# Polymeric Materials Research Group

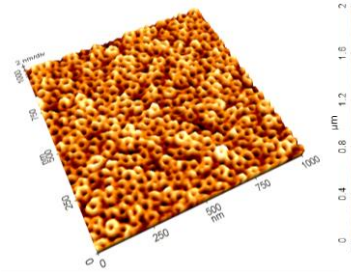
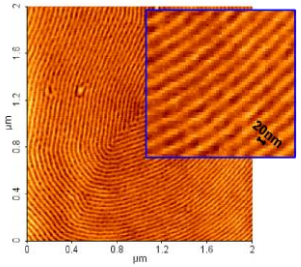
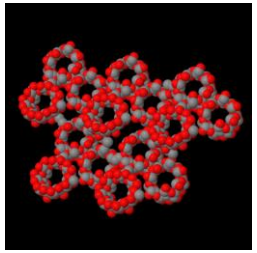
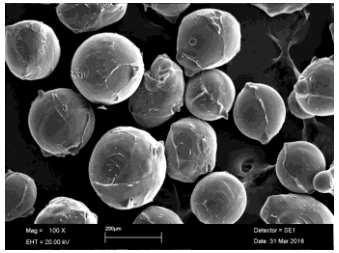
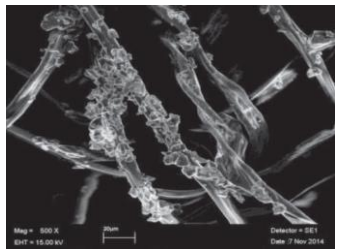
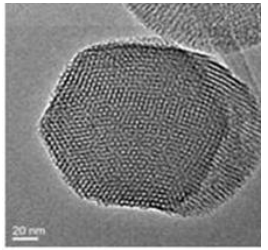
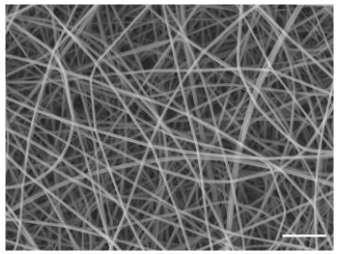
**Staff members:** Prof. Maria Paola Luda, Prof. Francesco Trotta, Prof. Pierangiola Bracco, Prof. Marco Zanetti, Prof. Dominique Scalarone, Dr. Valentina Brunella, Dr. Federico Cesano, Dr. Fabrizio Caldera, Dr. Tommaso Poli, Dr. Paola Croveri

## Main Research Fields:

- Dextrin-based polymers
- Nanotechnology applied to polymers (nanocomposites and nanosponges)
- Additive manufacturing with polymers
- Polymer electrospinning (nanofibrous scaffolds)
- Polymer recycling
- Degradation and stabilization of polymers
- Polymer flame retardance
- Polymers in medicine
- Molecularly imprinted polymers and membranes
- Microporous carbons from polymeric precursors
- Polymers for the conservation of cultural heritage

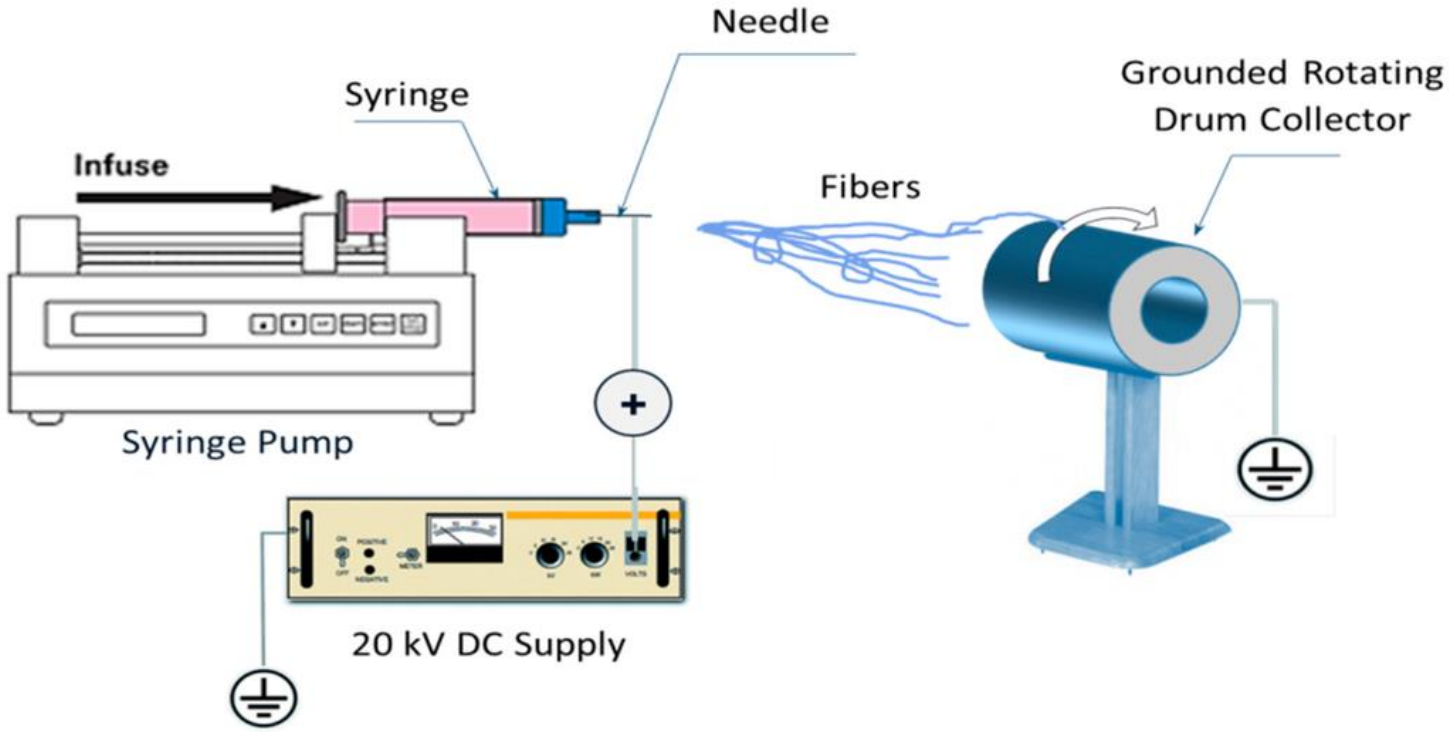
## Facilities, techniques, instruments:

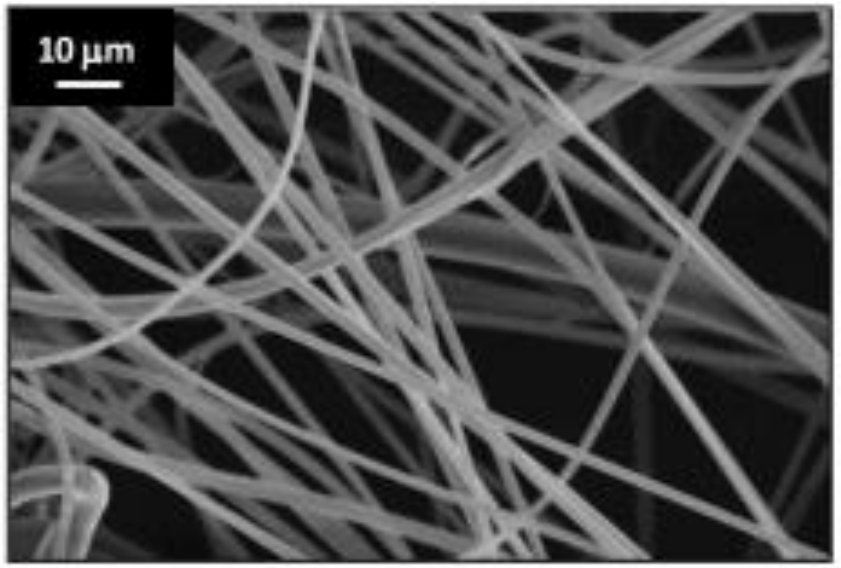
- *Chemistry lab equipped for polymer synthesis*
- *Chromatography:* HPLC, Py-GC/MS, GPC, CHNS-O
- *Spectroscopy:* FT-IR, UV-Vis
- *Thermal analysis:* TGA, DSC, DMA
- *Particle size analysis:* Zetasizer, NTA
- *Rheology:* rheometer, viscometers
- *Purification:* Soxhlet extractors, high pressure extractor
- *Sample preparation, polymer processing:* electrospinner, spray-dryer, freeze-dryer, ball mill, spin-coater, extruders, hydraulic heated press, film applicator, 3D printer
- *Separation and fractioning:* ultrafiltration cells, dialysis membranes, centrifuge

# Topic: ELECTROSPINNING OF DEXTRIN-DERIVED POLYMERS

**Supervisors:** Proff. Pierangiola Bracco (pierangiola.bracco@unito.it), Marco Zanetti (marco.zanetti@unito.it)

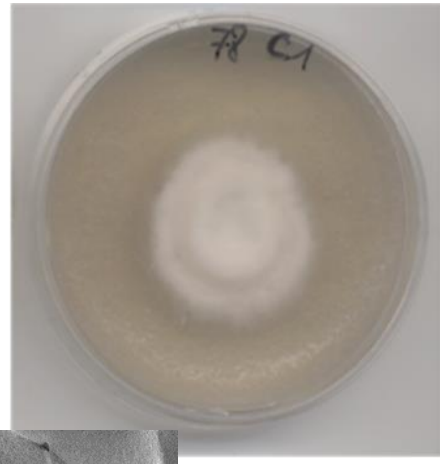


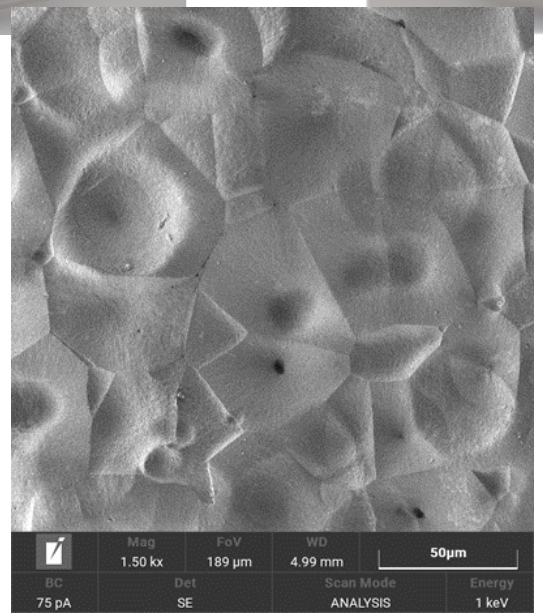



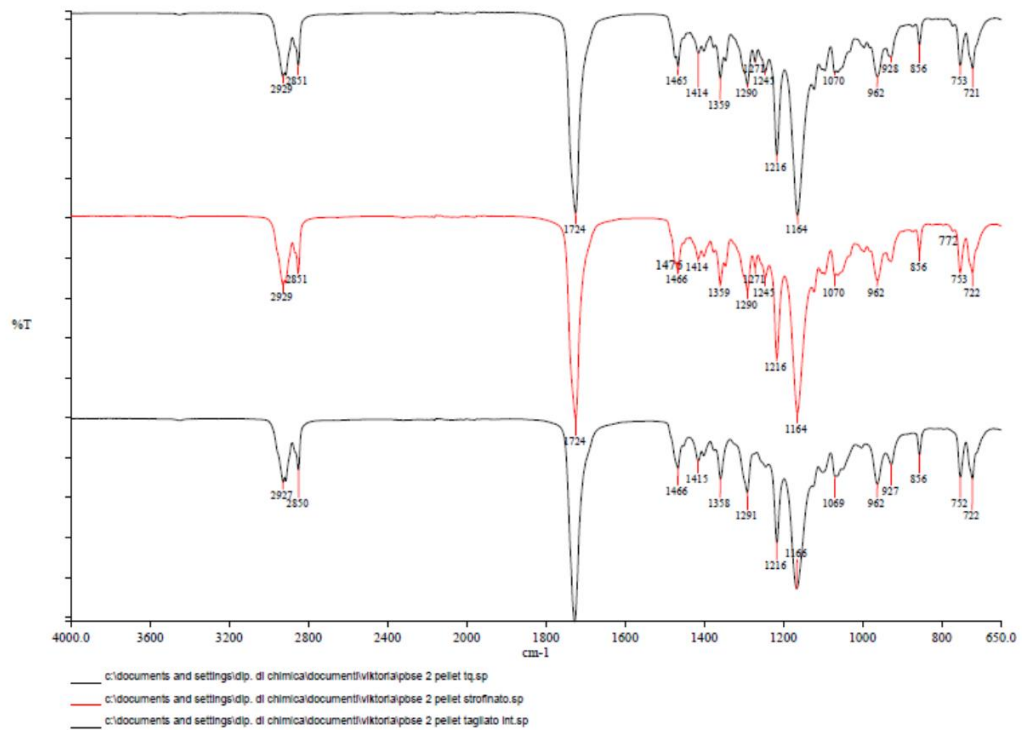

- Synthesis, modification and characterization of polymers derived from oligosaccharides (maltodextrins, cyclodextrins)
- Preparation of high surface area mats by electrospinning
- Study of applications in various fields: environmental (removal of pollutants), controlled release of drugs, carbon precursors, etc.

# Topic: FUNGUS-MEDIATED DEGRADATION OF BIODEGRADABLE POLYMERS

**Supervisors:** Proff. Pierangiola Bracco (pierangiola.bracco@unito.it), Marco Zanetti (marco.zanetti@unito.it)
in collaboration with the Department of Life Sciences and Systems Biology (Prof. C. Varese)

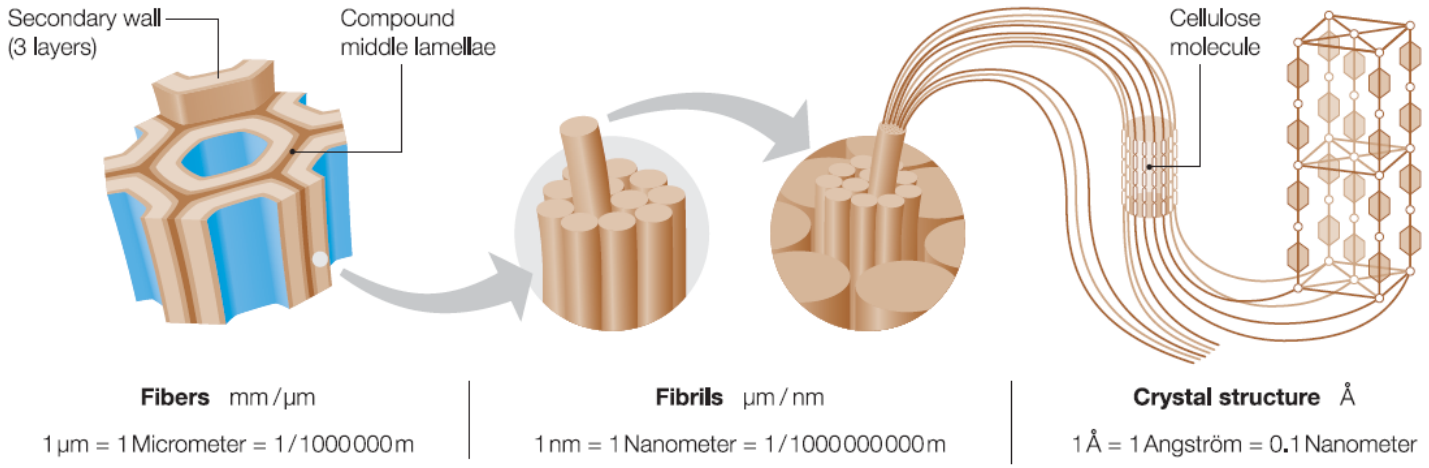



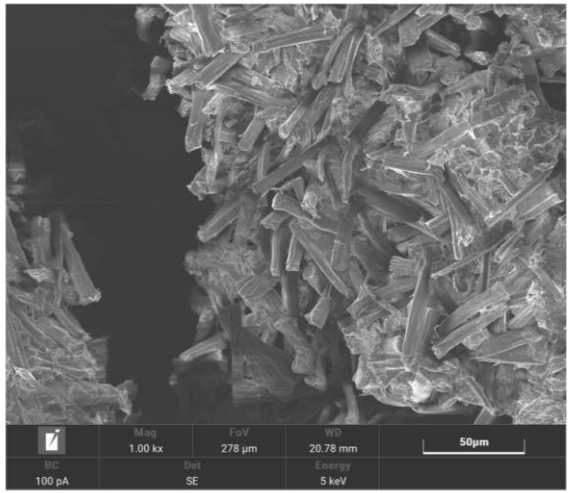




Monitoring of the degradation process of biodegradable polymers and study of their degradation mechanisms in the presence or absence of microorganisms

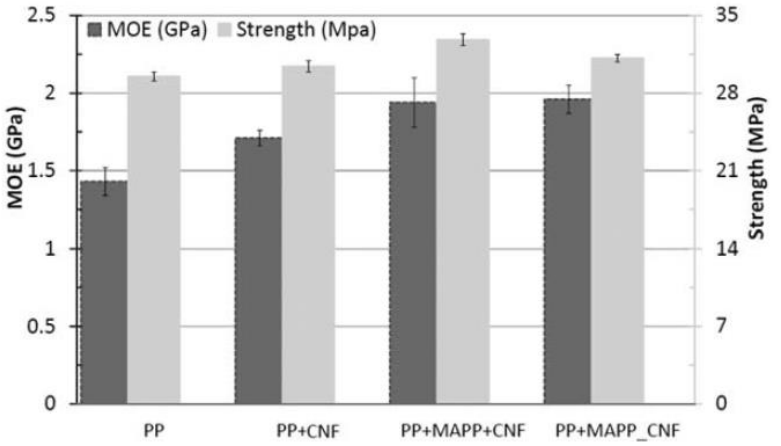
# Topic: CELLULOSE AND LIGNIN FROM WASTE BIOMASS AS FILLERS FOR POLYMER COMPOSITES and NANOCOMPOSITES

**Supervisor:** Prof. Pierangiola Bracco (pierangiola.bracco@unito.it), Prof. Marco Zanetti (marco.zanetti@unito.it)
in collaboration with Prof. E. Laurenti



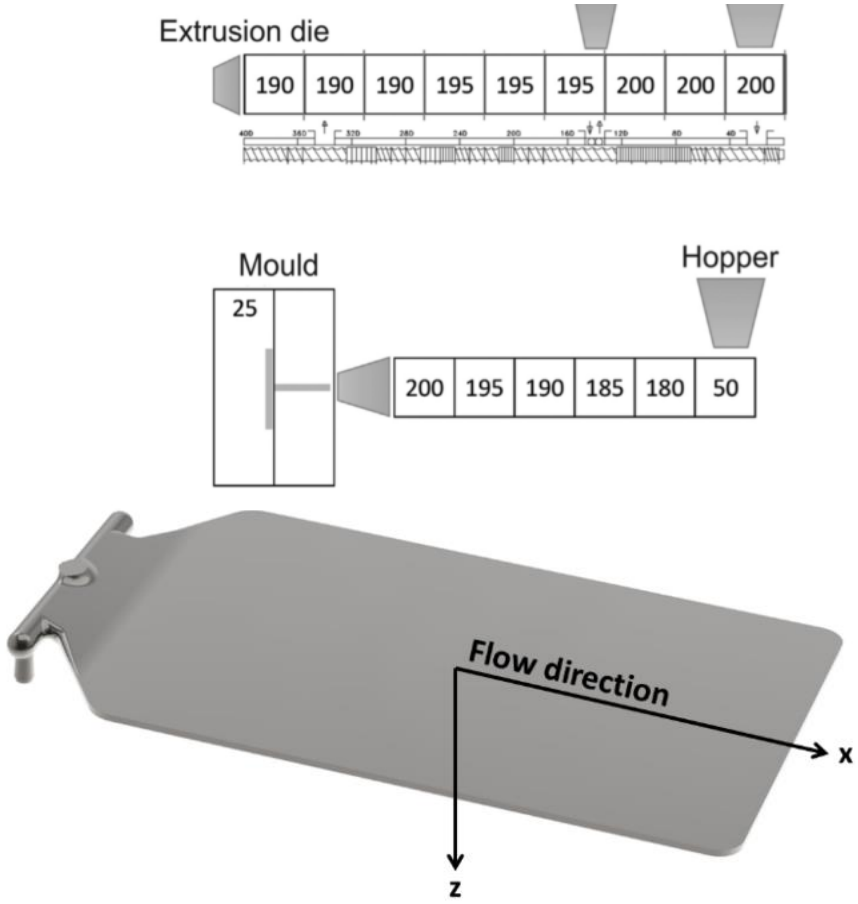




Extraction of lignocellulosic components from soybean processing waste and study of their application as bio-filler for polymer materials



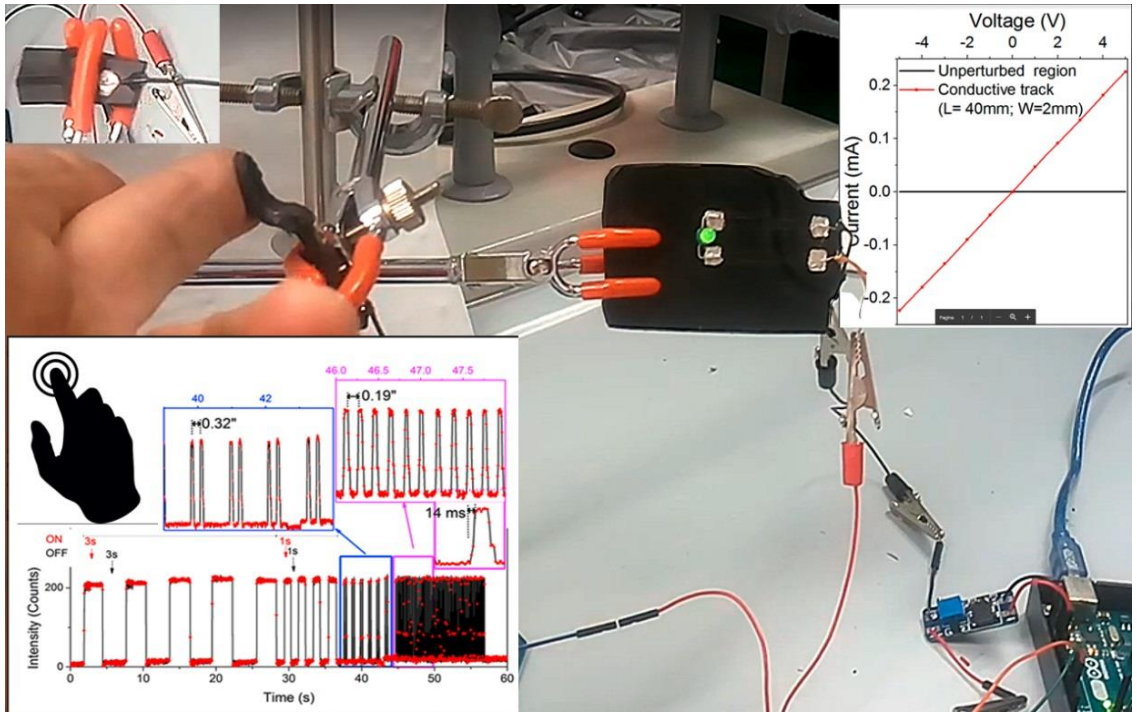
# Topic: COMPOUNDING AND PROCESSING OF CONDUCTIVE POLYMER COMPOSITES FOR SMART APPLICATIONS

**Supervisors:** Dr. Federico Cesano (federico.cesano@unito.it), Prof. Valentina Brunella (valentina.brunella@unito.it)




When in the polymer composite there are conductive fillers (including metal nanoparticles, carbon black, graphene, or nanotubes) not only electrical/thermal conductivity are obtained and the mechanical properties are increased , but also sensoring properties can be attained (embedded sensors).

Today, almost all polymers to be used in objects of daily use are modified by the addition of one or more fillers and additives to undertake a variety of purposes. Such fillers are normally used in small quantities in the final product and a uniform distribution in the polymer matrix is necessary to achieve a well stabilized product.



# Topic: ADVANCED POLYMERIC MATERIALS FOR AUTOMOTIVE APPLICATIONS

**Supervisors:** Prof. Valentina Brunella (valentina.brunella@unito.it), Prof. Marco Zanetti (marco.zanetti@unito.it). In collaboration with Fiat Research Center

- Smart textiles
- Elastomeric materials with high chemical resistance (including bio-origin materials)
- Laser ablation
- Nanocomposites with nanotubes
- Characterization of aesthetic surfaces

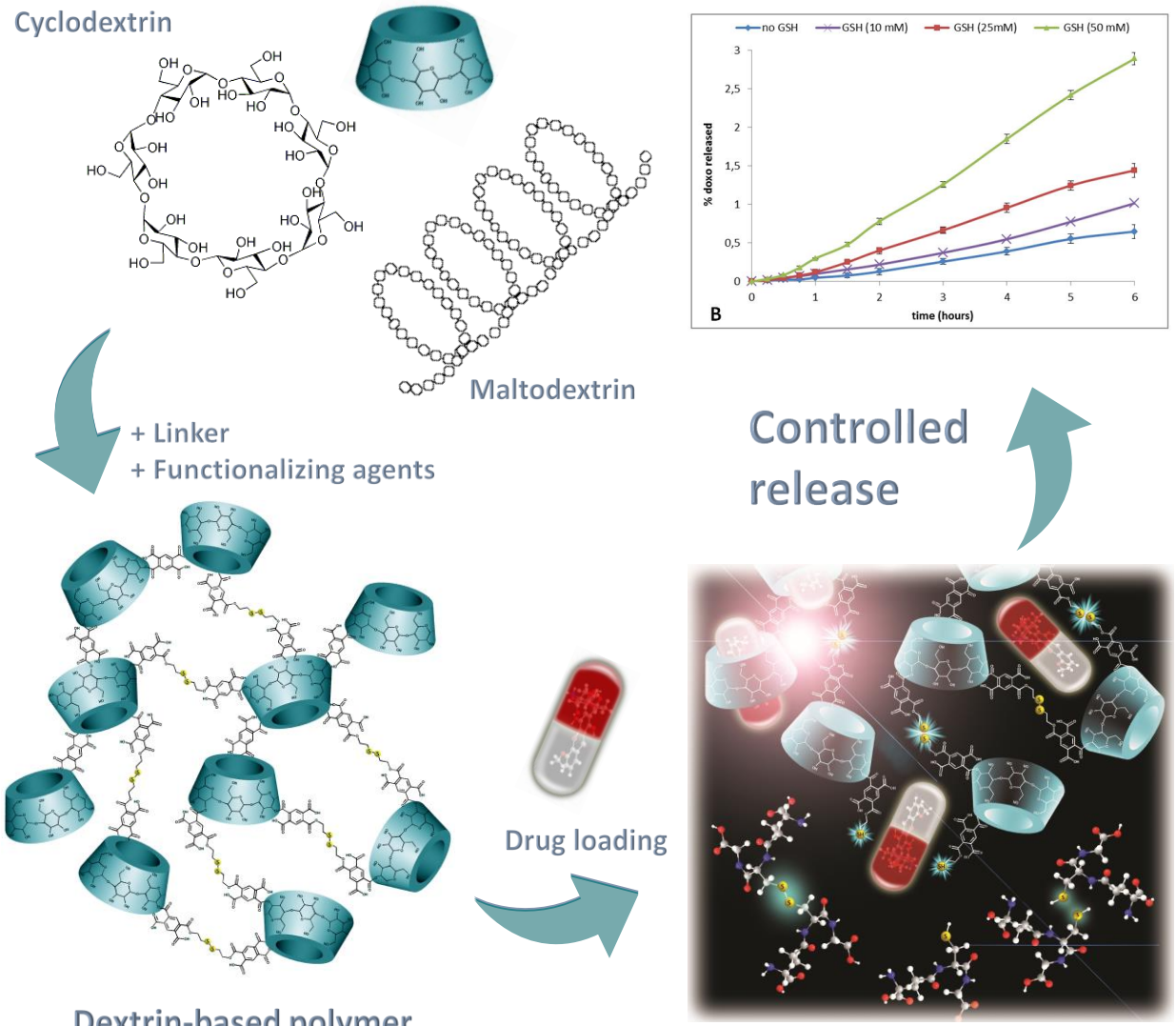
# Topic: MULTIFUNCTIONAL POLYMERS FOR PHARMACEUTICAL APPLICATIONS

**Supervisors:** Prof. Francesco Trotta (francesco.trotta@unito.it), Prof. Valentina Brunella (valentina.brunella@unito.it), Dr. Fabrizio Caldera (fabrizio.caldera@unito.it).
With the collaboration of Prof. Roberta Cavalli (Department of Drug Science and Technology, UniTo)

**Objectives:** synthesis, characterization and application of new multifunctional polymers for smart delivery of drugs.

**Approaches:** biocompatible polymers will be synthesized using starch-derivatives, i.e. cyclodextrins and maltodextrins, as building blocks. The dextrin monomers will be reacted with suitable linkers to produce hyper-branched or crosslinked polymers.
Then, the selected drug will be loaded in the polymer structure. The encapsulation efficiency and release kinetics will be optimized by changing the monomers formulation.
Targeted delivery and stimuli-responsive controlled release will be achieved by adding specific functional groups to the polymer structure.

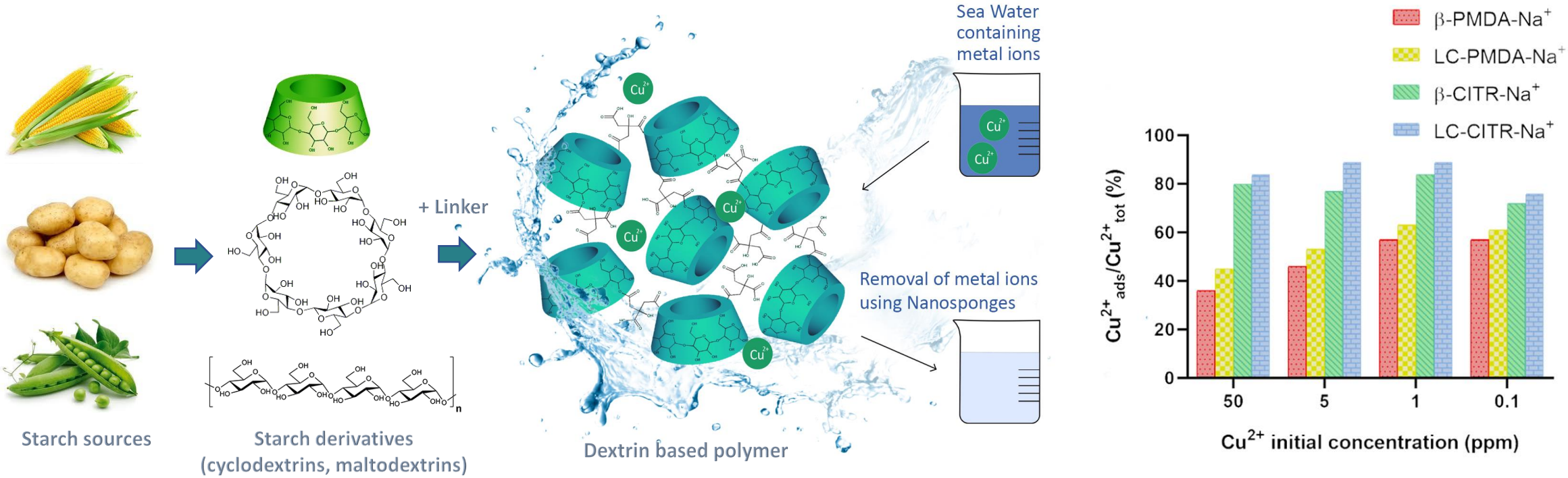
**Available projects:** transdermal delivery of melatonin, glutathione-responsive delivery systems for cancer therapy, gene delivery, enhancement of antivirals efficacy by controlled release, molecularly imprinted polymers for the treatment of Parkinson's disease.



# Topic: ECO-FRIENDLY POLYMERS FOR ENVIRONMENTAL APPLICATIONS

**Supervisors:** Prof. Francesco Trotta (francesco.trotta@unito.it), Dr. Fabrizio Caldera (fabrizio.caldera@unito.it)

Immediate availability



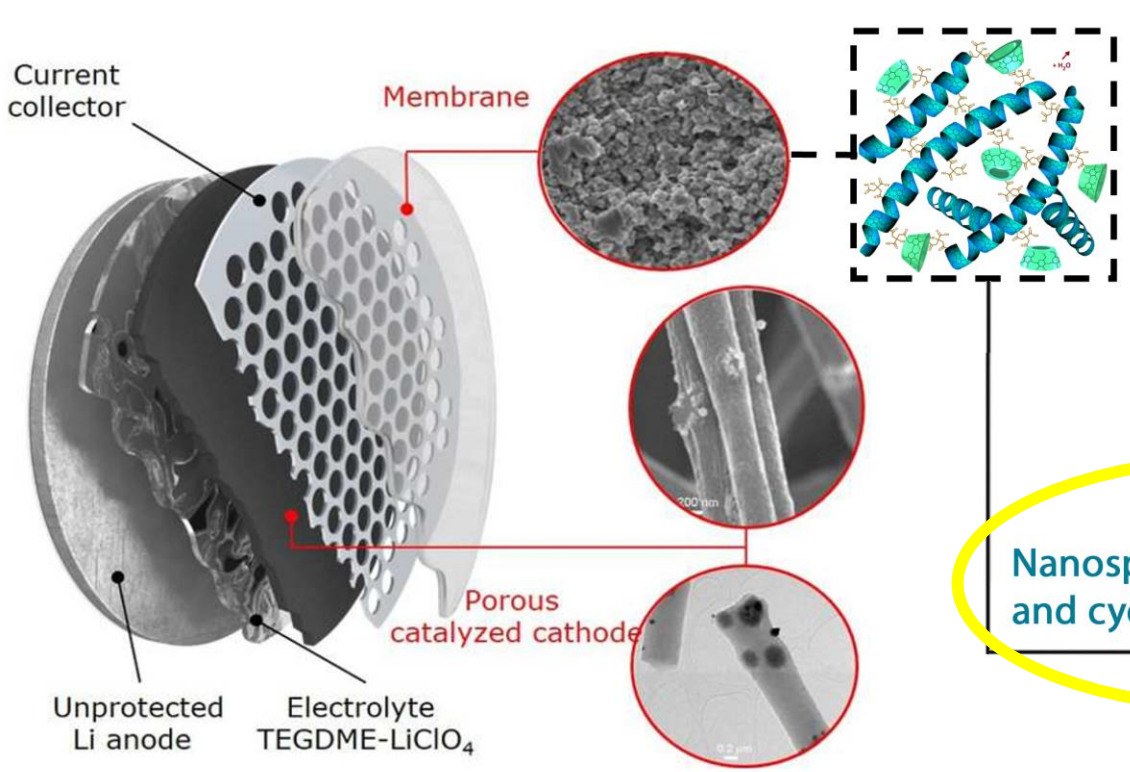

**Objectives:** synthesis, characterization and application of new eco-friendly polymers for wastewater treatment and environmental remediation.

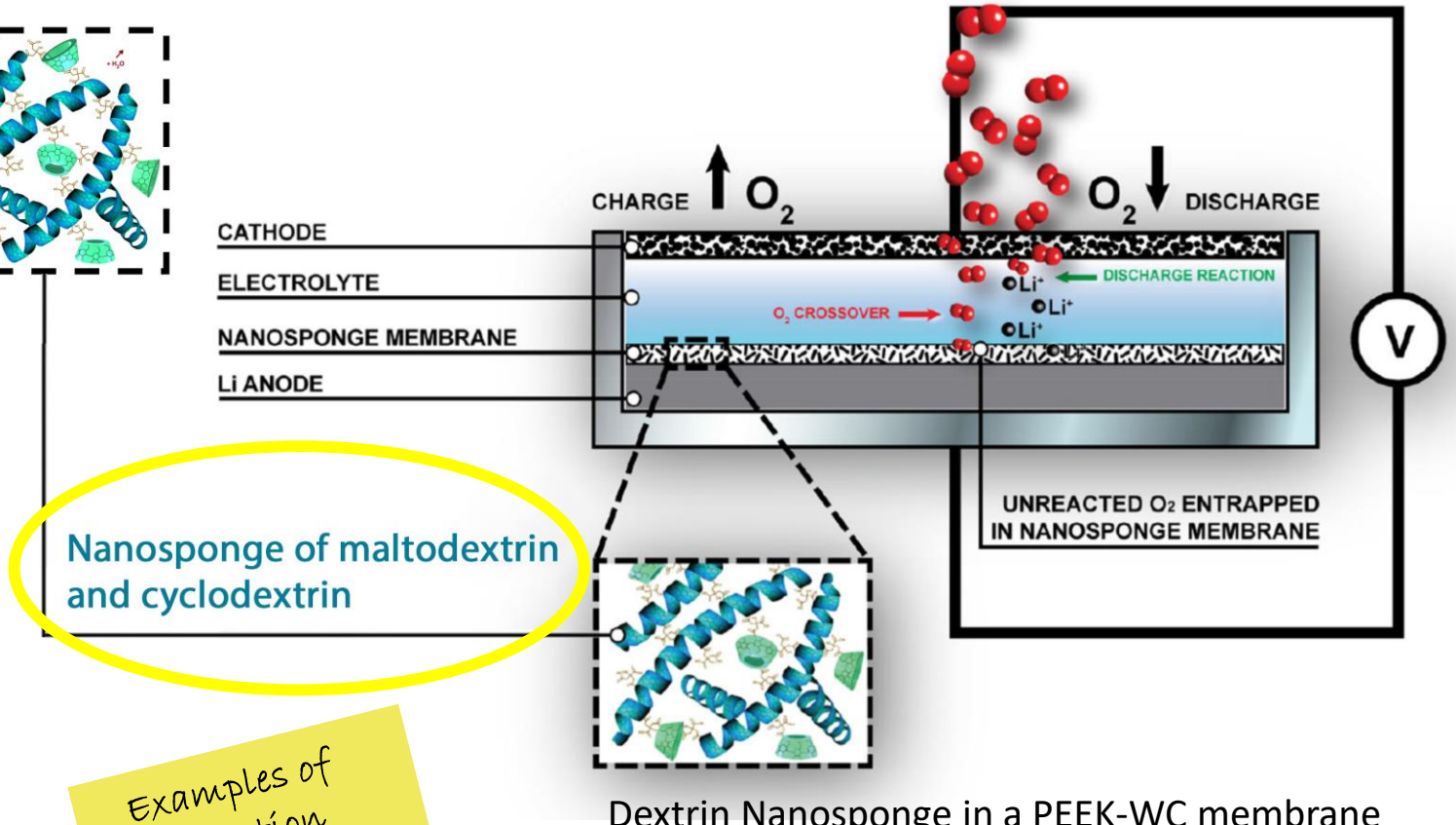
**Approaches:** starch derivatives such as cyclodextrins and maltodextrins will be reacted with linkers to prepare hyper-branched and crosslinked polymers (nanosponges). Green synthesis methods will be performed using only water as a solvent or NADES (natural deep eutectic solvents) or through mechanochemical techniques (absence of solvent).
The introduction of positively or negatively-charged moieties in the polymer structure allows to adsorb efficiently ionic chemical species (e.g. heavy metal ions, borates, etc.), while the hydrophobic internal cavity of cyclodextrins can be exploited to sequester organic pollutants.

# Topic: HYBRID MEMBRANES FOR GAS SEPARATION

**Supervisors:** Prof. Francesco Trotta (francesco.trotta@unito.it), Dr. Fabrizio Caldera (fabrizio.caldera@unito.it). In collaboration with Politecnico di Torino

Additives can modify the permeability properties of polymeric membranes.
**Objectives:** preparation of hybrid membranes, by addition of dextrin-based nanosponges to polymeric membranes, for gas separation and energy storage applications.




Dextrin Nanosponge in a PVDF-HFP membrane

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Low permeability to water, high permeability to oxygen

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Used to reduce the entry of water in a Li/air battery

Examples of application in Li/air batteries

Dextrin Nanosponge in a PEEK-WC membrane

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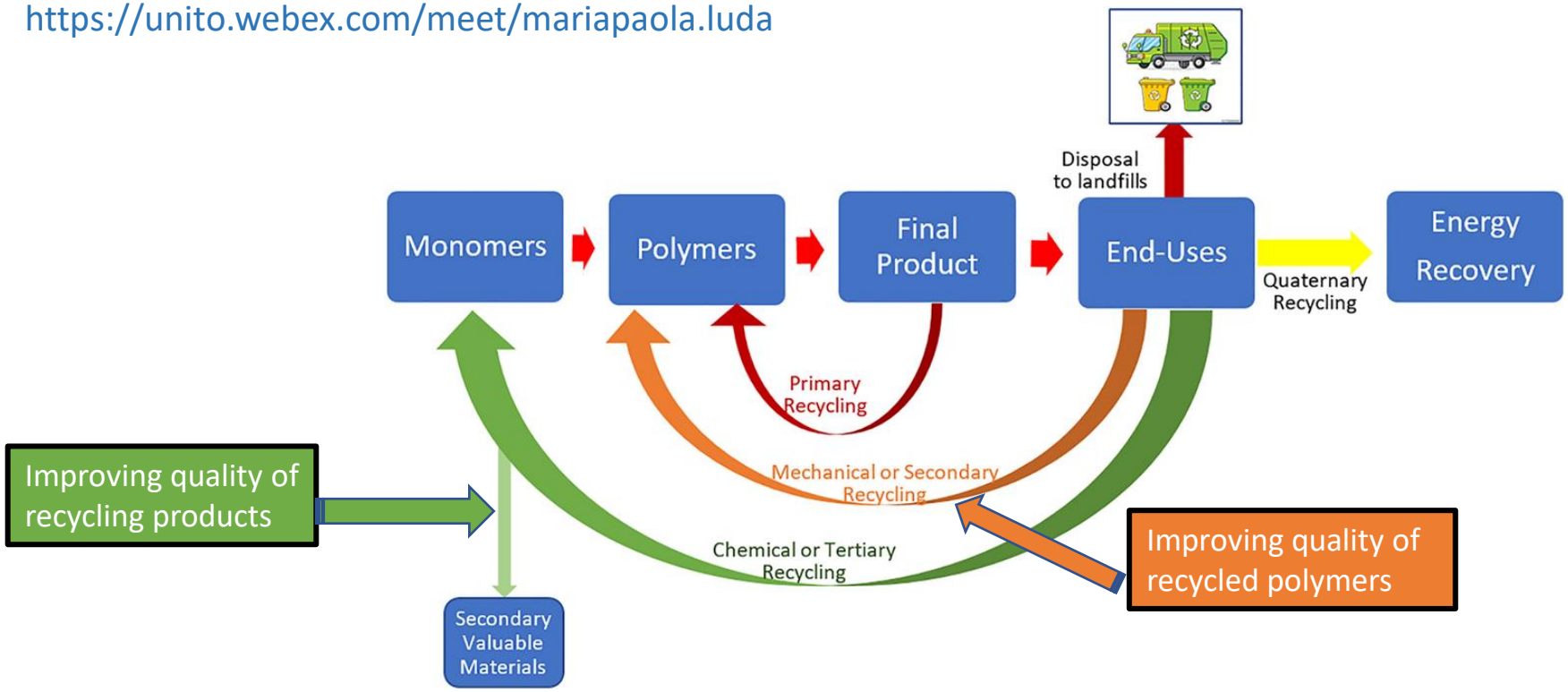
Low permeability to water, low permeability to oxygen

↓

Used for anode protection in Li/air batteries

# Topic: RECYCLING OF POLYMER WASTES

**Supervisors:** Prof. Maria Paola Luda (mariapaola.luda@unito.it), Prof. Valentina Brunella (valentina.brunella@unito.it)
https://unito.webex.com/meet/mariapaola.luda




**Objectives:** improving the quality of recycling products, characterization of recycling products

**Approaches:** Post-consume plastics are often degraded or contains impurities. Recycled items result often in scarcely valuable products. In a sustainable development scenario, improving their properties is needed. Characterization of items from secondary recycling (structural: mainly FTIR, thermal analysis, Pyrolysis GC/MS; mechanical: mainly DMA) obtained in different conditions enables to highlight the optimal process conditions. Upgrading of the recycling products from tertiary recycling allows to get valuable secondary materials. In collaboration with recycling industrial factories.

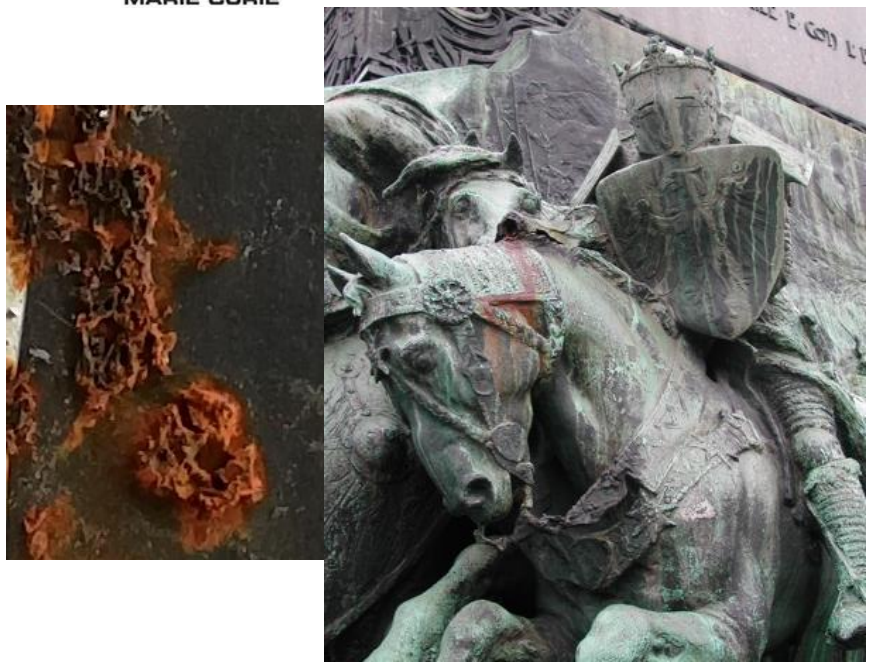
# Topic: DEVELOPMENT AND TESTING OF NEW POLYMER COATINGS WITH ANTICORROSION PROPERTIES FOR THE PROTECTION OF METAL SURFACES

**Supervisor:** Prof. Dominique Scalarone (dominique.scalarone@unito.it)

## Tech4Culture Project–
## PhD Technology Driven Sciences: Technologies for Cultural Heritage

**Horizon 2020, grant agreement No 754511**

- In-situ and laboratory characterization of corrosion patinas
- Formulation of sustainable, non-toxic polymeric coatings, with protective and anticorrosion properties
- Characterization of the coating and its properties
- Development of a methodology for monitoring the anticorrosion efficacy



# Internship in SICPA Italia S.p.A.

**Supervisors:** Prof. Dominique Scalarone (dominique.scalarone@unito.it)

SICPA is specialized in the development of microfluidic systems, formulations of inks for inkJet technologies, material science and silicon technology.
Laboratory activities will be performed in the Italian plant located in Arnad, Valle d'Aosta

## Objectives:

- Formulation of photocurable polymer coatings for digital inkjet print applications.

- Study of the interaction between the water- and solvent-based formulations and metal and plastic surfaces

    - Preparation and characterization of surfaces and solutions
    - Evaluation of the liquid/surface interaction