Polymeric Materials Research Group

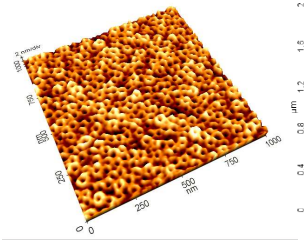
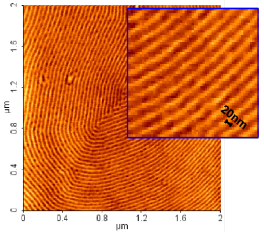
Staff members: Prof. Maria Paola Luda, Prof. Francesco Trotta, Prof. Pierangiola Bracco, Prof. Marco Zanetti, Prof. Dominique Scalarone, Prof. Valentina Brunella, Dr. Federico Cesano, Dr. Fabrizio Caldera, Dr. Tommaso Poli, Dr. Paola Croveri

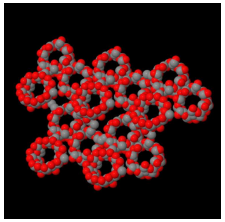
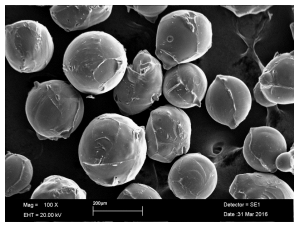
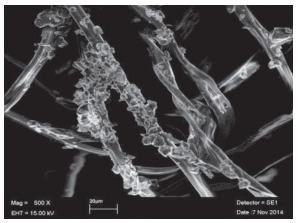
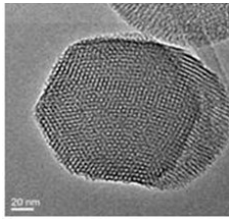
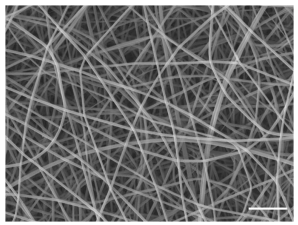
Main Research Fields:

- 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

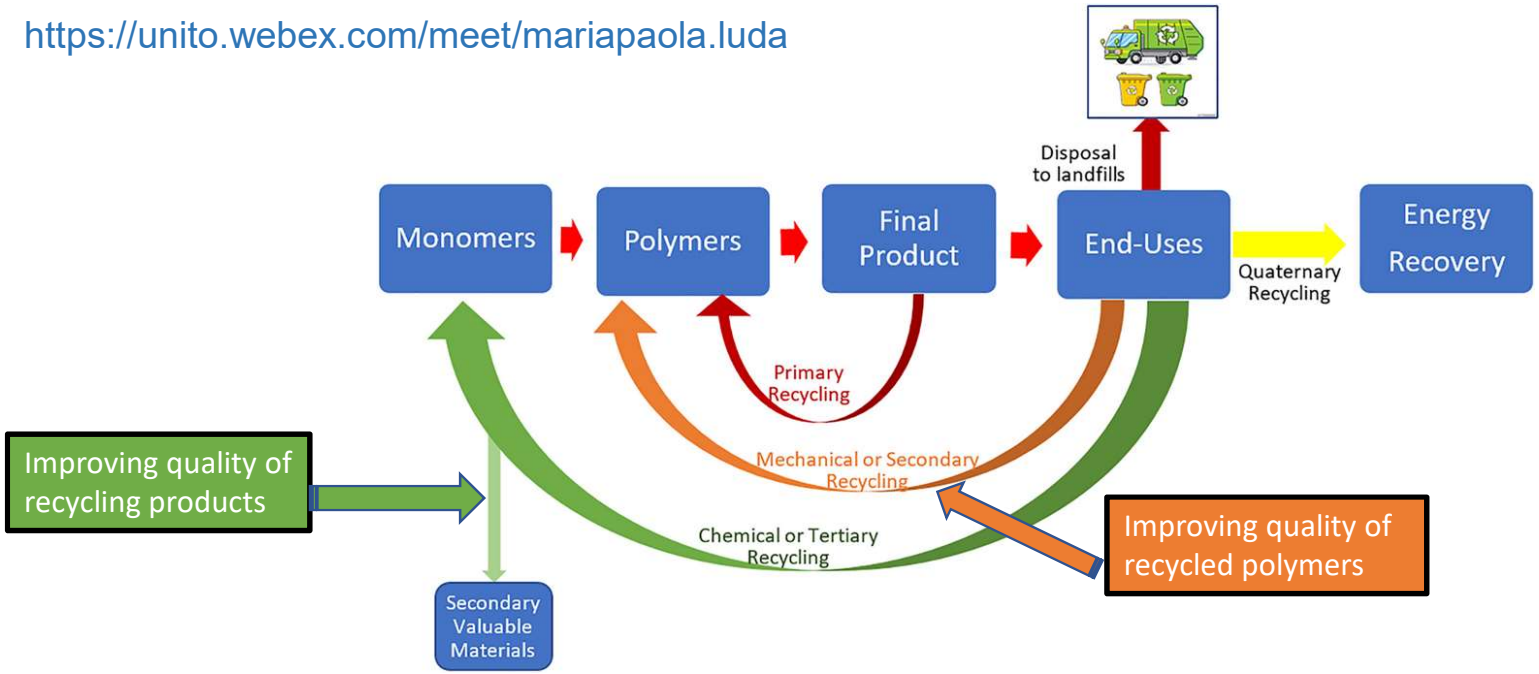






Topic: RECYCLING OF POLYMER WASTES: Characterization of polymeric system

Supervisors: Prof. Maria Paola Luda (mariapaola.luda@unito.it), Prof. Valentina Brunella (valentina.brunella@unito.it)

https://unito.webex.com/meet/mariapaola.luda

Immediate availability



Objectives: improving the quality of recycling products**, valorisation and 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.

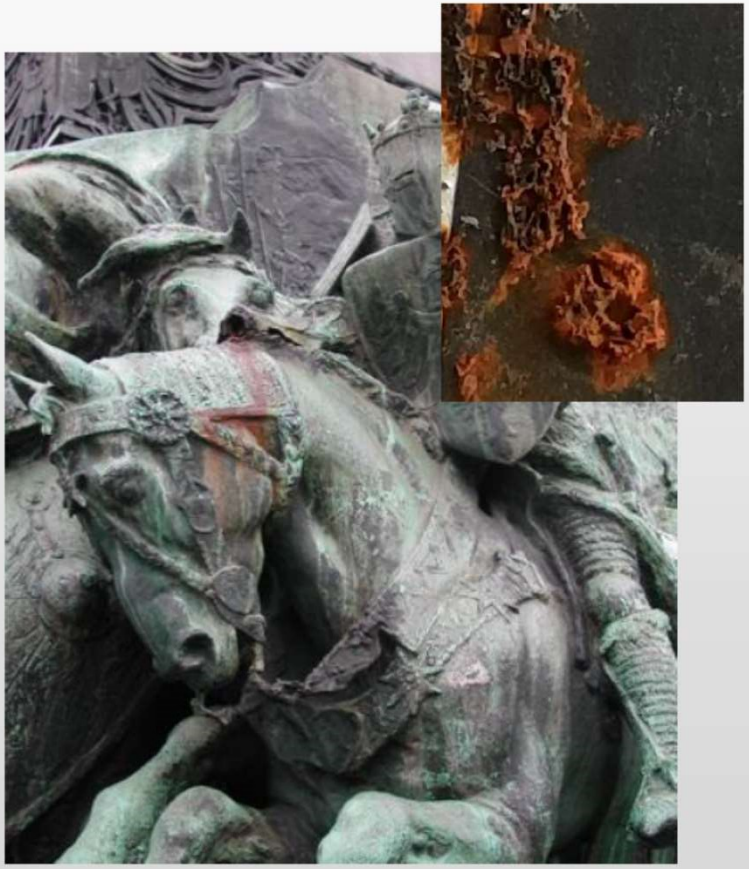
Topic: ADVANCED POLYMERIC MATERIALS FOR AUTOMOTIVE APPLICATIONS

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

Sviluppo e testing di nuovi coating con proprietà anticorrosive per la protezione di superfici metalliche

- Caratterizzazione in-situ e in laboratorio di patine di corrosione
- Formulazione di coating polimerici sostenibili, non-tossici, con proprietà protettive e di inibizione della corrosione
- Caratterizzazione del coating e delle sue proprietà
- Sviluppo di una metodologia di monitoraggio dell'efficacia anticorrosiva



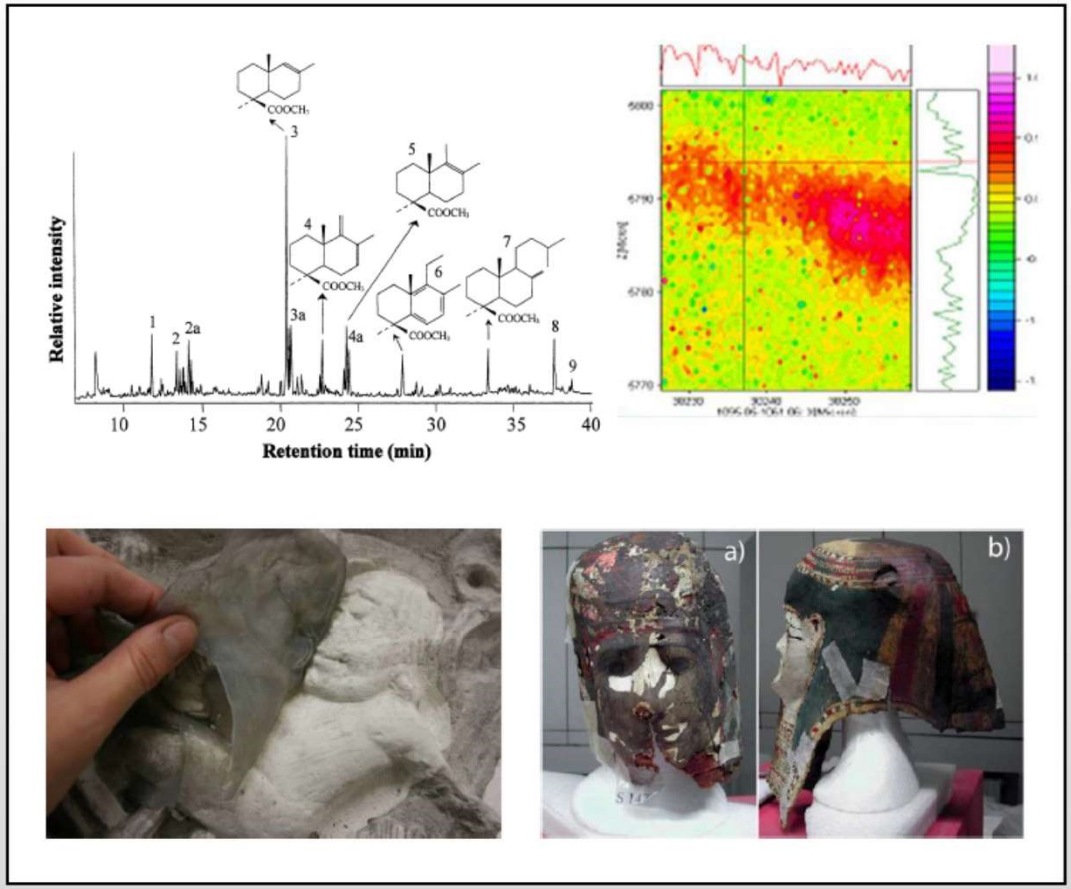
Contattare: dominique.scalarone@unito.it
Dipartimento di Chimica, Gruppo Materiali Polimerici

Identificazione di leganti, vernici e altri materiali organici in opere d'arte e reperti archeologici

- Sviluppo di procedure non invasive o micro-invasive per la rivelazione ed il riconoscimento di materiali organici

  Sviluppo di procedure analitiche di GC/MS, pirolisi-GC/MS e spettroscopia FTIR

- Riconoscimento di materiali originali costitutivi di opere d'arte e identificazione di materiali di restauro



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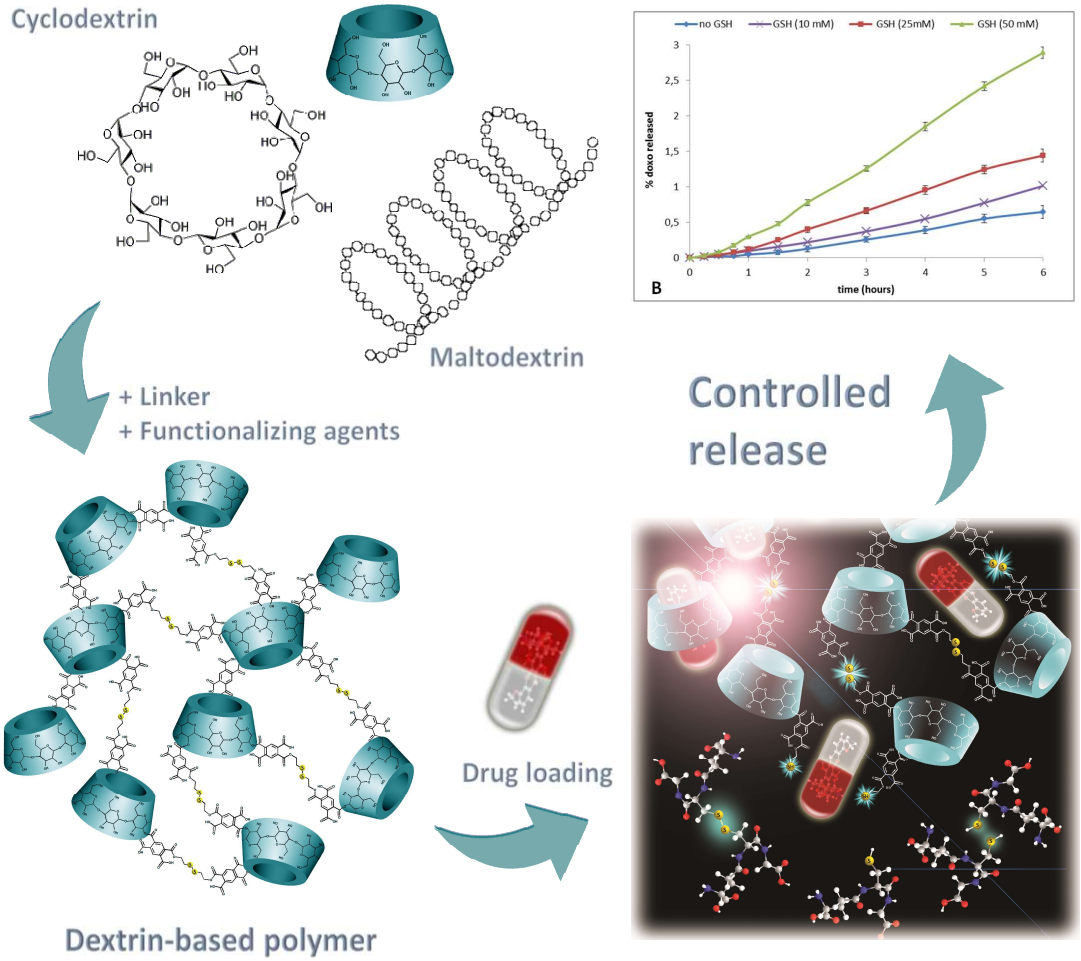
Topic: MULTIFUNCTIONAL POLYMERS FOR PHARMACEUTICAL APPLICATIONS

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.

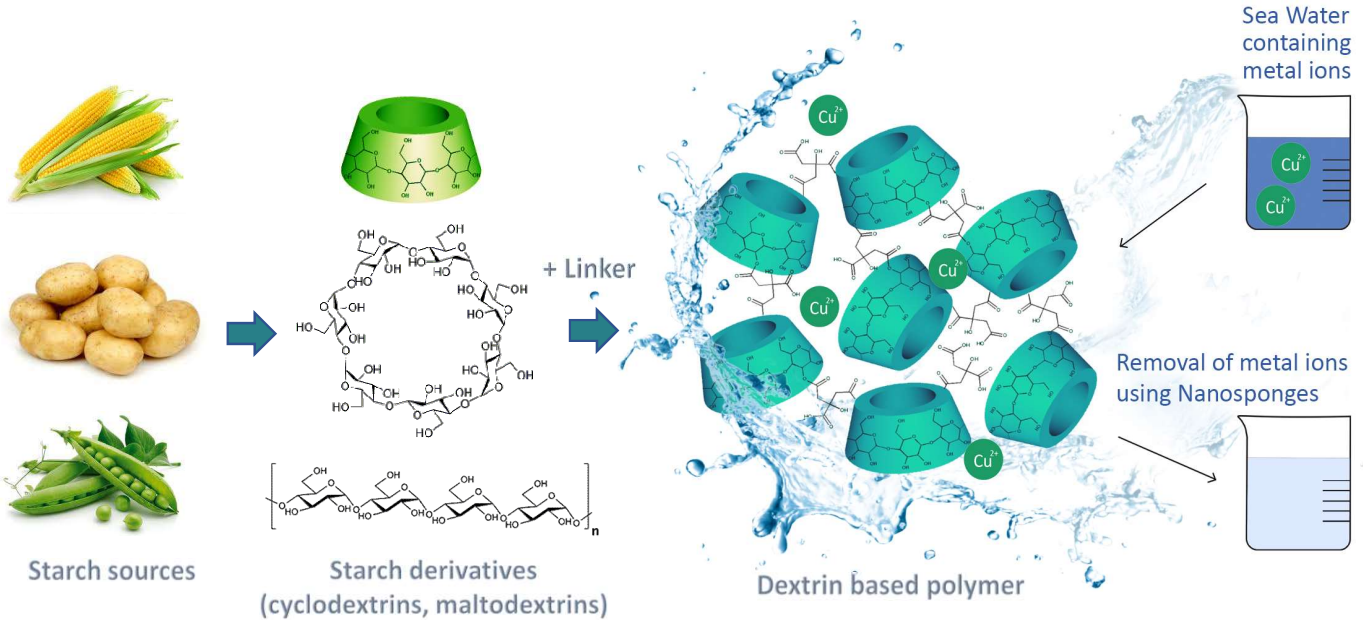
Available projects: transdermal delivery of melatonin, glutathione-responsive delivery systems for cancer therapy, gene delivery, enhancement of antivirals efficacy by controlled release, molecularly imprinted polymers for the treatment of Parkinson's disease.

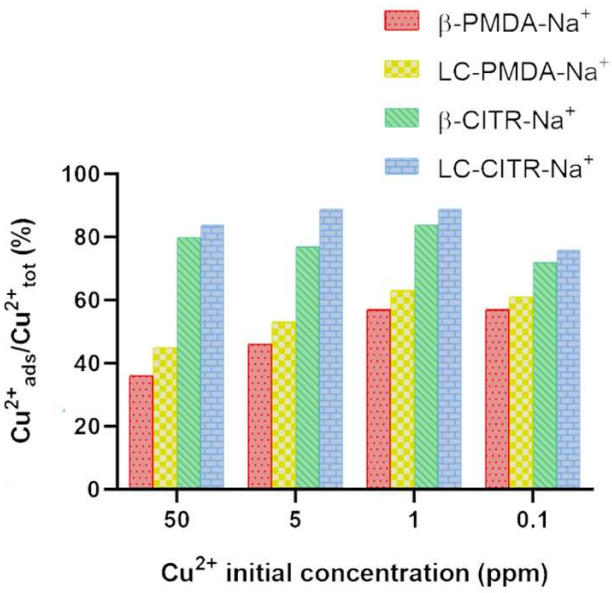


Topic: ECO-FRIENDLY POLYMERS FOR ENVIRONMENTAL APPLICATIONS

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.

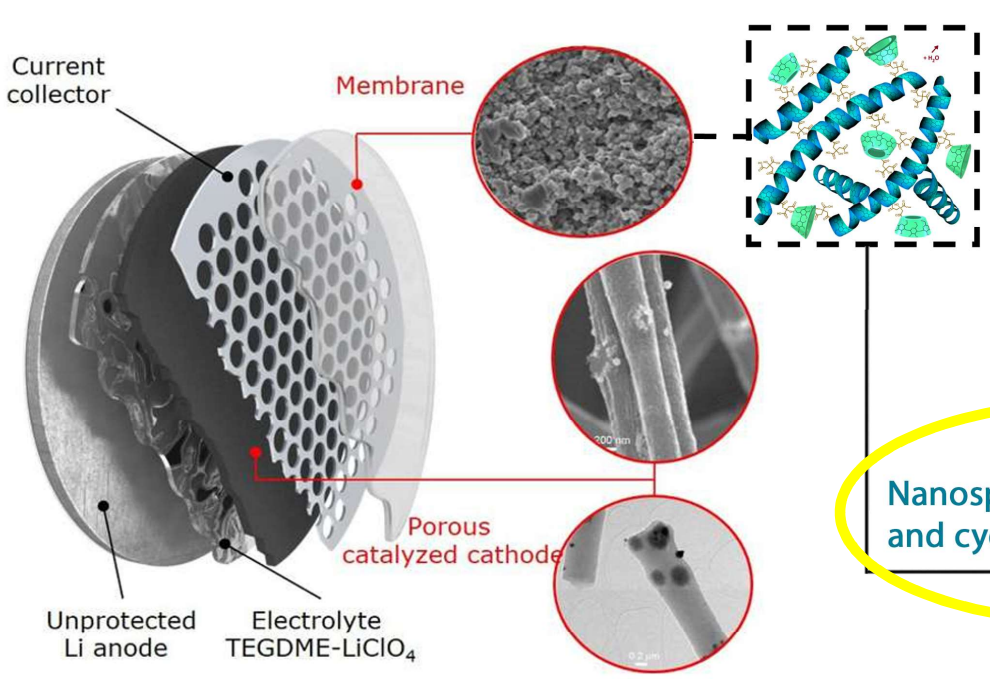
Approaches: starch derivatives such as cyclodextrins and maltodextrins will be reacted with linkers to prepare hyper-branched and crosslinked polymers (nanosponges). Green synthesis methods will be performed using only water as a solvent or NADES (natural deep eutectic solvents) or through mechanochemical 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

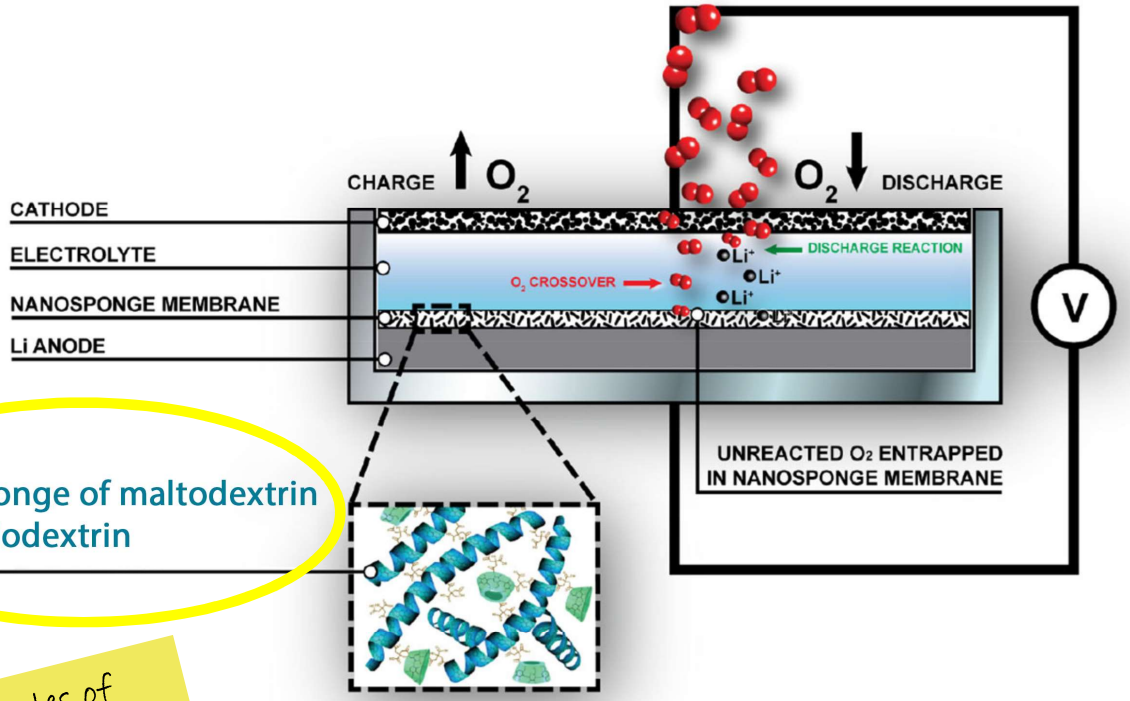
Supervisors: Prof. Francesco Trotta (francesco.trotta@unito.it), Dr. Fabrizio Caldera (fabrizio.caldera@unito.it). In collaboration with Politecnico di Torino

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.



Nanosponge of maltodextrin and cyclodextrin



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

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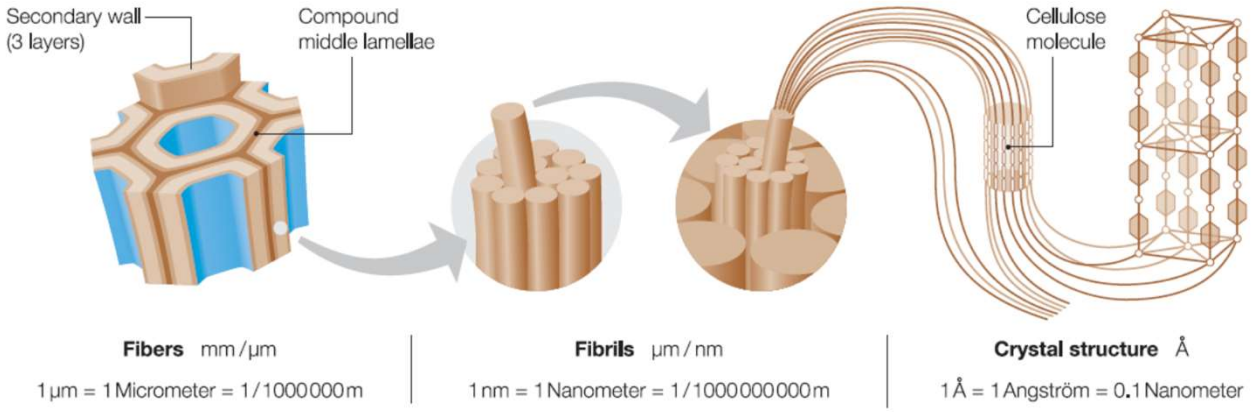
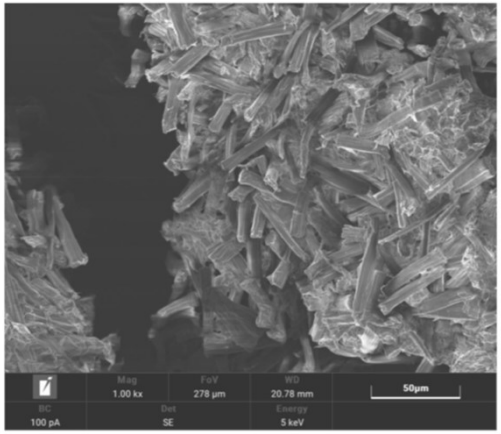
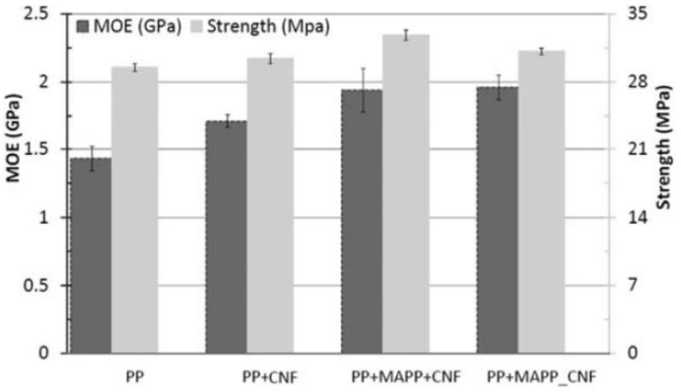
Used for anode protection in Li/air batteries

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

Supervisor: Prof. Pierangiola Bracco (pierangiola.bracco@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: ELECTROSPINNING OF DEXTRIN-DERIVED POLYMERS

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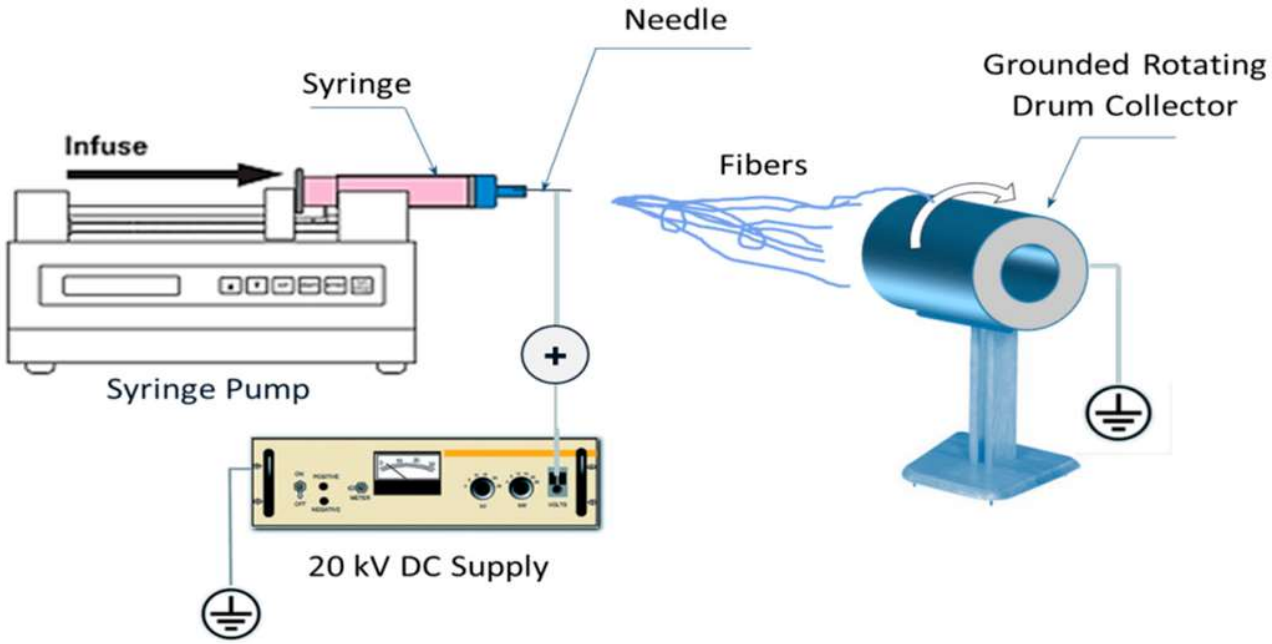
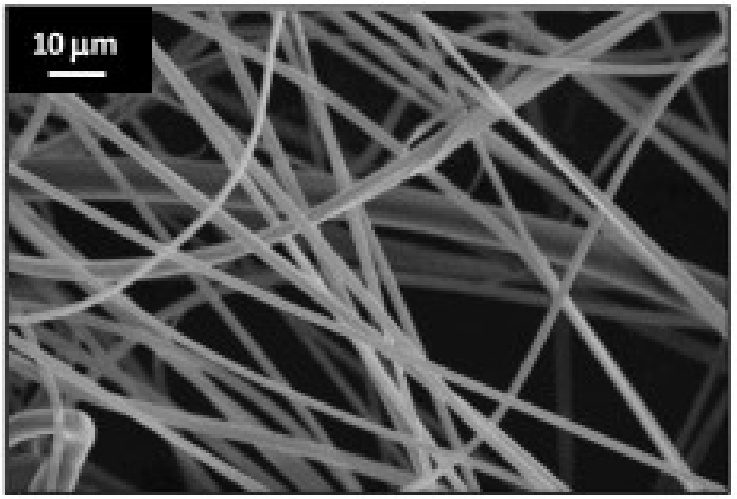
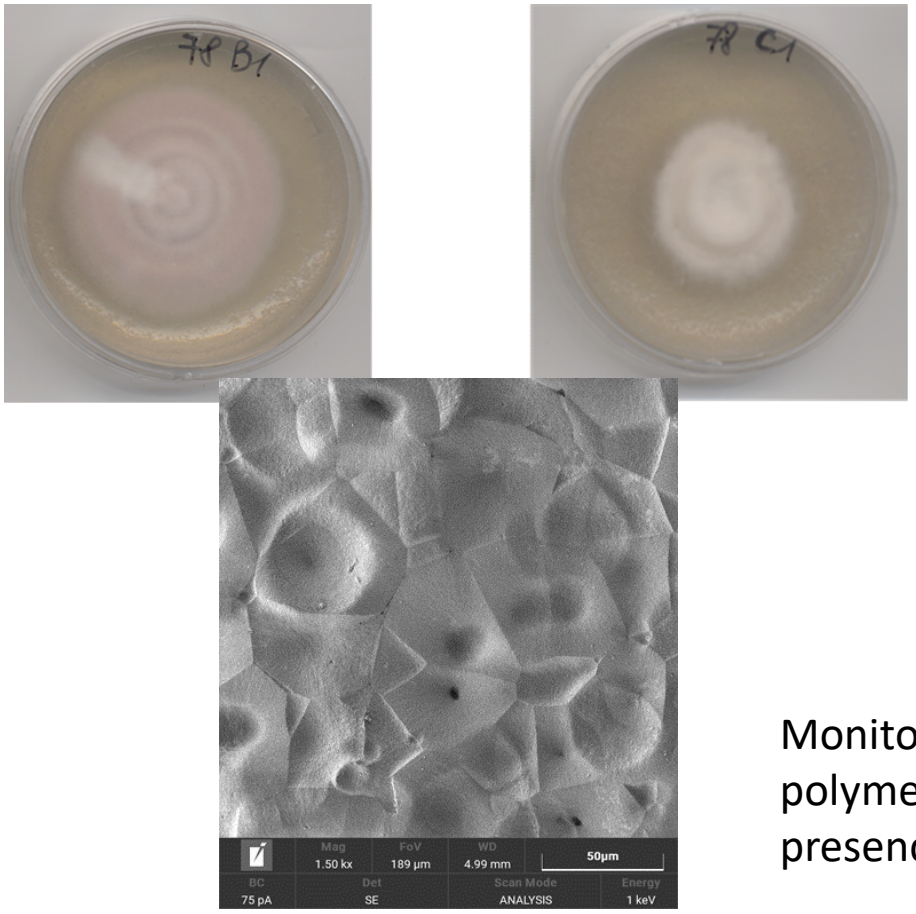


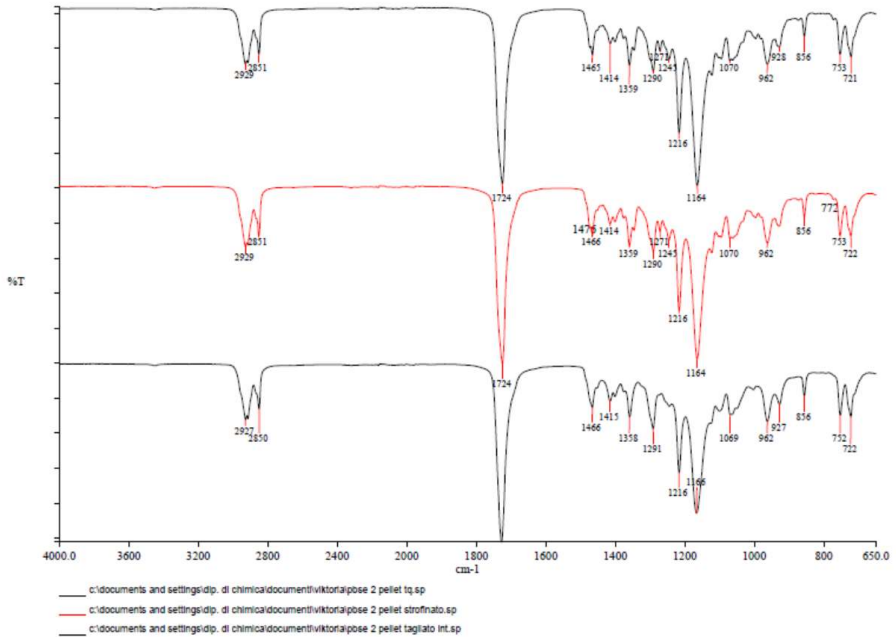


- Synthesis, modification and characterization of polymers derived from oligosaccharides (maltodextrins, cyclodextrins)
- Preparation of high surface area mats by electrospinning
- Study of applications in various fields: environmental (removal of pollutants), controlled release of drugs, carbon precursors,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

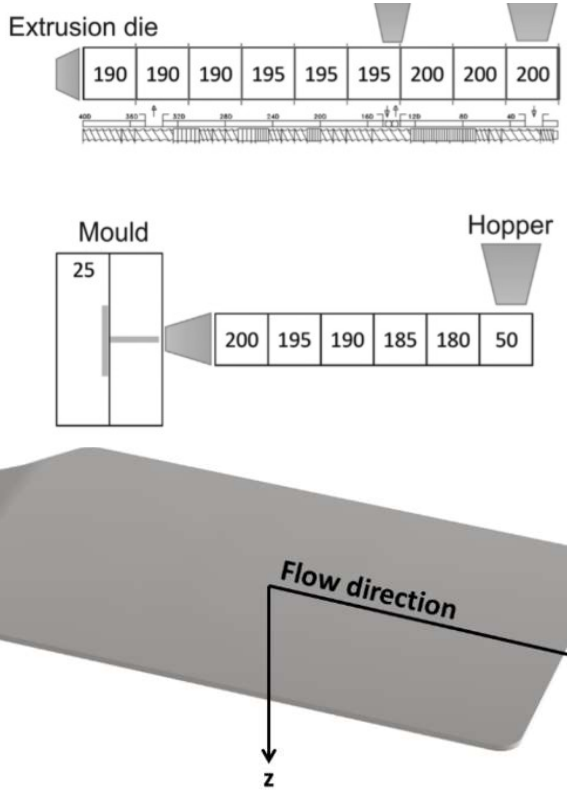




Monitoring of the degradation process of biodegradable polymers and study of their degradation mechanisms in the presence or absence of microorganisms

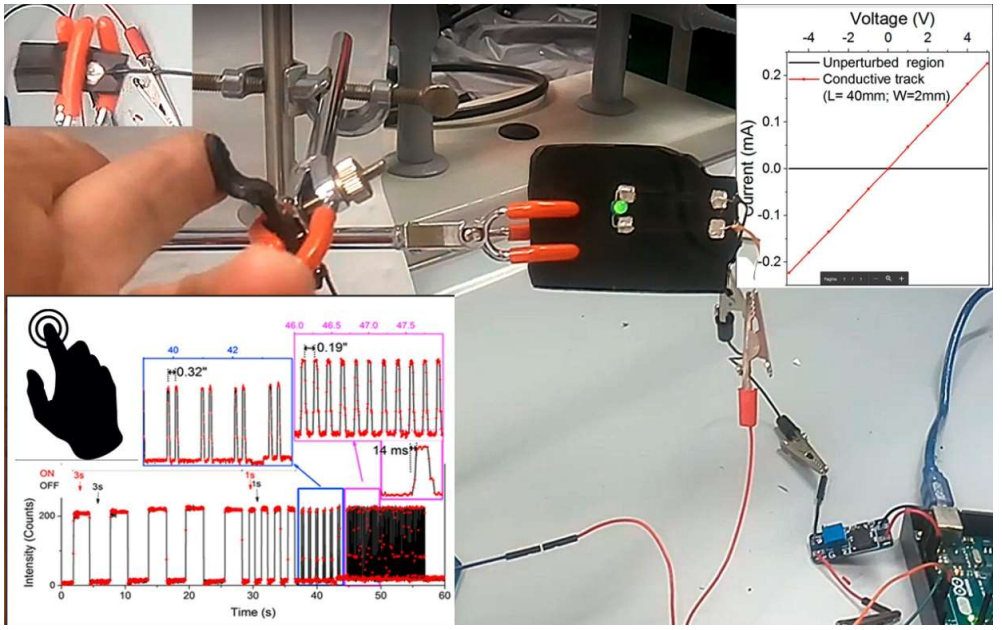
Topic: COMPOUNDING AND PROCESSING OF CONDUCTIVE POLYMER COMPOSITES FOR SMART APPLICATIONS

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.



Tesi esterne presso SICPA Italia S.p.A.

SICPA è specializzata in progettazione microfluidica, formulazione di inchiostri per tecnologie InkJet, scienza dei materiali e processi del silicio.
È possibile svolge tesi magistrali nella sede italiana dell'azienda, Arnad, Valle d'Aosta.

Progetti di tesi:

1. Sviluppo formulativo di un coating fotoreticolabile polimerico per applicazioni nella stampa digitale inkjet.
2. Studio dell'interazione di formulazioni (a base acquosa e base solvente) verso superfici metalliche e plastiche.

   Preparazione e caratterizzazione di superfici e soluzioni - Valutazione dell'interazione liquido-superficie.

SICPA Italia S.p.A.

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