and use to preserve land and sea environmental quality. CNR participates with 3 Institutes: SCITEC and IPCB (DSCTM) and IBF (DSFTM). They are mainly involved in testing activities on field to study the properties degradation, upon exposure in Mediterranean Sea water and soil burial, of new bio-based plastic compounds designed for short-term applications, such as cutlery, agricultural films, flexible and rigid packaging. https://bioplasticseurope.eu/

MARVEL

Project manager
DR. M. CRETICH

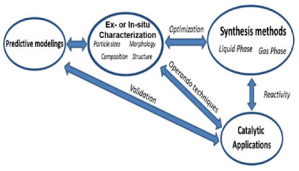
Extracellular vesicles (EV) as part of cell-to-cell communication are considered the new frontier for therapeutic and diagnostic purposes. The aim of the EU-funded MARVEL project is to scale up the EV isolation process beyond the analytical scale. We will introduce a paradigm shift from antibodies to peptides as an alternative class of affinity ligands characterized by high efficiency of EV capturing. The technology will be applied to production of EV-based medicinal products for cardiac repair and to the diagnosis of bladder cancer in urine samples.



BIKE

Project manager
DR. V. DEL SANTO

BIKE project (https://www.bike-msca.eu/) funded within the H2020 MSCA-ITN 2018 call, aims at the rational development of bimetallic catalysts for blue and green hydrogen production by means of three industrially relevant processes: Steam Reforming of bio-gas/bio-methane; Aqueous Phase Reforming of Liquid Renewable Feedstocks; Anion Exchange Membrane Water Electrolysis. The consortium, led by CNR-SCITEC and with CNR-ICCOM as Partner, brings together 10 top academic groups and 3 companies, and is currently training 14 Early Stage Researchers (ESRs).



Excellence of the Institute

- Advanced materials and technologies for green chemistry, circular economy and energy: development of catalysts, synthetic routes and processing technologies for the synthesis of new molecules and macromolecules.
- Design, synthesis and characterization of precursors and functional molecules for photonics, dye sensitized solar cells, organic photovoltaic cells, novel smart optoelectric devices and microsystems.
- Design and development of bioactive molecules of nutraceutical, cosmetic and pharmaceutical interest, through competences at the interface between organic synthesis, bio-organic chemistry and biotechnologies.
- Chemical technologies for life science, oriented to the precision and translational medicine; nanotechnologies and nanomedicine; advanced diagnostic systems; extracellular vesicles; structural, physical-chemical, spectroscopic and metabolic characterization of bioactive molecules for human health.
- Analytical techniques for studying the authenticity and safety of food products.
- Spectroscopic and diagnostic methodologies for the conservation and restoration of cultural heritage.
- Computation modelling for the in silico design of new molecules and advanced materials: atomic, molecular and macromolecular systems, studies of folding and molecular dynamics of peptide and proteins.

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