Tirocinio: Istruzione per l'uso

19751	TIROCINIO I	7 CFU
19752	TIROCINIO II	3 CFU

Sito CDS: Tirocini

Commissione Tirocini
Prof.ssa Elisabetta Salatelli
Prof.ssa Maria Carmela Iapalucci
Prof.ssa Patricia Benito Martin

Ufficio tirocinio Scienze
Scuola di Scienze - Tirocini
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Coordinatore CdS: mariafrancesca.fochi@unibo.it
Tutor CdS: andrea.pellegrini11@studio.unibo.it

Tirocinio presso il Dipartimento di Chimica Industriale

Chimica Inorganica
Chimica Organica

Chimica Analitica
Chimica Fisica
Chimica Ambientale
Chimica Industriale (catalisi)
Chimica Industriale (polimeri)
Impianti Chimici
Chimica e Biotecnologia delle Fermentazioni

Docenti
Marco Garavelli

Dottorandi/Assegnisti/Borsisti
Flavia Aleotti

In ogni ambito sono attivi diversi gruppi di ricerca **Chimica Fisica**

Ivan Rivalta
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Orlandisilvia.cristofaro@unibo.it

Luca Mucciolifrancesco.segatta@unibo.it

Elisabetta Venuti

Tommaso Salzillo

Elisabetta Canè

Filippo Tamassia

Alberto Arcioni

Lorenzo Soprani

Lorenzo Pandolfi

Silvia Cristofaro Silvia Francesco Segatta

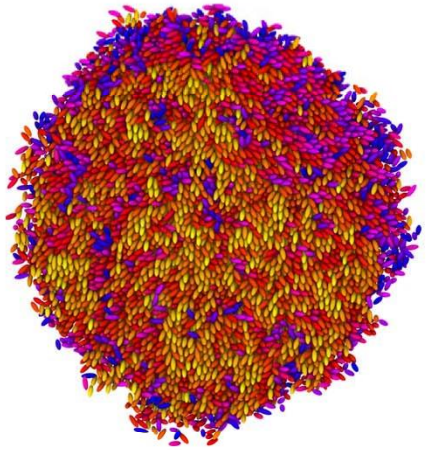
Vishal Kumar Jaiswal Mohammad

Giacomo Fanciullo

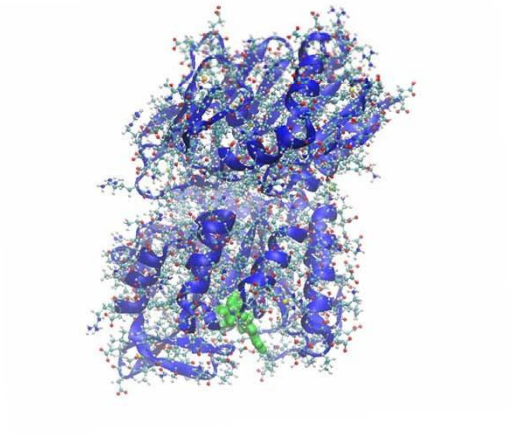
Mario Taddei

Emilio Lorini

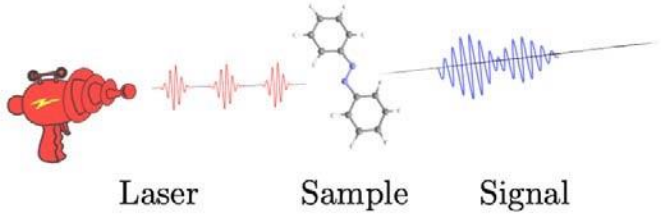
Chimica Fisica Computazionale



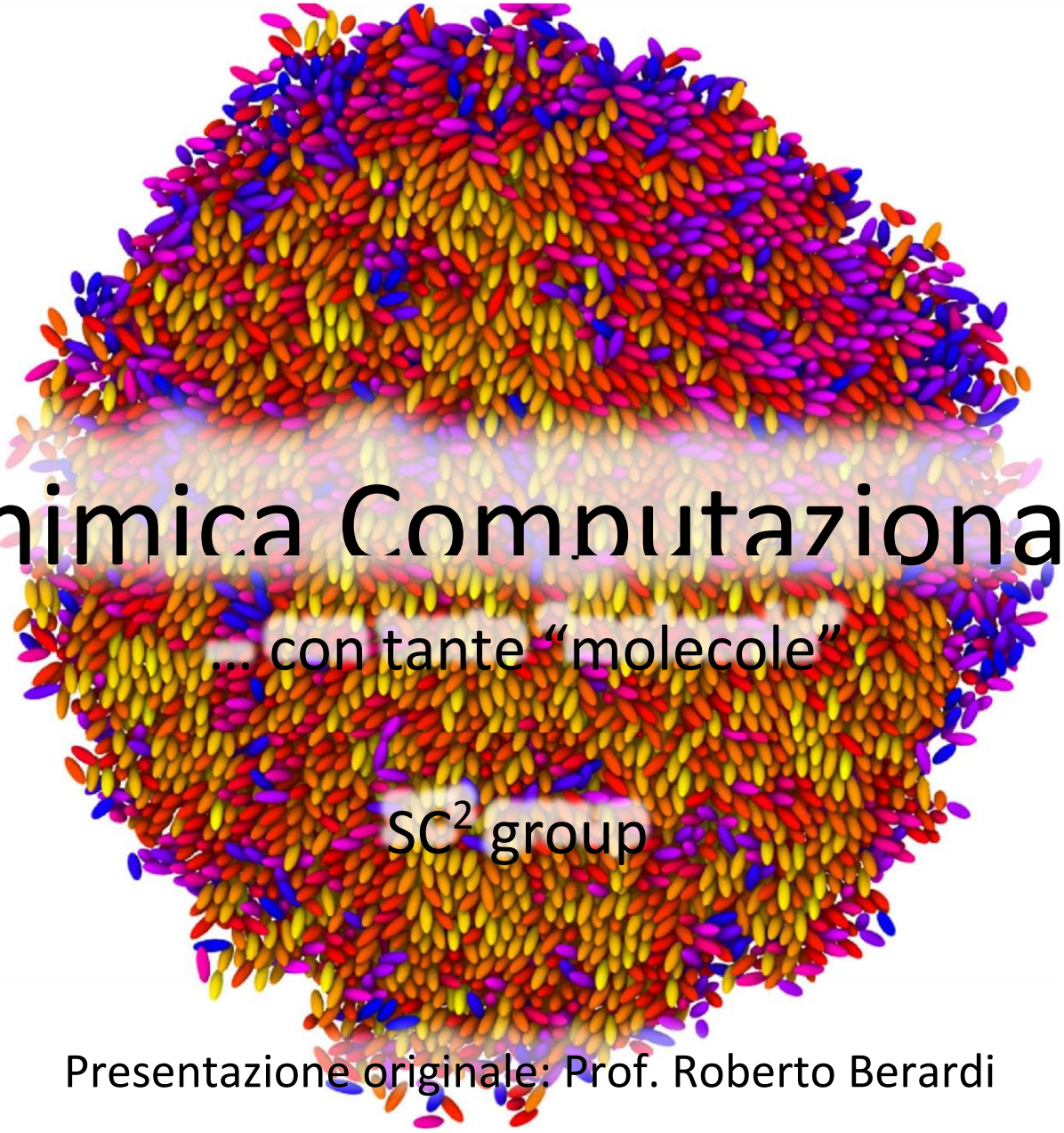
…tante “molecole”…



…catalisi e trasporto …



… fotochimica e fotofisica …



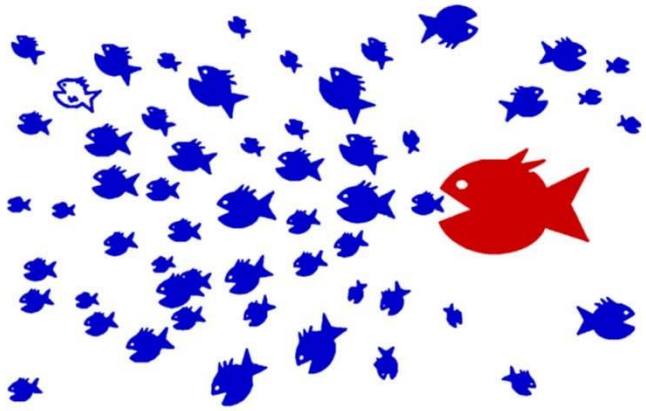
Chimica Computazionale

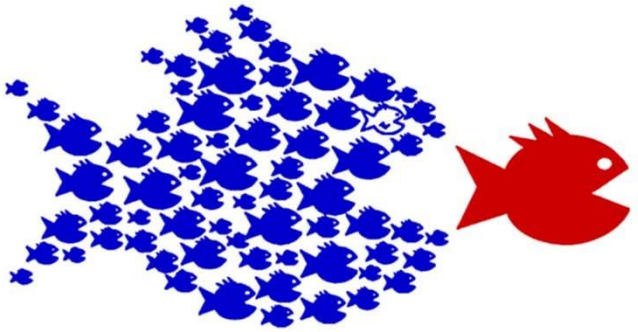
… con tante “molecole”

SC^2 group

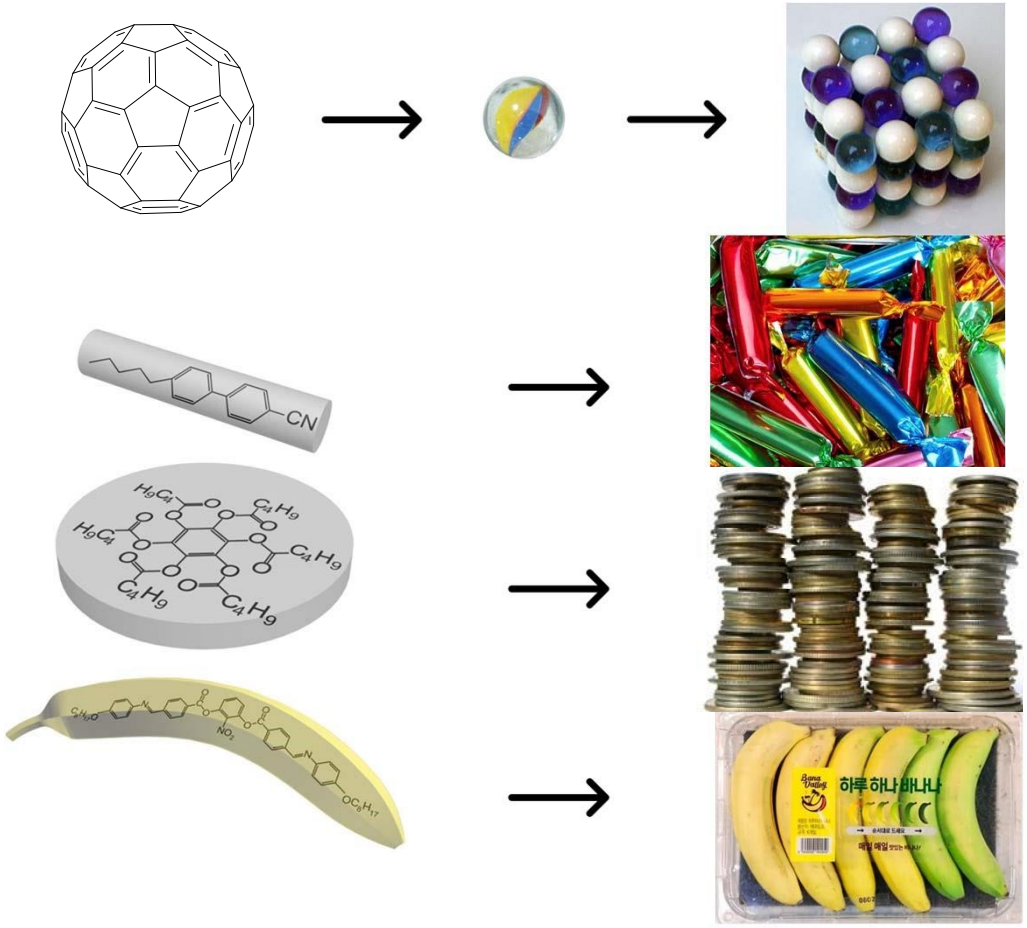
Presentazione originale: Prof. Roberto Berardi

… con **tante** "molecole"



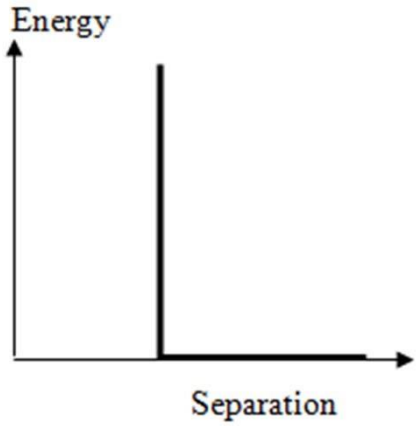


… con tante **"molecole"**

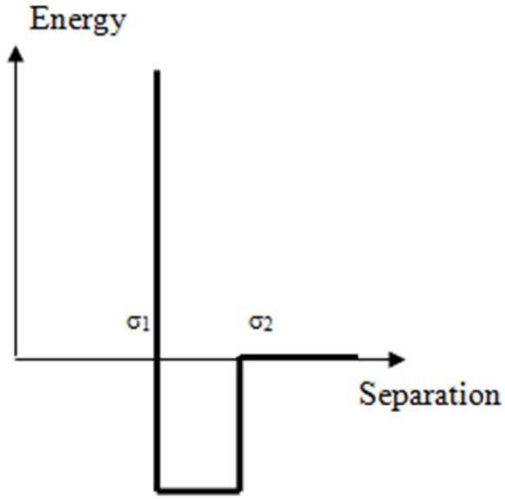


Interazioni semplificate

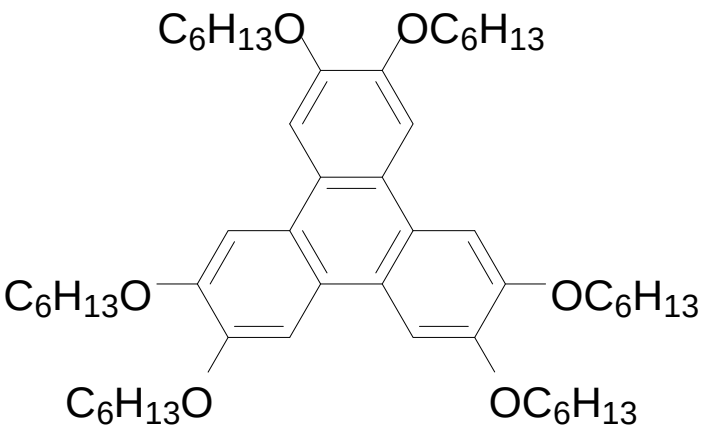
Hard spheres

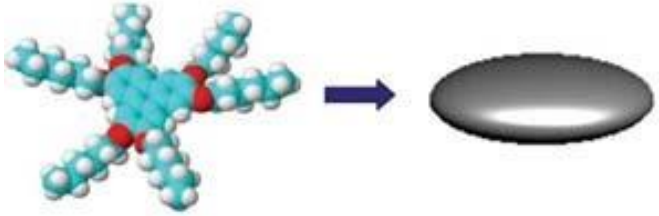


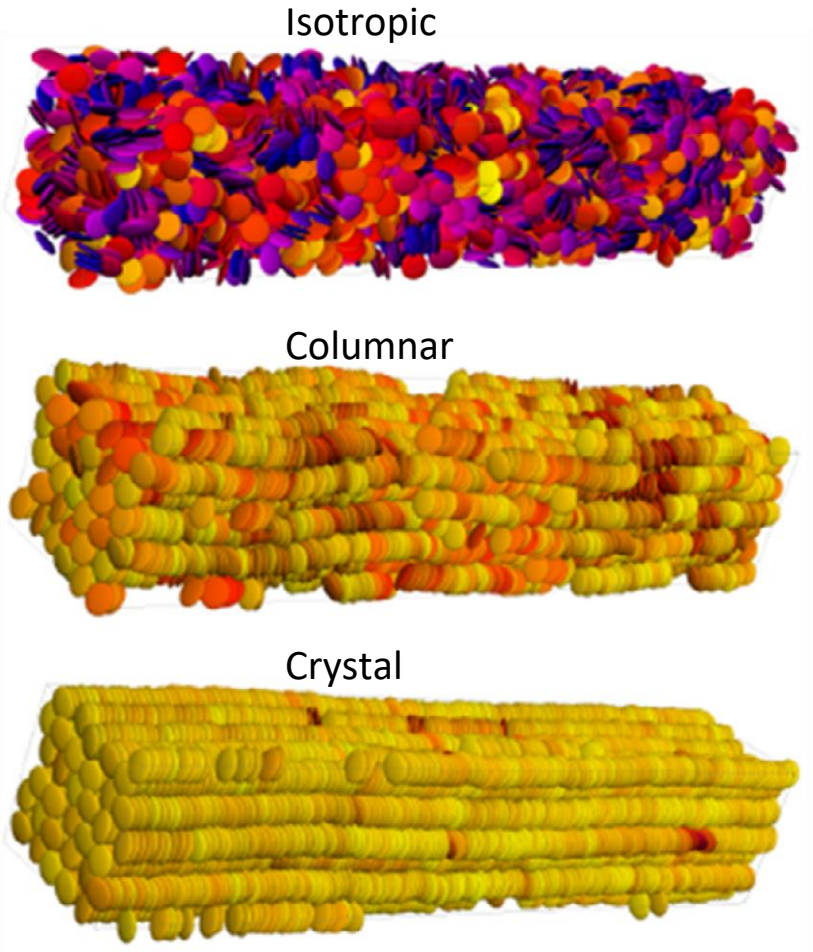
Square well



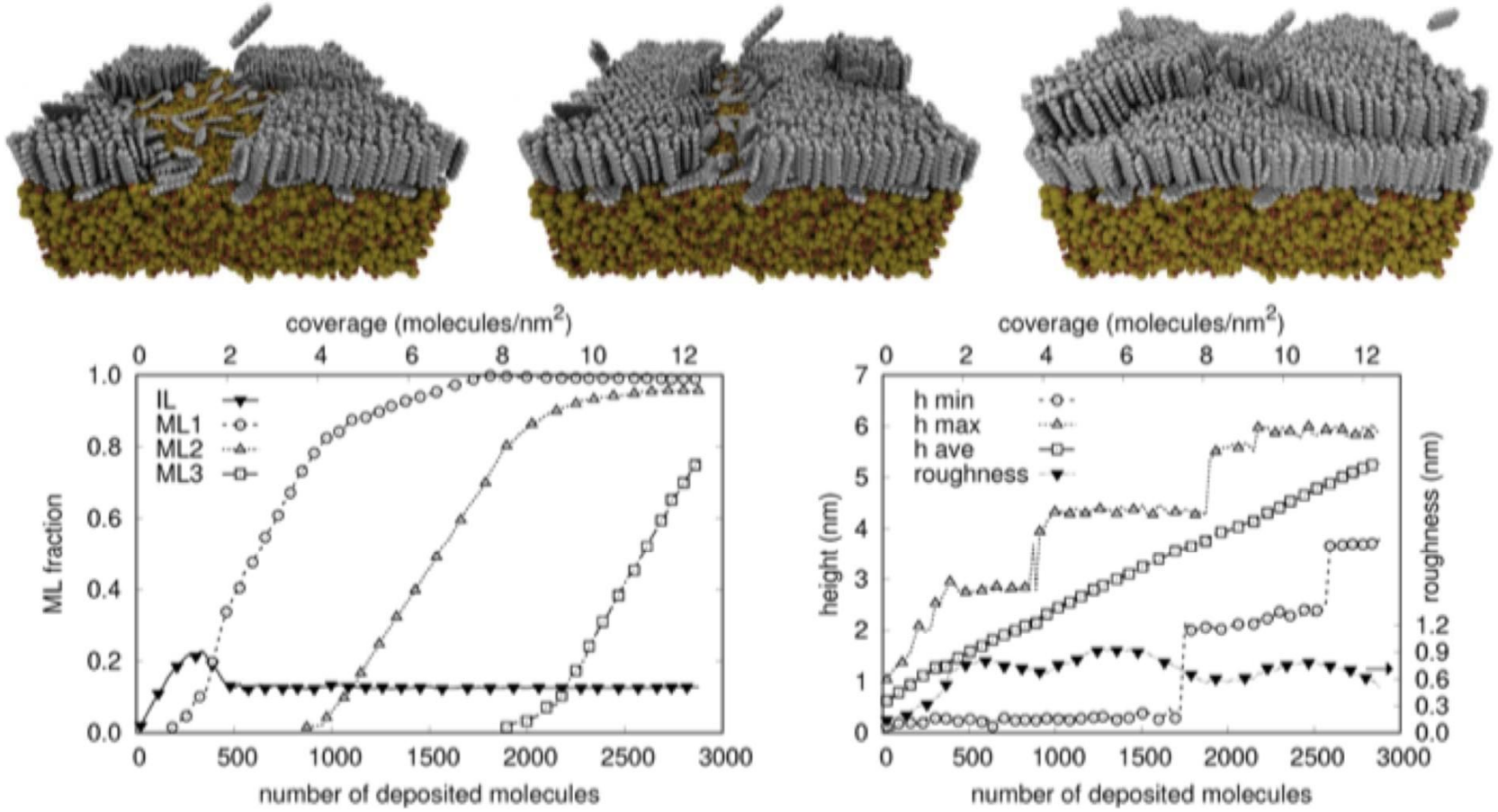
Previsioni sulle fasi di aggregazione



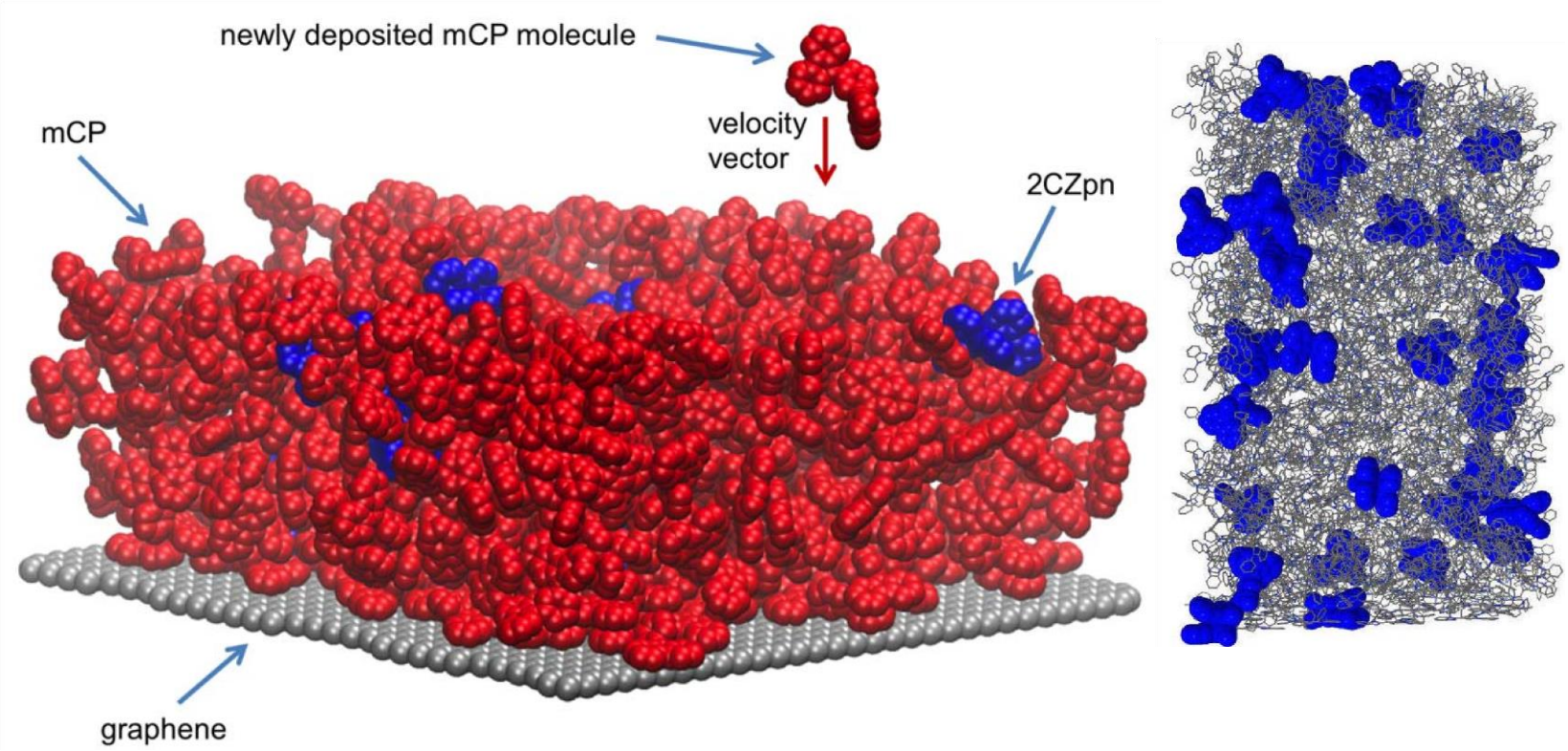




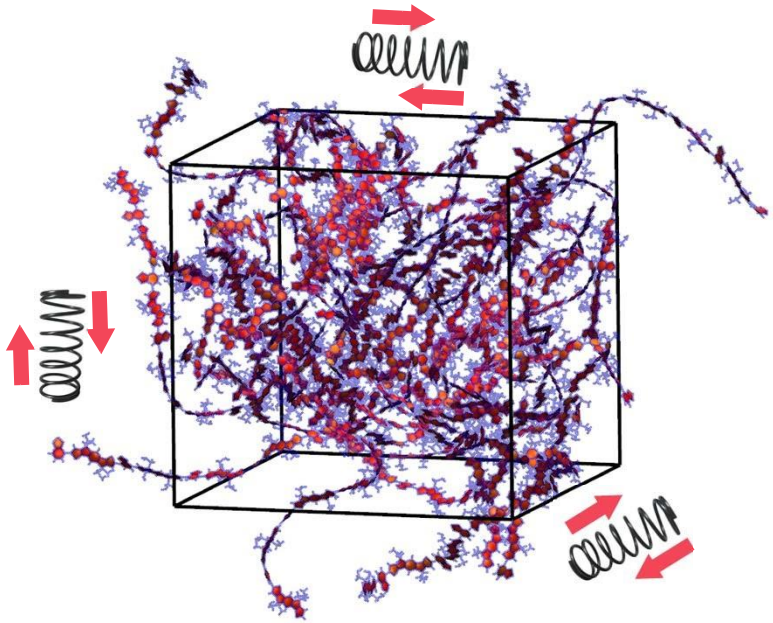
Accrescimento di cristalli

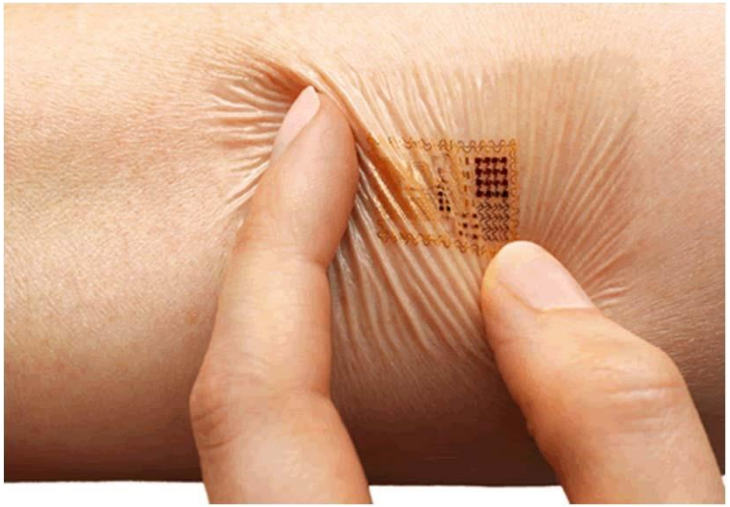


Simulazione di deposizione di materiali per OLED

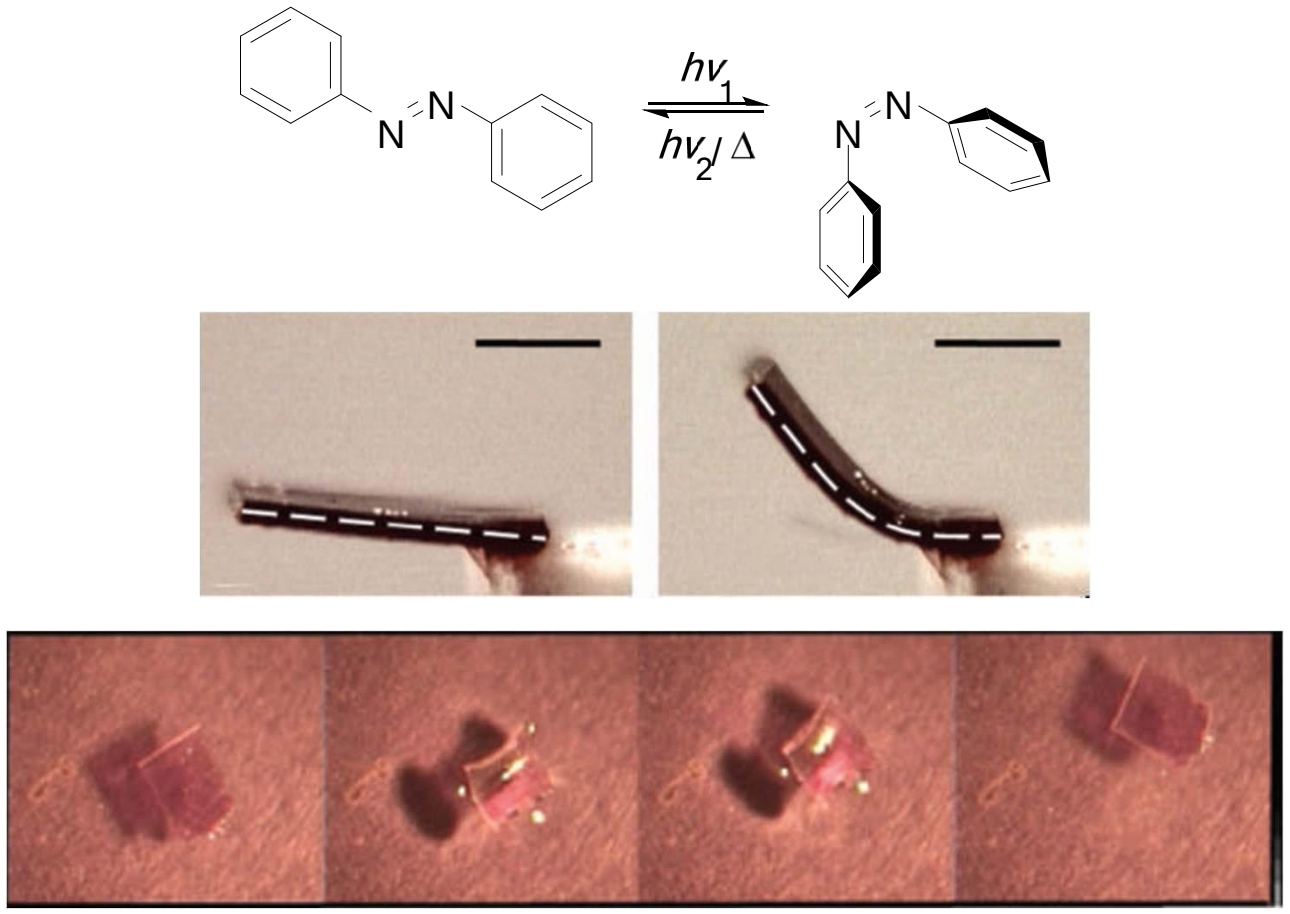


Studio delle proprietà meccaniche di polimeri semiconduttori





Simulazioni semiclassiche di fenomeni fotochimici (azobenzene)



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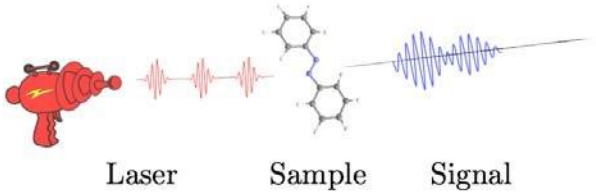
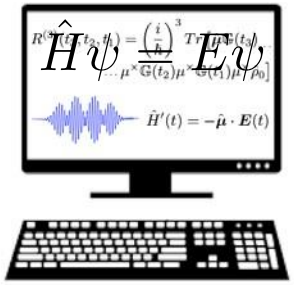
FOTOCHIMICA COMPUTAZIONALE

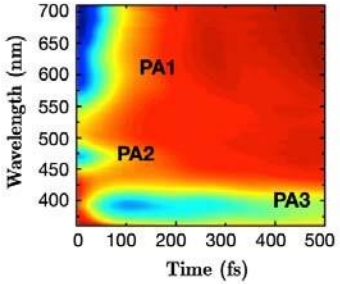
(Prof. Marco Garavelli)

Simulazioni al CALCOLATORE di proprietà statiche e dinamiche

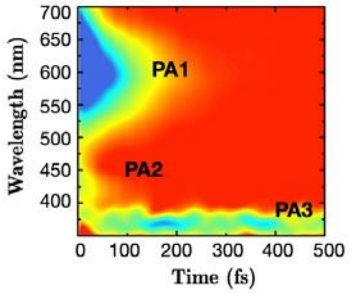
di STATO ECCITATO usando metodi QUANTOMECCANICI







Esperimento



Simulazione

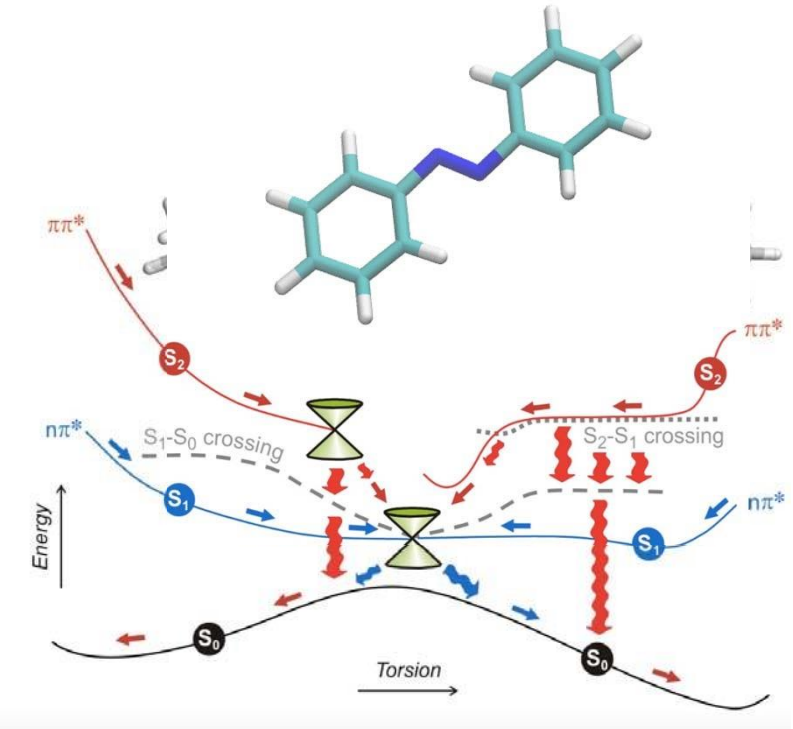
COSA FACCIAMO?

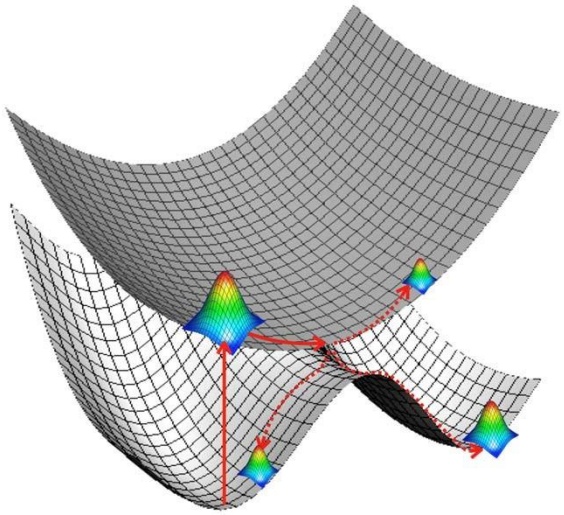
Calcoli di Chimica Quantistica

Simulazioni di Spettroscopia

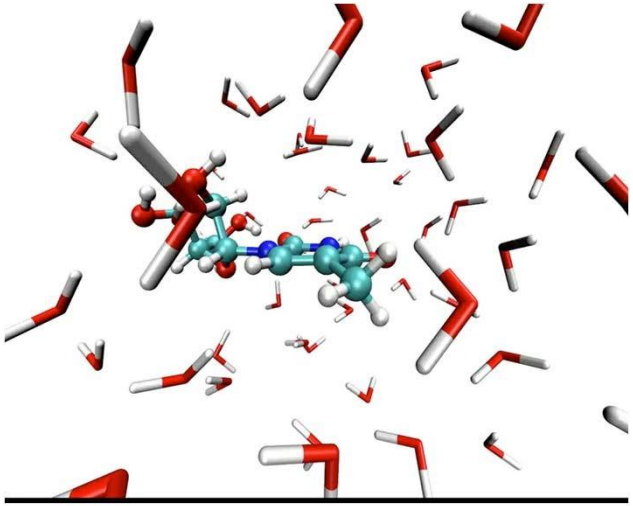
COSA FACCIAMO?

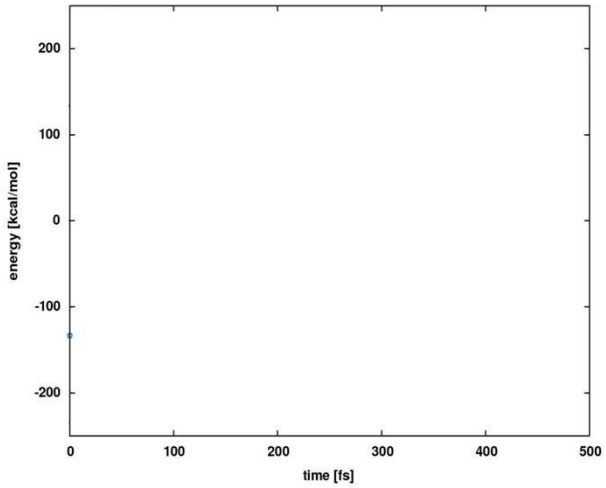
Meccanismi di reazione su STATO ECCITATO





COSA FACCIAMO?

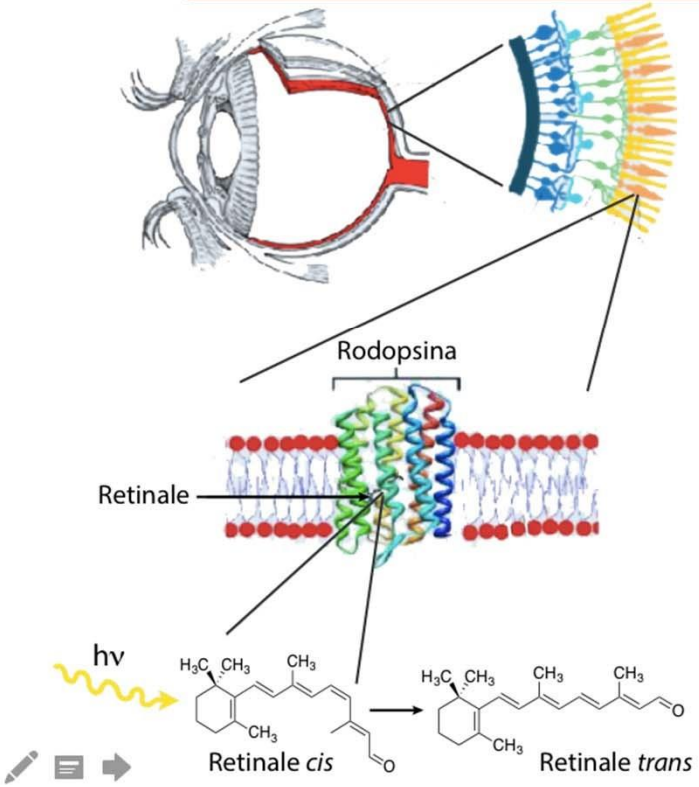




COSA FACCIAMO?

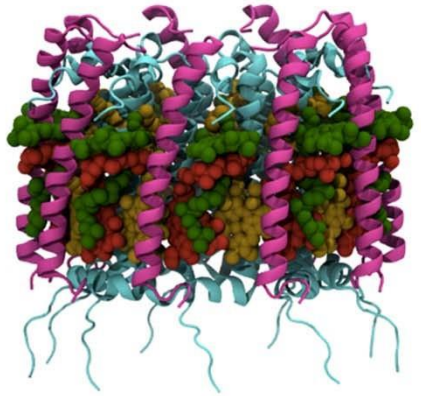
Cosa succede a un sistema molecolare quando viene eccitato dalla luce?

Meccanismo della visione



DNA

Light Harvesting complexes



CONTATTI

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Chimica Computazionale:

- Catalisi

- Trasporto in sistemi complessi

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

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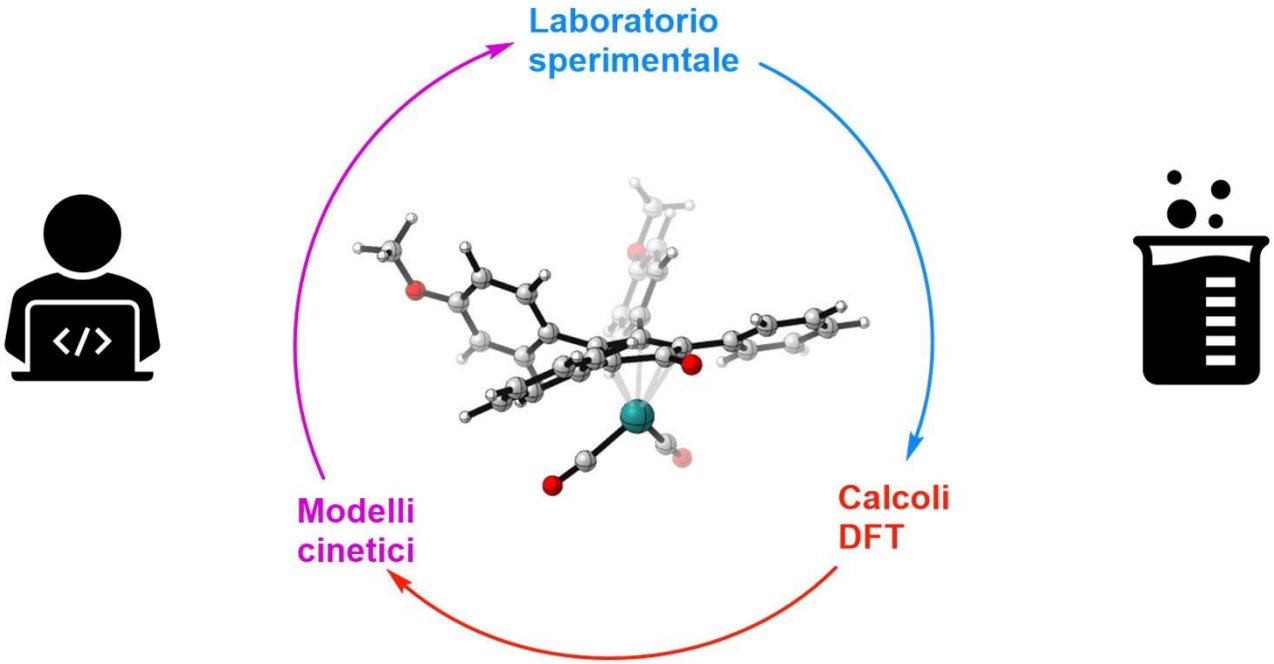
Dr. Giacomo Fanciullo, giacomo.fanciullo2@unibo.it
Dr. Aria Gheeraert, aria.gheeraert3@unibo.it

Dipartimento di Chimica Industriale "Toso Montanari"

Studio teorico di catalizzatori omogenei

Sistemi metallorganici
(catalizzatori organorutenici)

Reattività
(meccanismi e cinetiche)



Formazione e ricerca:

- **Modeling** (molecolare e sistemi in soluzione)
- **Chimica quantistica** (teoria DFT)
- **Reattività** (teoria dello stato di transizione e modelli cinetici)

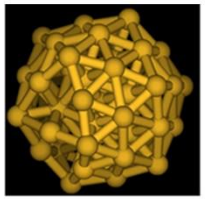
Dr. Francesco Calcagno
francesco.calcagno@unibo.it

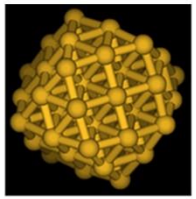
Studio teorico di catalizzatori eterogenei

Modeling di nano-materiali

Nanoparticelle metalliche

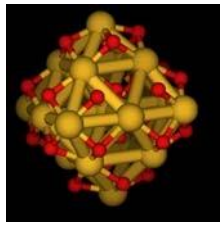
Au_{55}

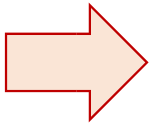




Nanoparticelle ossidi metallici

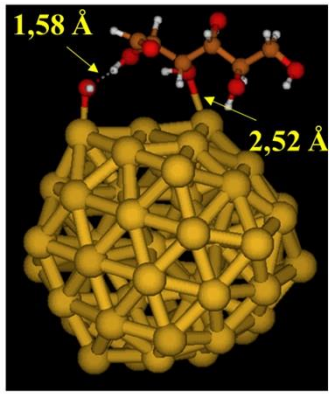
ZrO_2

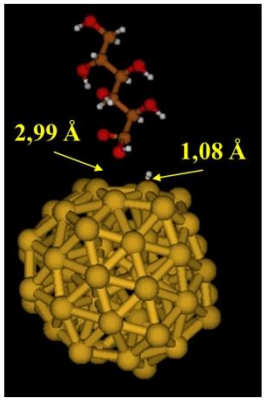




Reattività

(adsorbimento e meccanismi)





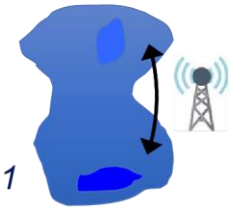
Formazione e ricerca:

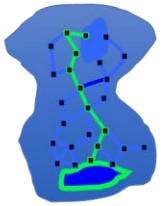
- **Modeling** (molecolare e nanosistemi)
- **Chimica quantistica** (teoria DFT)

Dr.Alessia Ventimiglia
alessia.ventimiglia3@unibo.it

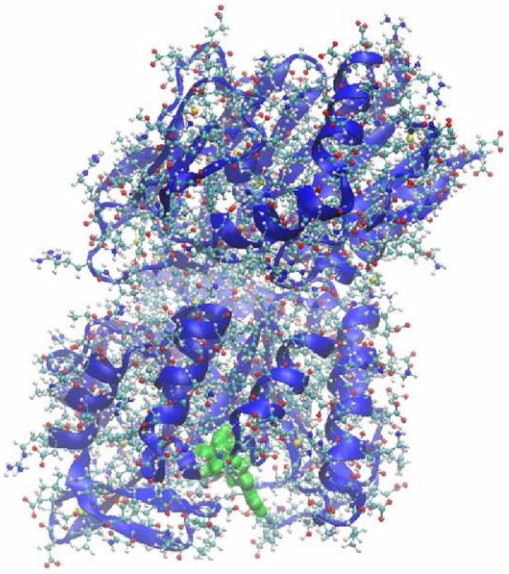
- **Reattività** (teoria dello stato di transizione e modelli cinetici)

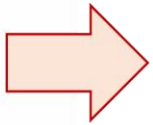
Segnali chimici nei sistemi biologici

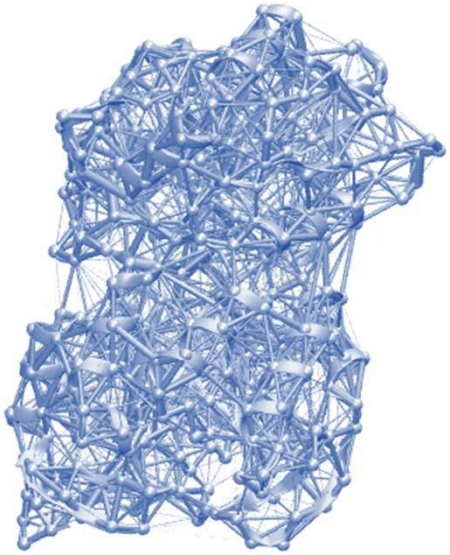




Dinamica molecolare classica







Formazione e ricerca:
Sito 2

Dr. Aria Gheeraert

Proteine

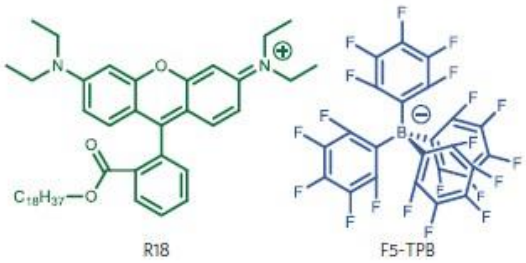
Rete di comunicazione proteica

aria.gheeraert3@unibo.it

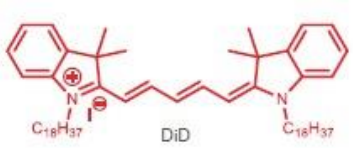
- **Dinamica molecolare** (meccanica classica)
- **Analisi di sistemi complessi** (teoria delle reti ed intelligenza artificiale)

Trasporto di energia luminosa in sistemi artificiali

Nanoantenna



Donatore **controione**

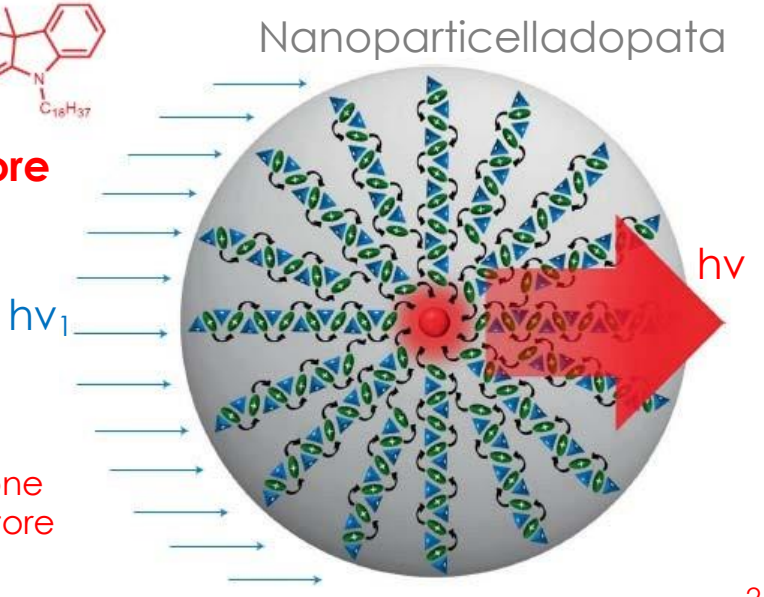


Accettore

Assorbimento Donatore

Emissione Accettore

Trasferimentodi energia



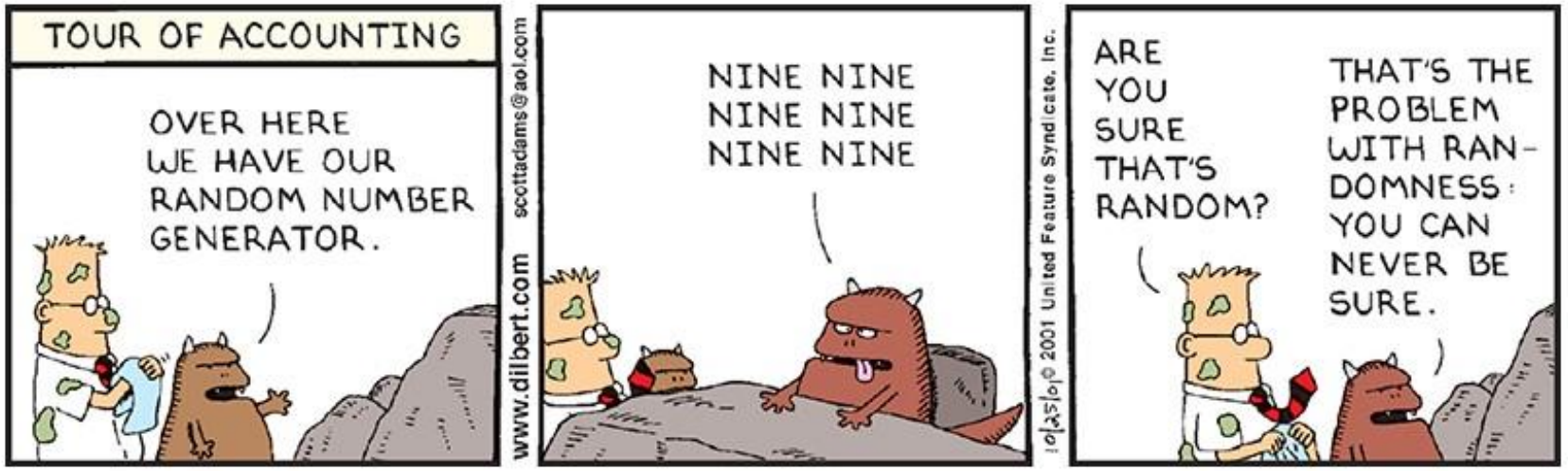
Formazione e ricerca:

Dr. Giacomo Fanciullo

- **Modeling** (molecolare e sistemi complessi) *giacomo.fanciullo2@unibo.it*
- **Chimica quantistica** (teoria DFT e time-dependent DFT)
- **Dinamica molecolare e trasporto** (meccanica classica e modelli cinetici)

Effetti collaterali positivi (?)

- Sviluppo di *soft skills* (pazienza)
- Si diventa bravini col computer
- Spazio per arte e creatività



Docenti

Stefano Zacchini

Inorganica

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Silvia Bordoni Andrea Masetti

Rita Mazzoni Valentina di Matteo

Stefano Stagni valentina.dimatteo5@unibo.it Giacomo Drius

Maria Cristina Cassani Federico Nicoli

Alberto Credi Erica Paltrinieri

Stefano Corrà ….

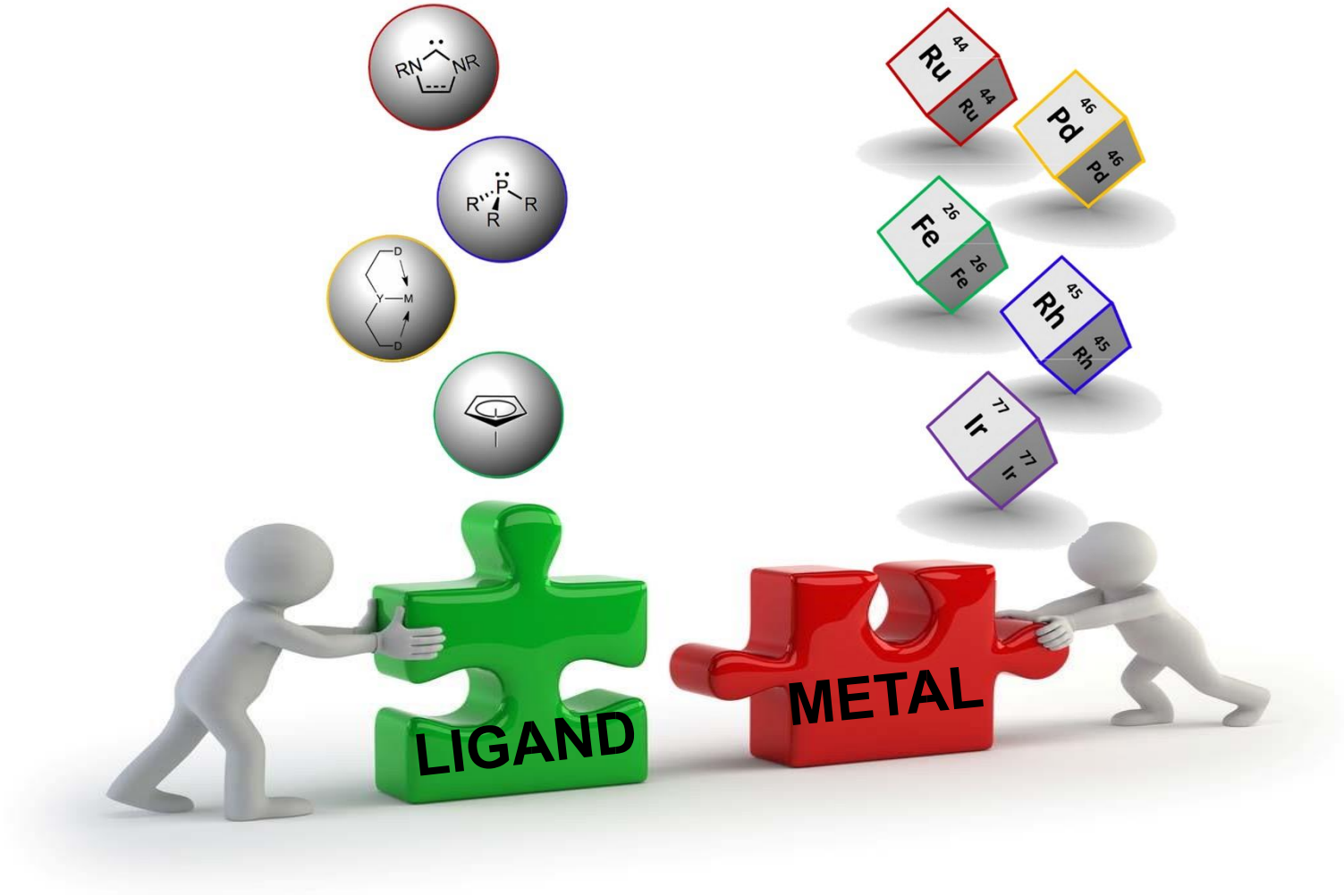
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Laboratoryof organometallic chemistry

Prof.: Valerio Zanotti, Rita Mazzoni, Stefano Stagni.

Dipartimento di Chimica Industriale «Toso Montanari»

Organometallic chemistry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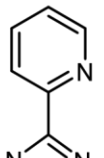
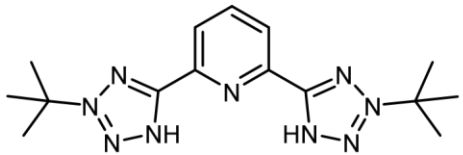
LIGAND
METAL

Organometallic chemistry



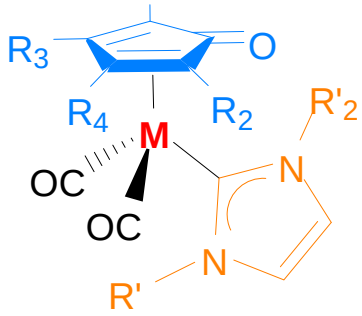


Rita Mazzoni Dipartimento di Chimica Industriale «Toso Montanari»

E-mail: rita.mazzoni@unibo.it

R_1

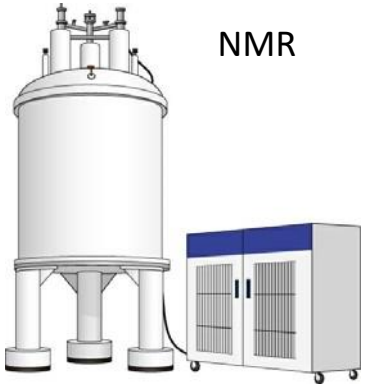
LIGANDS COMBINATIONS ON TRANSITION METAL (Fe, Ru, Mn) ORGANOMETALLIC COMPLEXES



M = e.g. (Fe, Ru, Mn)

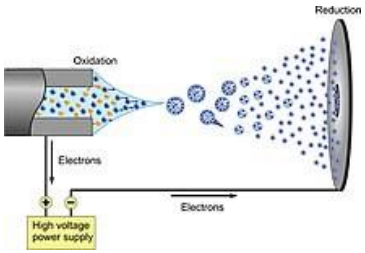
• ***CHARACTERIZATION***

NMR

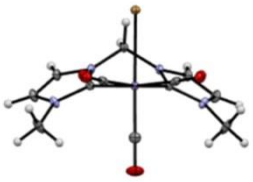


IR

ESI-MS

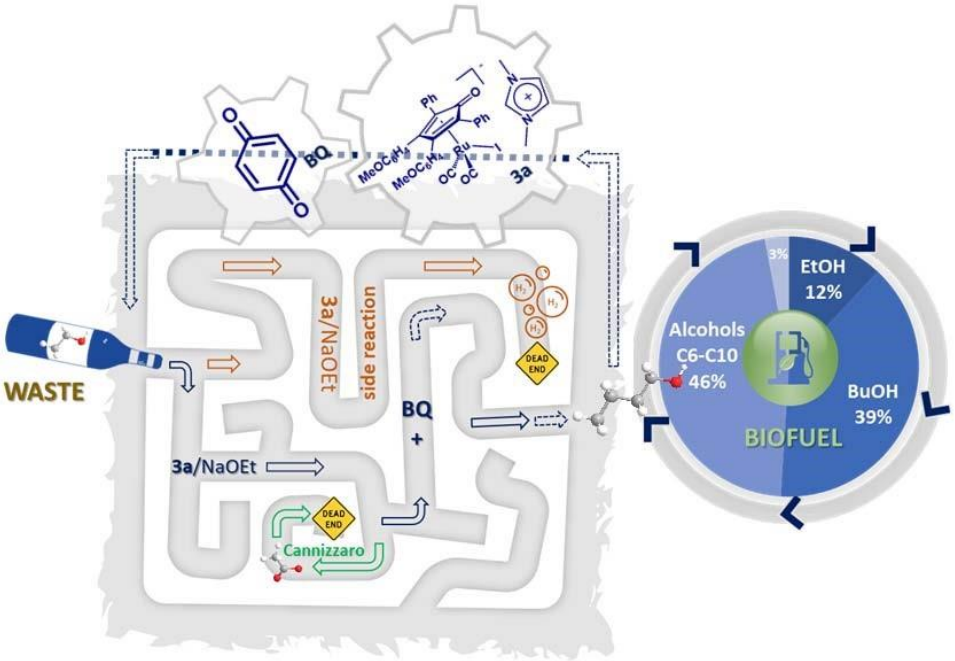


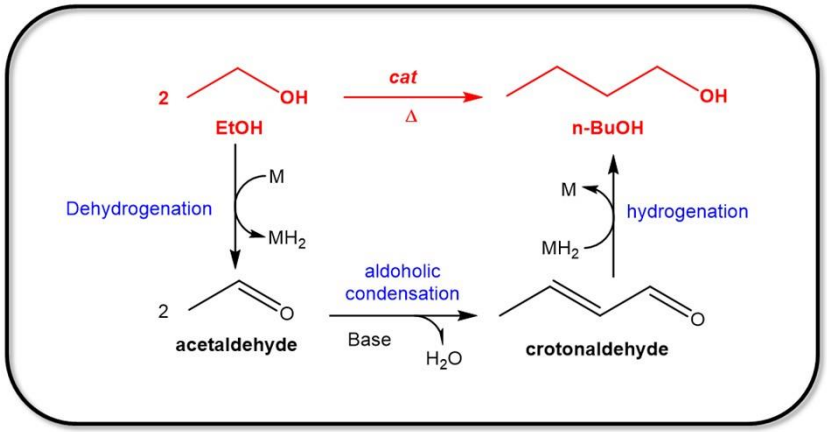
X-RAY DIFFRACTION



HOMOGENEOUS CATALYSIS APPLIED TO SUSTAINABILITY

- ***Valorization of biomass derivatives (e.g. Bioethanol homologation)***;





C. Cesari, A. Gagliardi, A. Messori, N. Monti, V. Zanotti, S. Zacchini, I. Rivalta, F. Calcagno, C. Lucarelli, T. Tabanelli, F. Cavani, R. Mazzoni, J. Catal. 405 2022 47–59

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HOMOGENEOUS CATALYSIS APPLIED TO SUSTAINABLE ENERGY

- ***Electrocatalytic water oxidation;***

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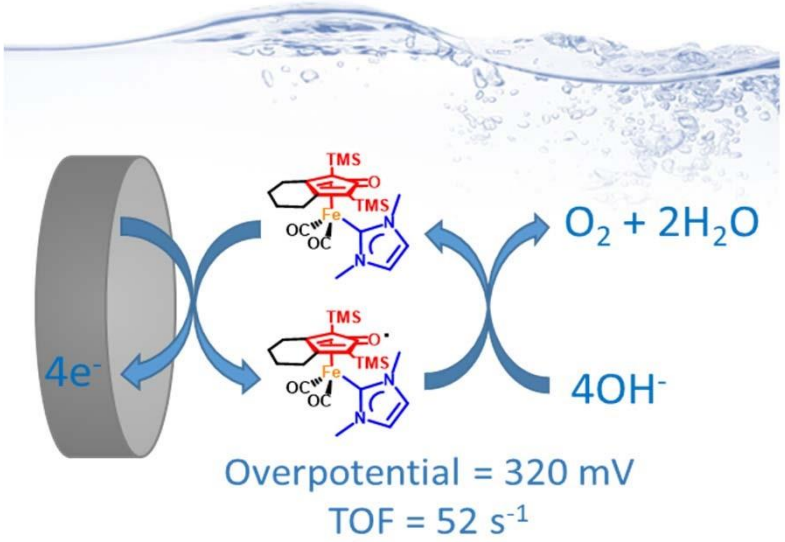
Design and application of earth abundant iron based molecular electrocatalysts for water oxidation, an essential challenge for sustainable energy applications.



A. Cingolani, I. Gualandi, E. Scavetta, C. Cesari, S. Zacchini, D. Tonelli, V. Zanotti,ab P. Franchi, M. Lucarini, E. Sicilia, G. Mazzone, D. Nanni, R. Mazzoni, Catal. Sci. Technol., **2021**, 11, 1407–1418. rita.mazzoni@unibo.it

- ***«Hydrogen storage»****: de-hydrogenation of amino-borane*;

MOLECULAR CATALYSTS IMMOBILIZATION

- ***Hydrogen transfer in Biphasic mixtures (e.g. ^{i}PrOH/ionic liquids);***
- ***Immobilized Ruthenium molecular catalysts (e.g. H-transfer on polymeric dendrimers);***

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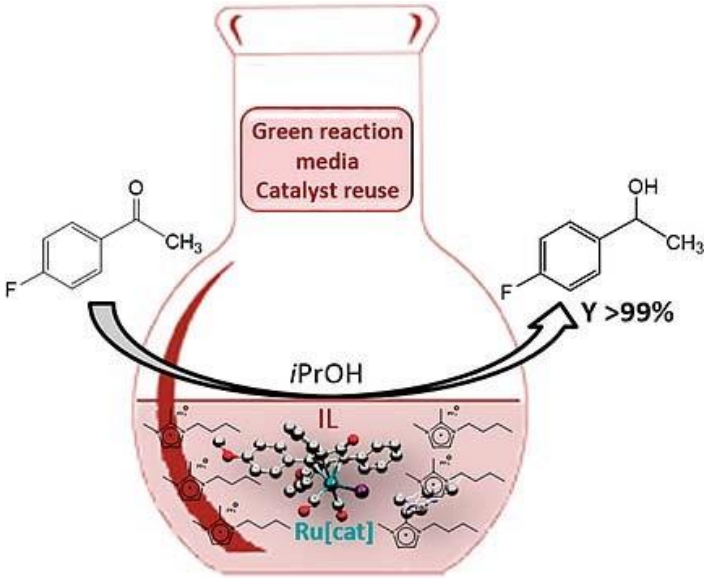
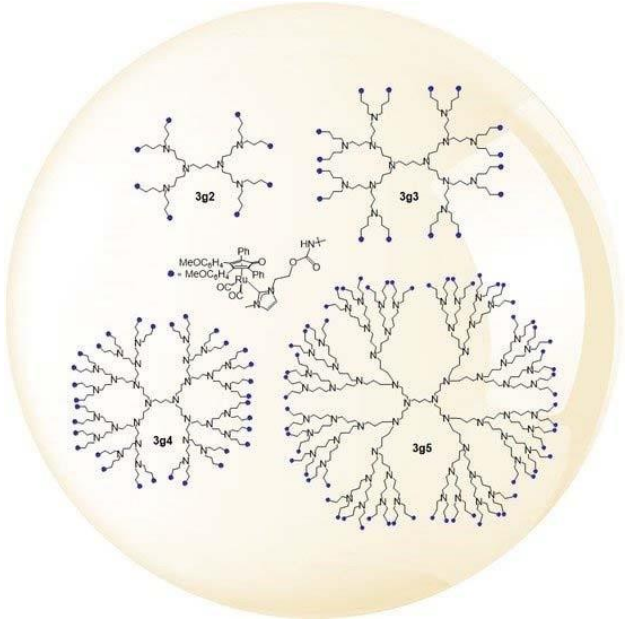


C. Cesari, A. Cingolani, M. Teti, A. Messori, S. Zacchini, V. Zanotti, R. Mazzoni, Eur. J. Inorg. Chem. **2020**, 1114–1122



C. Cesari , R. Conti, A. Cingolani, V. Zanotti, M. C. Cassani, L. Rigamonti. R. Mazzoni, Catalysts **2020**, 10, 264-275

- ***Design and synthesis of suitable polymers for*** rita.mazzoni@unibo.it ***recycle and reuse;***

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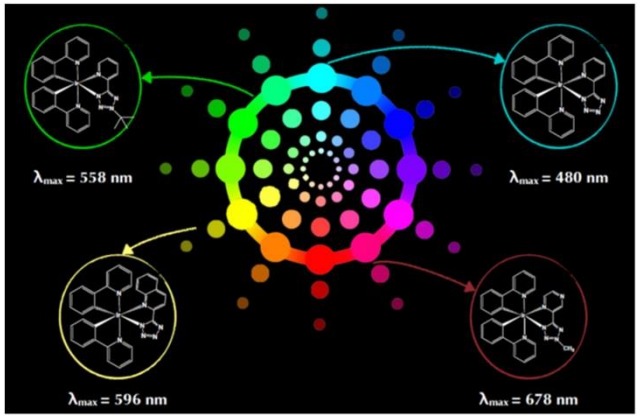

Photoactive Metal Complexes for Materials Science

Organic molecules are combined with **transition metal ions** such as **Ir(III)**, **Re(I)**, **Ru(II)**, **Cu(I)**,

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Pt(II), to prepare **coordination/organometallic complexes** that can efficiently **absorb visible light**, can display **bright luminescence,** are able to **transfer electrons** or, possibly, can do **all these things together**.

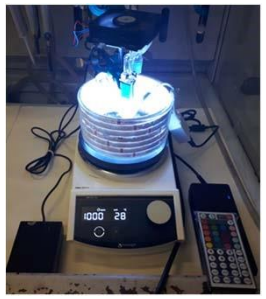
LuminescentMetalComplexes aredesignedforobtaining **afull-colouredpalette** ofemissivemoleculestobeusedin **photocatalysis**, **lightemittingdevices** (OLEDs, LEECs), **luminescentsolarconcentrators** , **whitelight** emitters.

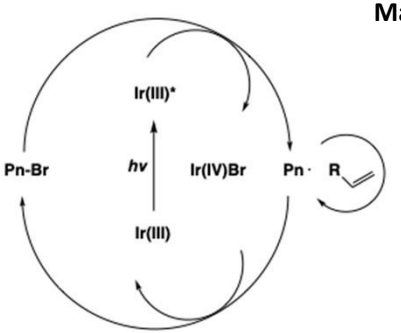
OLEDs..

with
Massimo Cocchi @CNR

LSC

Luminescent Solar Concentrators
with Proffs **Andrea Pucci** @UniPI
and **Loris Giorgini** @UniBO





White Light emission

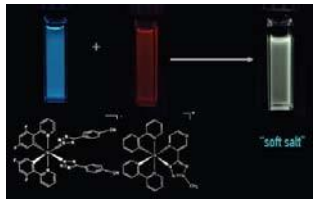


Photo-ATRP

Atom Transfer Radical Polymerization
with Prof. **Loris Giorgini** @UniBO

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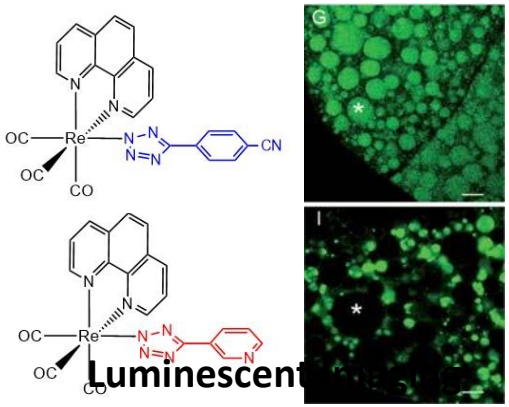
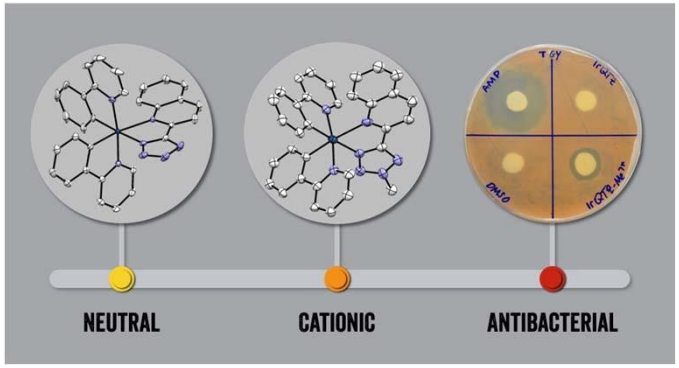
Stefano Stagni Dip. Chimica Industriale Toso Montanari
stefano.stagni@unibo.it

Photoactive Metal Complexes for Life Science

Luminescent metal complexes of Ir(III), **Re(I)**, and **Ru(II)**, are designed and synthesized for obtaining new **optical markers for live cells**, new classes of **selective antibacterials** and new **luminescent dyes for protein staining**.



Luminescent [illegible]
of Live Eukaryotic Cells and Live Bacteria
with Prof. **Max Massi** @Curtin Uni. **Australia**



Metal complexes as new ANTIBACTERIALS
with Dr. **Alessandra Stefan** @UniBO
alessandra.stefan@unibo.it

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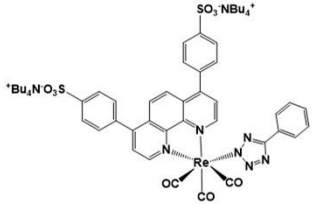
Luminescent Staining of Proteins

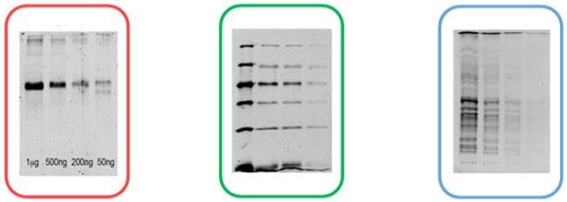
with Dr. **Alessandra Stefan** @UniBO



Bovine Serum Albumine

Protein molecular weight marker

E. coli protein extract



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alessandro.messori6@unibo.it

ALMA MATER STUDIORUM
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TRANSITION METAL CARBONYL CLUSTER COMPOUNDS

DESIGN, SYNTHESIS AND CHARACTERIZATION OF METAL CARBONYL CLUSTERS AS MOLECULAR METAL NANOPARTICLES

Area di Chimica Inorganica

Dipartimento di Chimica Industriale "Toso Montanari"

RESEARCH GROUP

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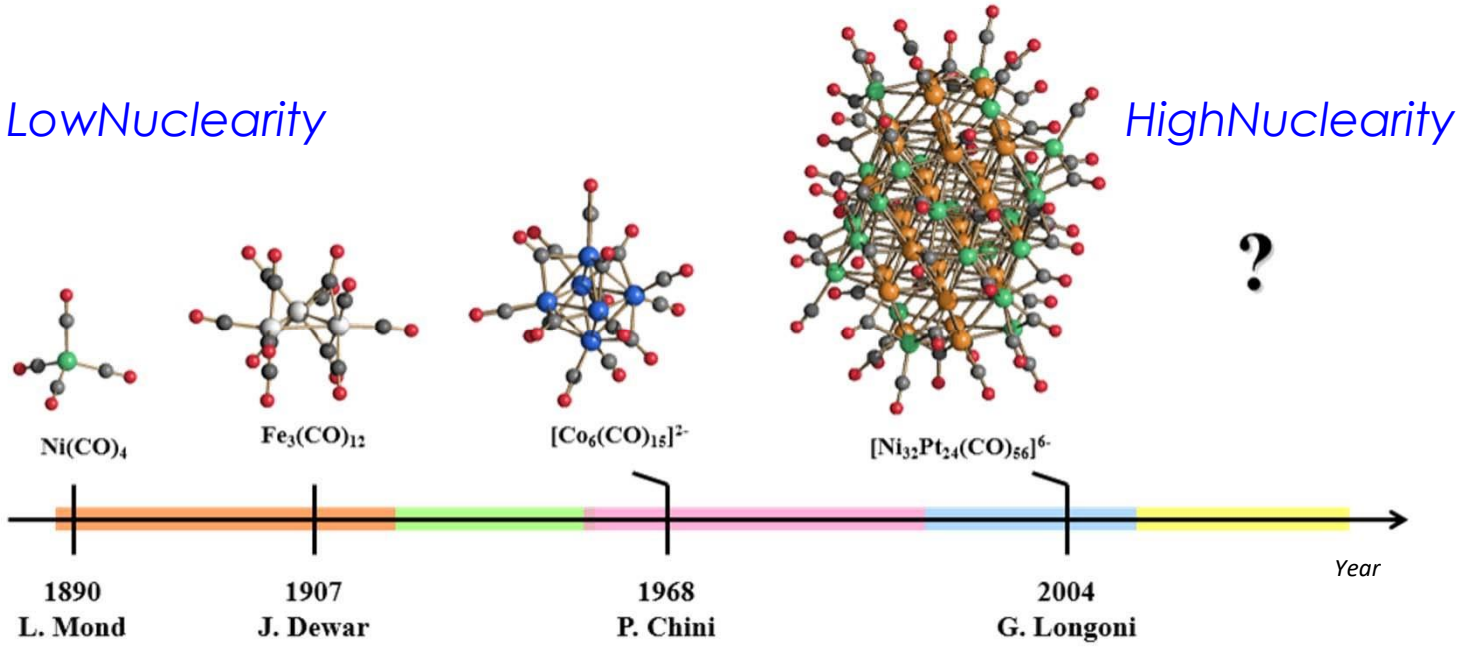
Prof. Stefano Zacchini
stefano.zacchini@unibo.it

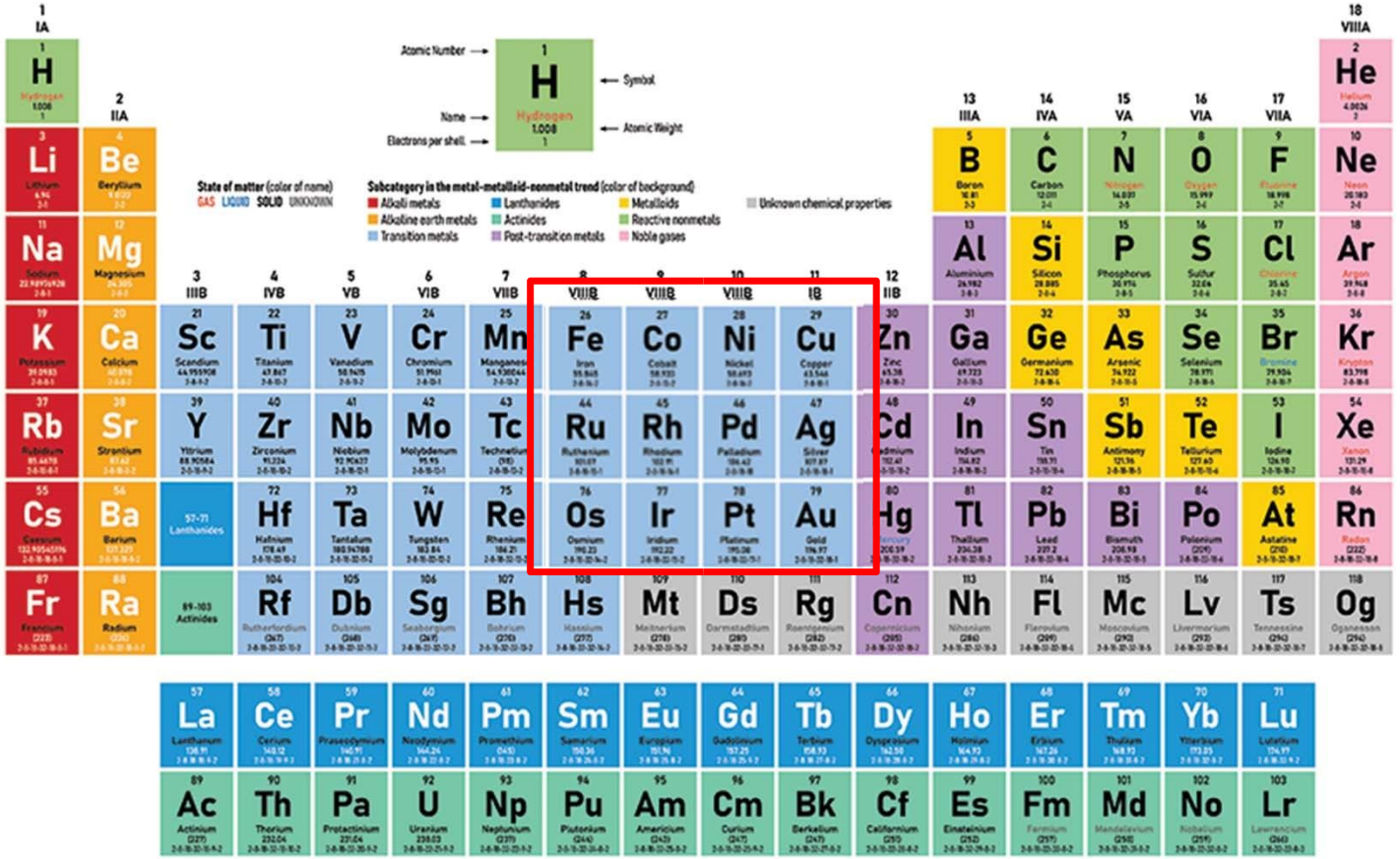
What is a Metal Cluster?

F. A. Cotton (1966): a metal cluster is a molecular species consisting of "…*a finite group of metal atoms held together mainly, or at least to a significant extent, by metal-metal bonds.*"



Coord. Chem. Rev., **2006**, *250*, 1580; *Eur. J. Inorg. Chem.*, **2011**, 4125; *J. Clust. Sci.*, **2014**, *25*, 115; *Coord. Chem. Rev.*, **2018**, *335*, 27; *Eur. J. Inorg. Chem.*, **2018**, 3285, *Acc. Chem. Res.*, **2018**, *51*, 2748

Periodic Table of the Elements



what do we do?

- Synthesis of inorganic compounds under an inert atmosphere (Schlenk technique)
- Spectroscopic and structural characterization (IR, multinuclear NMR, XRD)
- Electrochemical and spectrochemical studies (Prof. Tiziana Funaioli, Università di Pisa)
- Determination of the magnetic properties of molecular nanocluster through SQUID (Prof. Mauro Riccò, Università di Parma)
- Computational studies and DFT calculations (Prof. Marco Bortoluzzi, Università di Venezia)

- Use of molecular clusters as precursors of nanostructured catalytic materials or precursor of catalysts in omogeneous catalytic reactions (Prof.ssa S. Albonetti and F. Basile, Università di Bologna)

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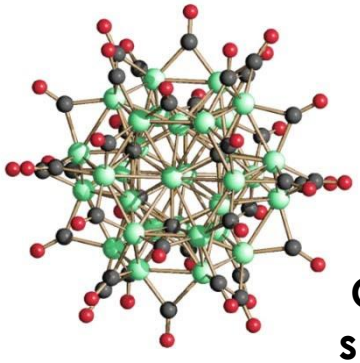
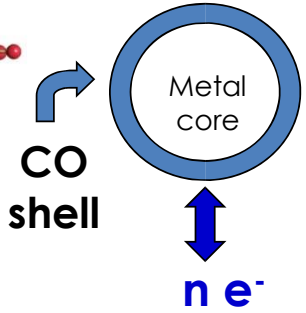
Application of Metal Carbonyl Clusters MCCs

Possible

Nanocapacitors

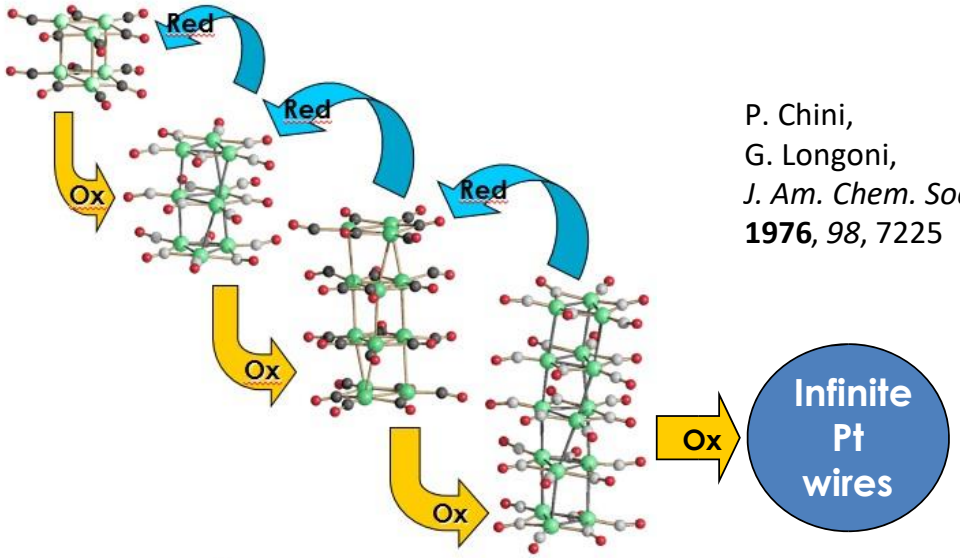
$[Ni_{32}C_6(CO)_{36}]^{6-}$





F.Calderoni,F.Demartin,
F.FabrizideBiani,C.Femoni,
M.C.Iapalucci,G.Longoni,
Molecular

Molecular Conductive Platinum Nanowires



P. Chini,
G. Longoni,
J. Am. Chem. Soc.,
1976, *98*, 7225

Angew. Chem., Int. Ed, **2006**,
45, 2060; *Eur. J. Inorg. Chem*, **2007**,
1483-1486 ; *Inorg. Chem.*, **2010**,

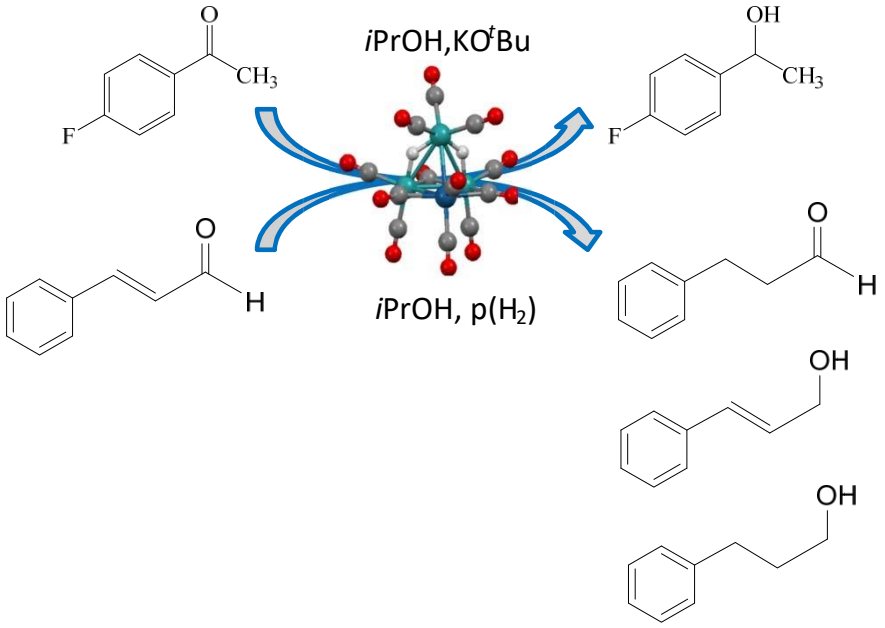
49, 5992-6004.

P. Zanello, *Eur. J. Inorg. Chem.*, **1999**, 663

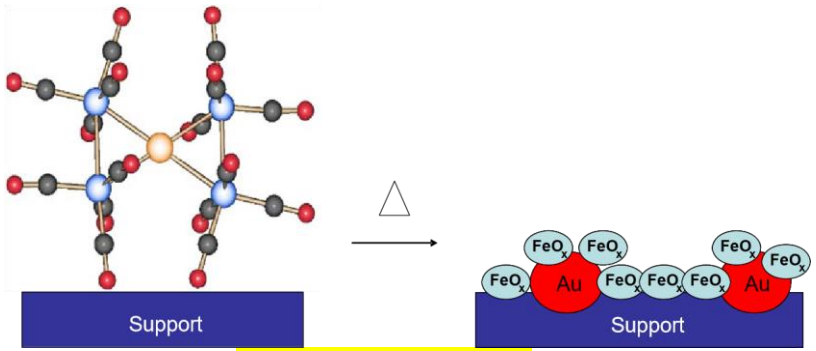
Application of Metal Carbonyl Clusters MCCs

Precursor for omogeneous catalytic reactions

$[H_2Ru_3Ir(CO)_{12}]^-$



Precursor for TiO_2-supported Catalysts

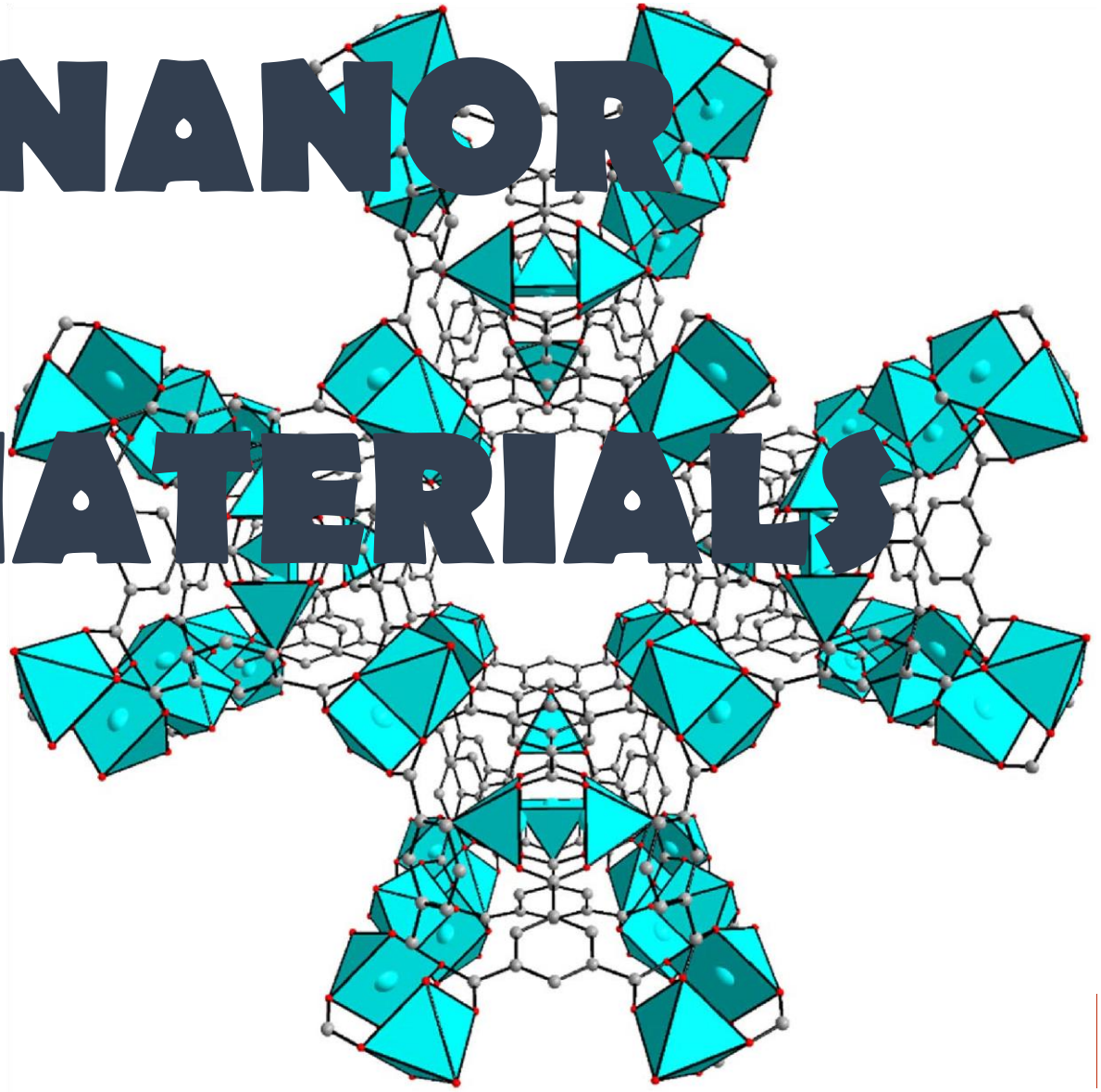


$[AuFe_4(CO)_{15}]^-$

Catalysts, **2012**, *2*, 1; *Appl. Catal. A*, **2011**, *400*, 54, *Appl. Catal. A*, **2010**, *372*, 138

CHINANOR

NANOMATERIALS



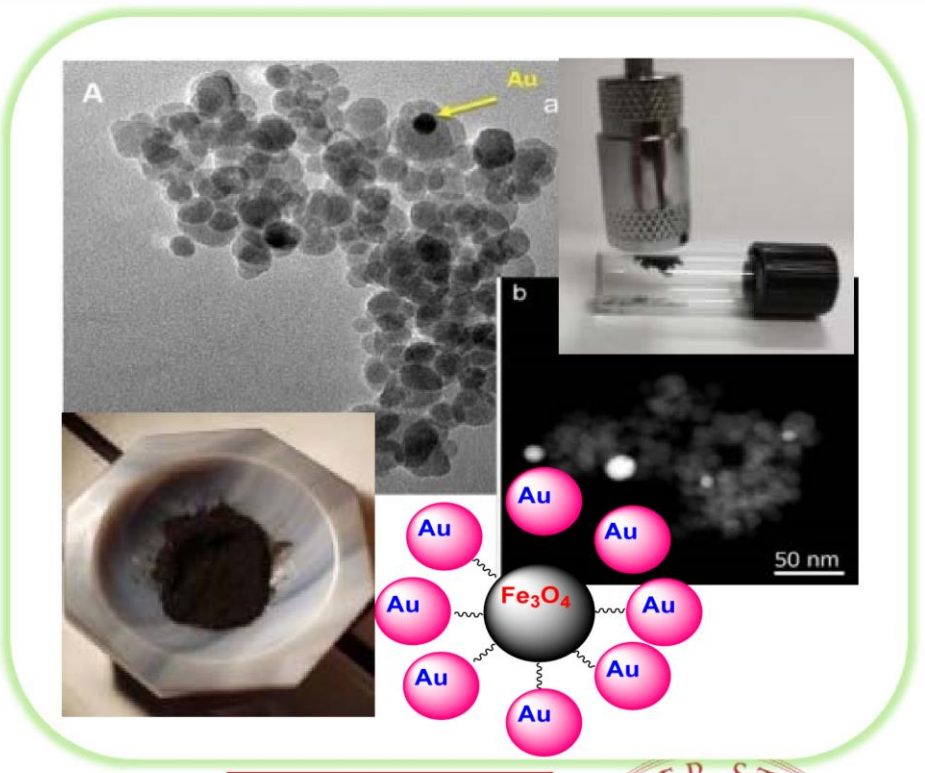
«solo la conoscenza a 360° dei materiali permette di sfruttare totalmente le loro proprietà»

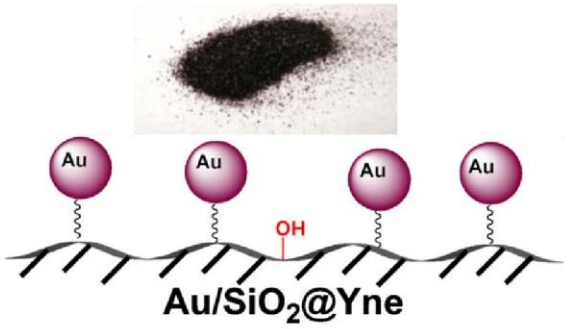
Progettazione, preparazione e caratterizzazione di materiali nanostrutturati innovativi per applicazioni nel settore catalitico, ambientale ed energetico.

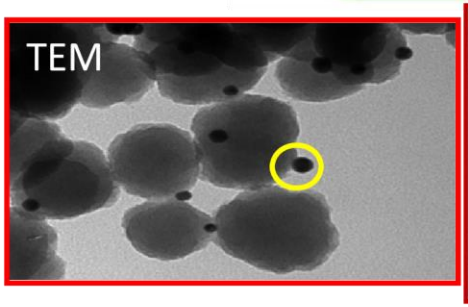
IL NANOMONDO PER APPLICAZIONI INDUSTRIALI

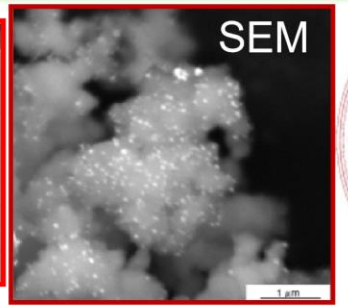
su nanoparticelle metalliche

Questa linea di ricerca riguarda la messa a punto di procedure sintetiche/elettrosintetiche atte all'ottenimento di sistemi nanostrutturati a base di nanoparticelle metalliche (Au, Ag, Pt ecc.) supportate su materiali di vario tipo (silice, allumina, titania, magnetite, idrotalcite, cellulosa, ecc.) funzionalizzati con residui organici. Tali nuove procedure riguardano sistemi che siano in grado sia di formare le nanoparticelle sia di stabilizzarle con gruppi funzionali opportuni (ammine, tioli, ecc.). Modulando opportunamente la scelta del supporto e/o del funzionalizzante utilizzato si riesce a controllare la distribuzione dimensionale delle nanoparticelle.









Sviluppo di sistemi nanostrutturati basati

sintetiche/elettrosintetiche

supportate su materiali

opportuni

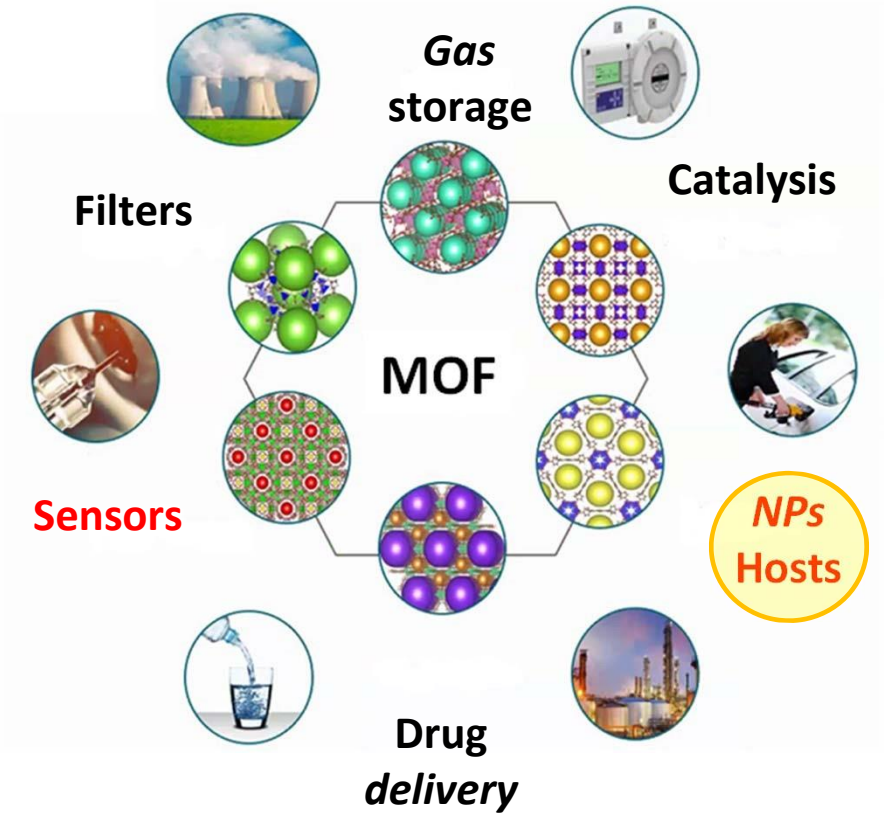
MOFs: Metal Organic Frameworks

I MOFs sono una classe di materiali cristallini con alta area superficiale.

Rispetto ai tradizionali adsorbenti porosi, l’unicità della struttura cristallina

Large variety of applications

deiMOFspermette di progettare strutture con dimensioni e proprietà chimico-fisichedella superficie interna dei pori predeterminate, per applicazioni specifiche.



Organic Ligand

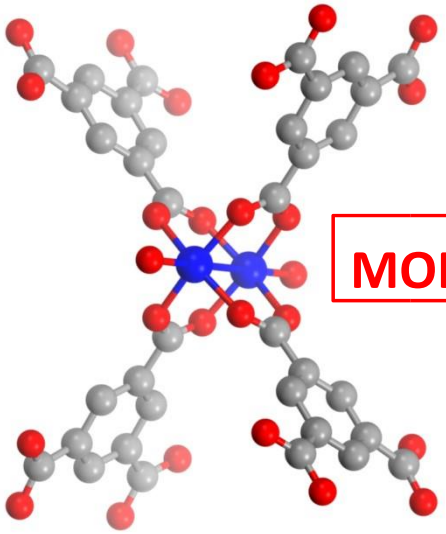
METAL ORGANIC FRAMEWORKS (MOFs)

Sintesi

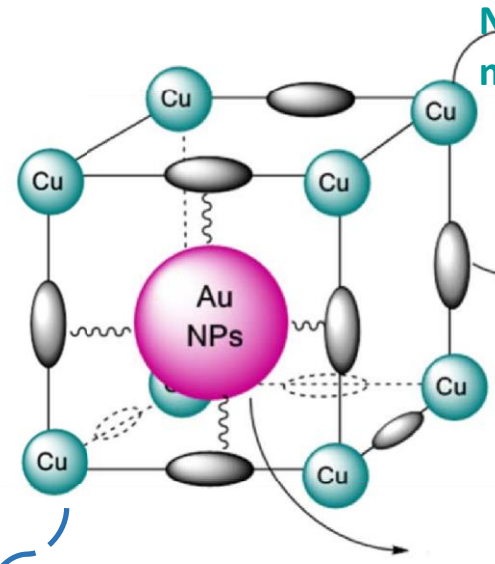
Legante

\+

Metallo



MOF



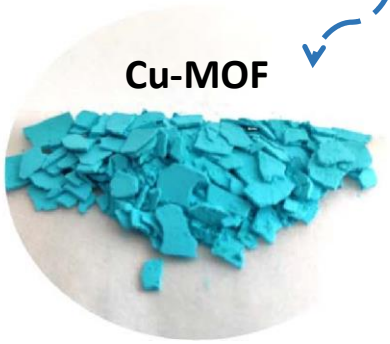
Nodo metallico

Legante organico

GC

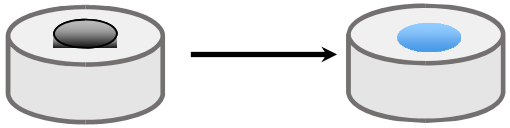
Specie ospite

Cu-MOF

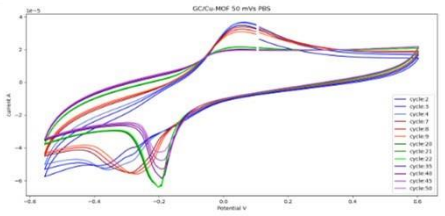


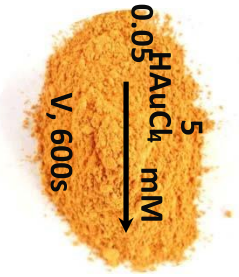
Sensore per nitriti

Synthesisof dropcasted electrode



GC/Cu-MOF



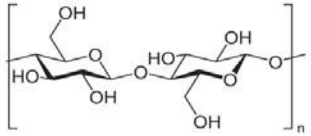


GC/Cu-MOF electrodewith AuNPs

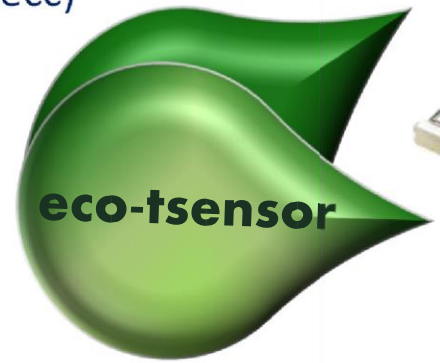
Dalla carta all'elettronica

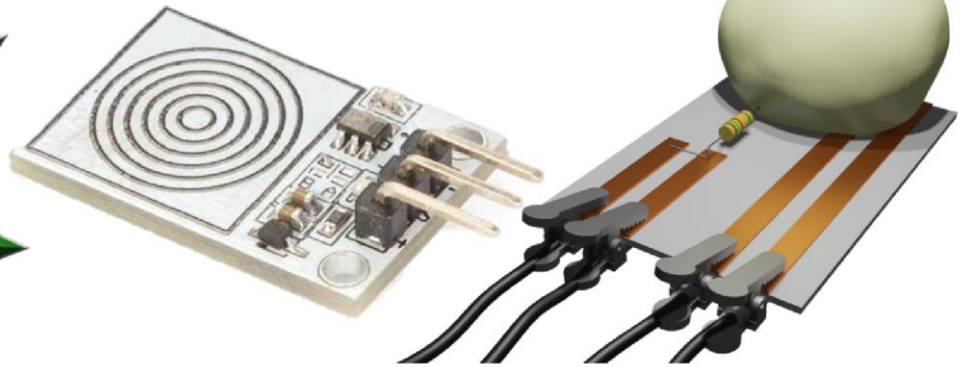
Sviluppo di sistemi compositi per applicazioni nel settore energetico e sensoristico

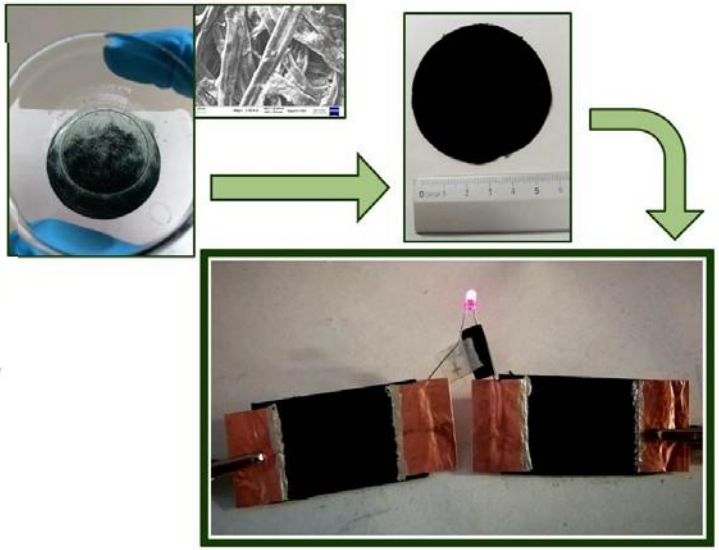
Sintesie/oelettrosintesidifilmcompositiabasedi ***polimeri conduttori***.Oltreaipolimeri,imaterialiutilizzatinelcomposito possonoessere ossidi,materialiconduttori,maanchelapiù economicacellulosa.



L'obiettivoèlacostruzione di dispositivi in grado di accumulareenergia, nel caso dei pseudocapacitori, o compierefunzioni utili, come nel caso della paper electronics (esempio sensori tattili, sensori per gas ecc)

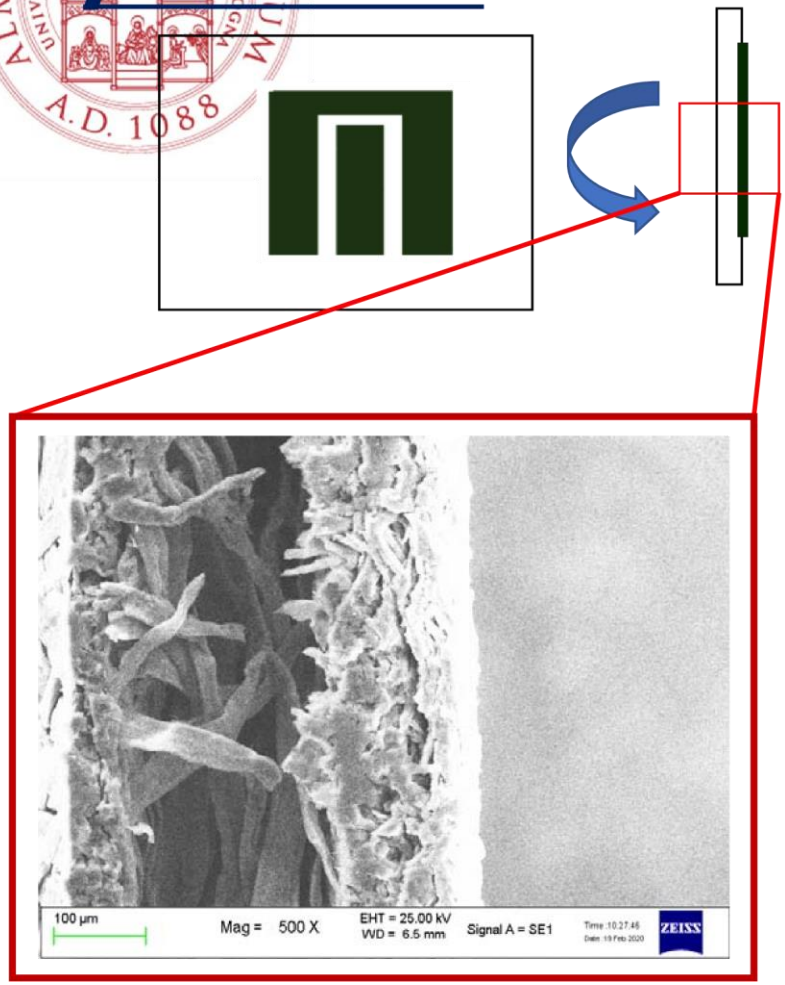




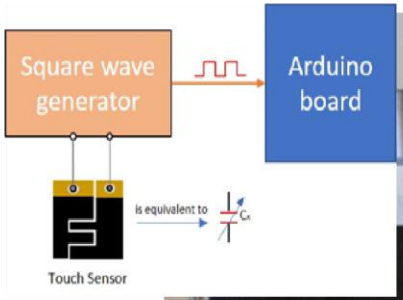


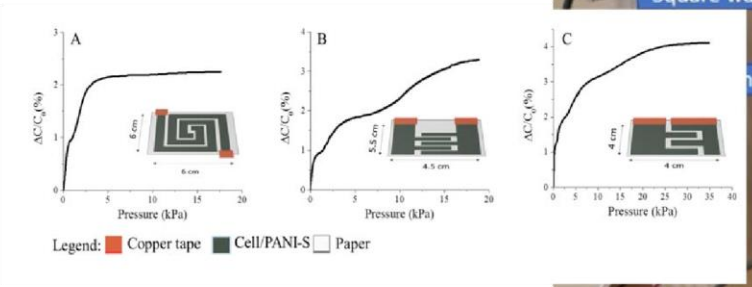
Interruttore

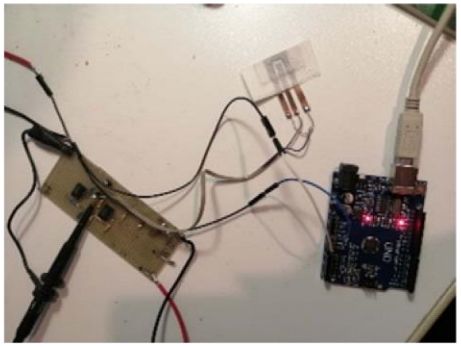
Smart paper: sensori di pressione e umidità



response time: 52 ms

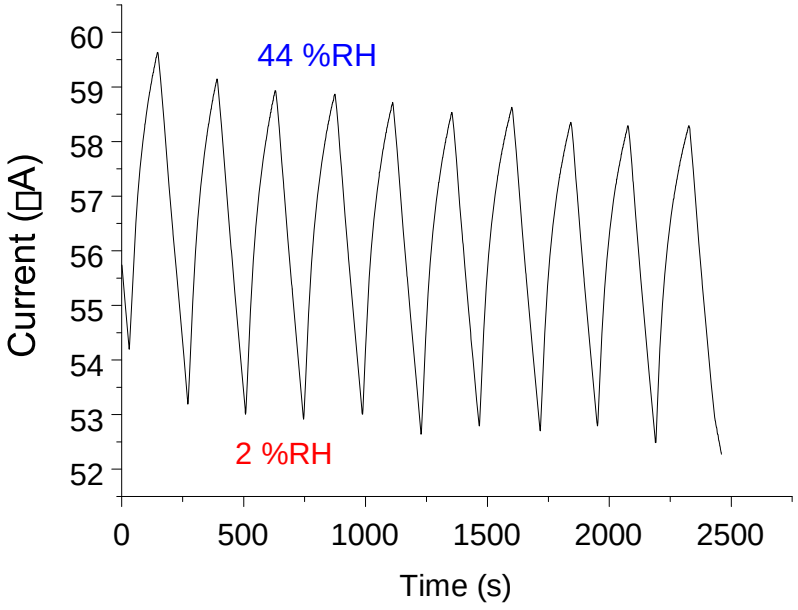


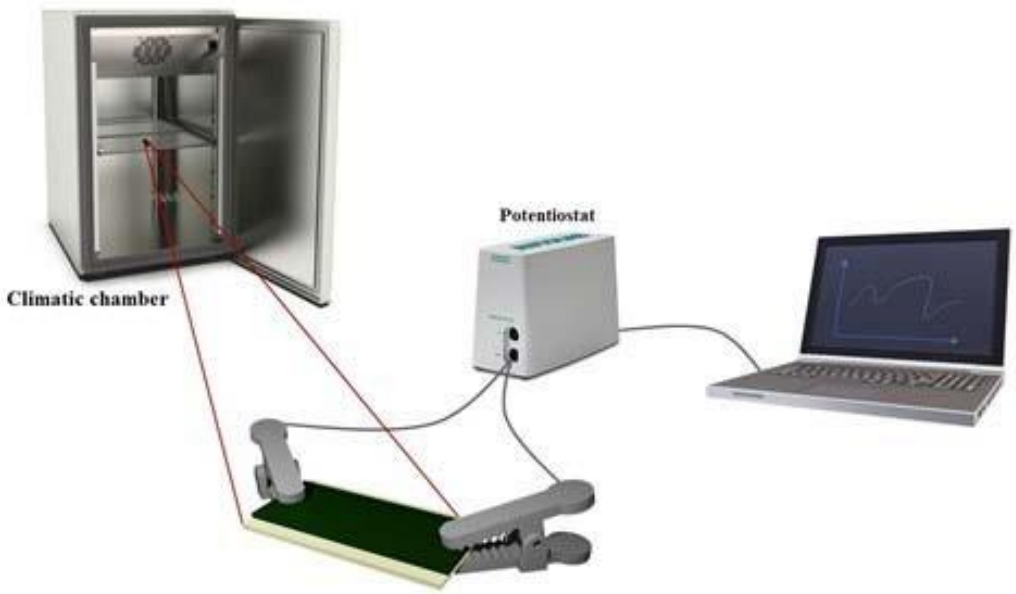


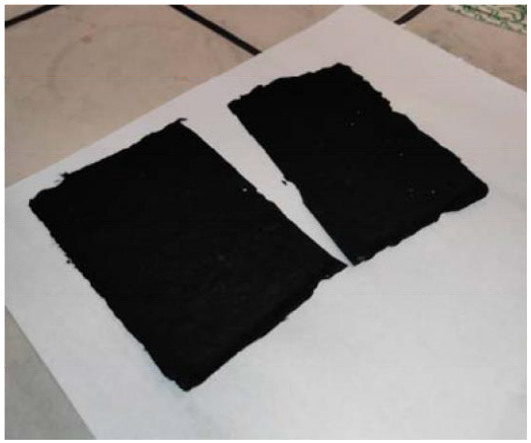


Misuratore di P

Smart paper: sensori di pressione e umidità

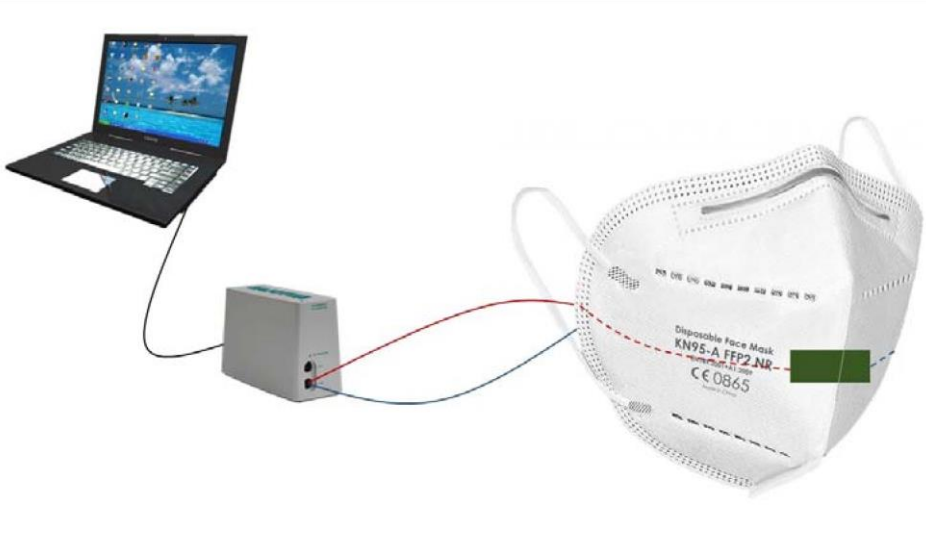




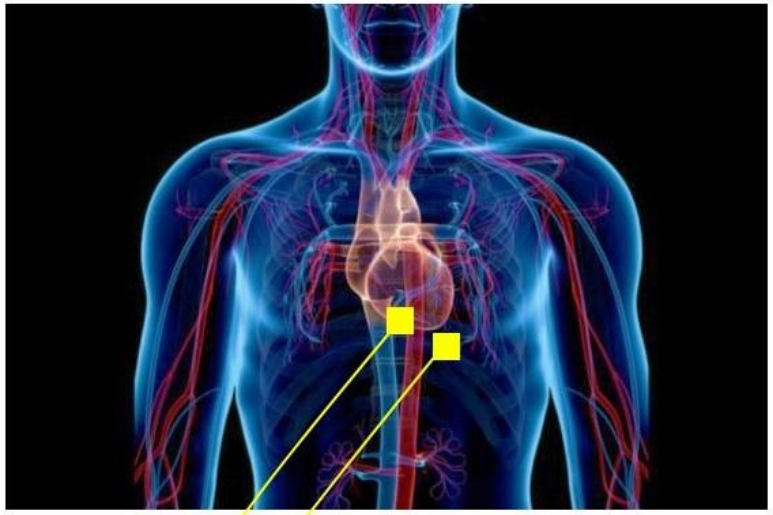


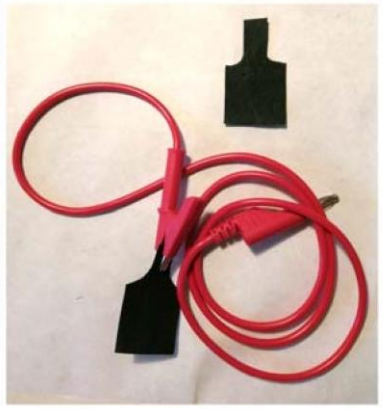
Smart paper: sensori FLESSIBILI

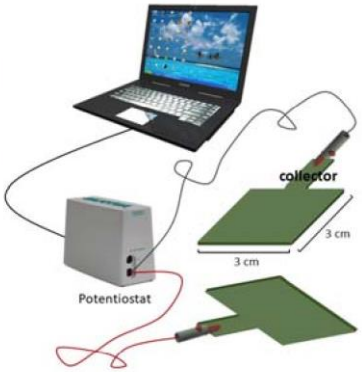
Controllo Respirazione



Controllo Attività Cardiaca







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Michele Mancinelli	Denisa Bisag
Luca Bernardi	Chiara Spanu
Mariafrancesca Fochi	Veronica Vetri
Emanuela Marotta	Buratti
Paolo Righi	Mirko Maturi
Giorgio Bencivenni	Gabriele Micheletti
Mauro Comes Franchini	Francesca Gambassi
Letizia Sambri	…..
Paolo Zani	

Carla Boga

ORGANIC CHEMISTRY

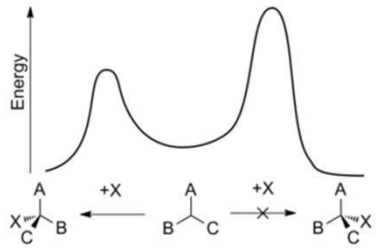
- **Prof Giorgio Bencivenni, Emanuela Marotta, Paolo Righi**
- **Prof Andrea Mazzanti**
- **Prof Luca Bernardi, Mariafrancesca Fochi**

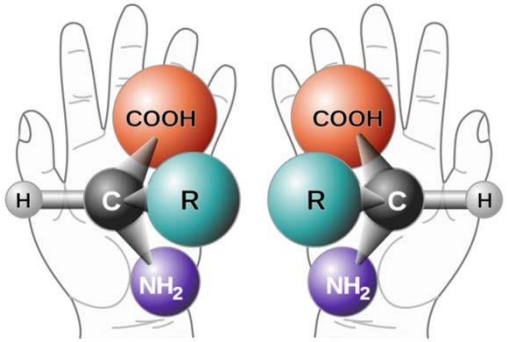
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

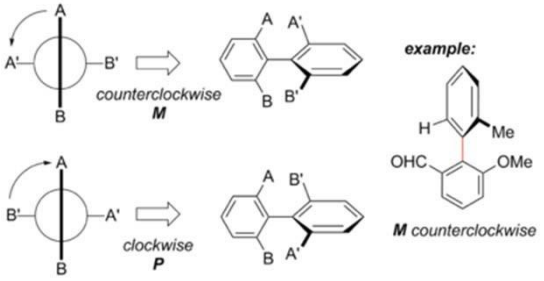
Dipartimento di Chimica Industriale «Toso Montanari»

ASYMMETRIC SYNTHESIS

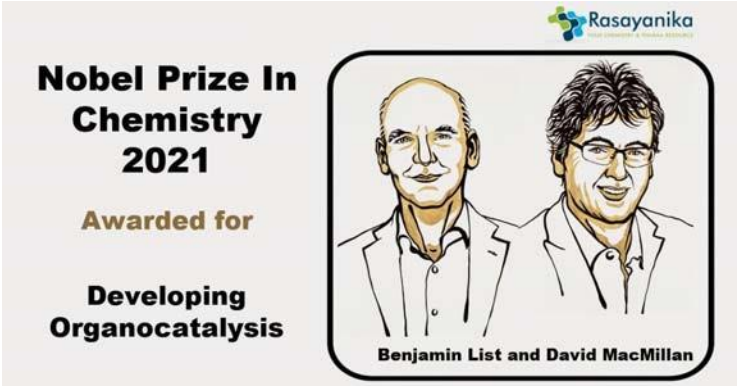
Chemical reaction in which one or more new elements of **chirality** are formed in a substrate molecule and which produces the **enantiomeric** or **diastereomeric** products in **unequal amounts**.







Organocatalysis



ORGANIC SYNTHESIS

- Substratesynthesi sand purification
- Reaction optimization

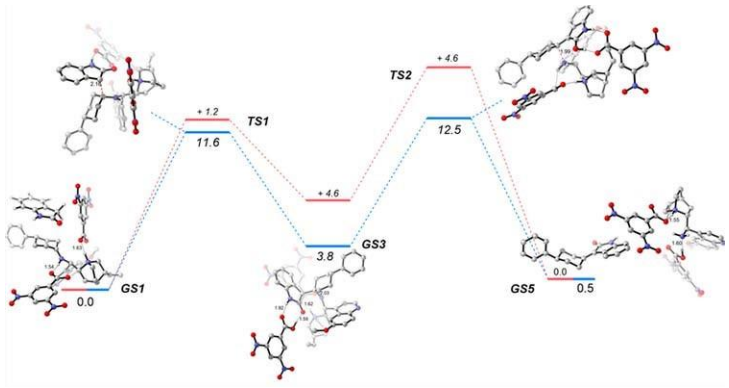
- Product characterization

Nuclear
Magnetic
Resonance

Chiral
High **P**erformance
Liquid
Chromatography

Gas
Chromatography

COMPUTATIONAL STUDIES



DFT calculation

-

OCSA – Organic Catalysis Structural Analysis

Asymmetric Synthesis Lab

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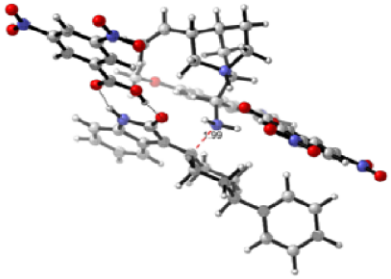
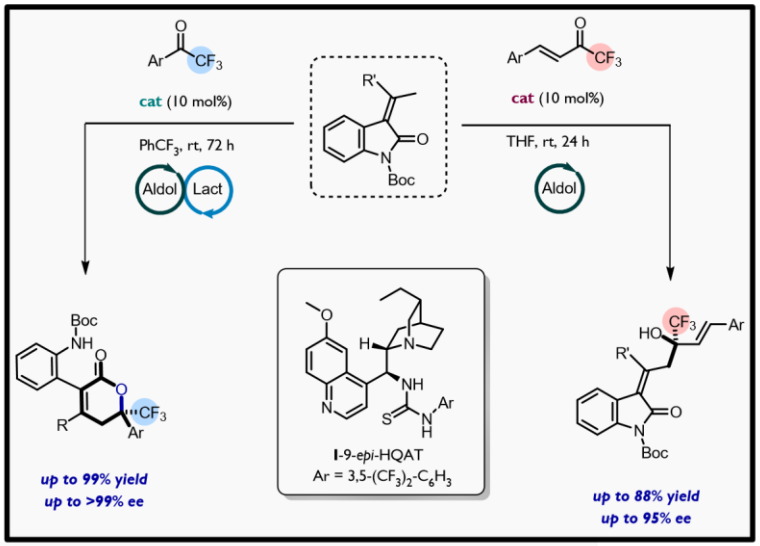
Prof. Emanuela Marotta - emanuela.marotta@unibo.it
Prof. Paolo Righi – paolo.righi@unibo.it

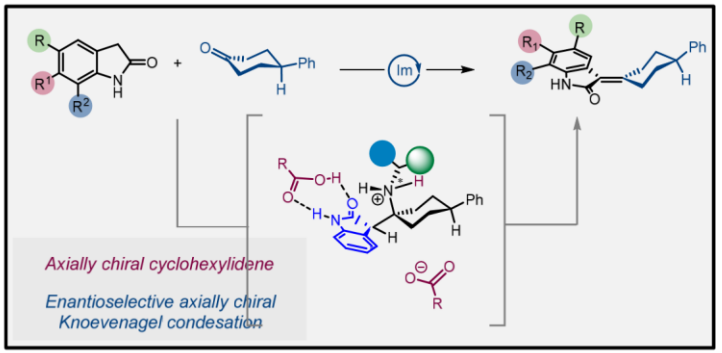
OCSA – Organic Catalysis Structural Analysis

PhD Chiara Portolani – chiara.portolani2@unibo.it
PhD Giovanni Centonze – giovanni.centonze2@unibo.it





Bencivenni, et al. *J. Org. Chem*. **2018**, *83*, 12440.
Bencivenni, et al. *RSC Adv.*, **2018**, *8*, 33451



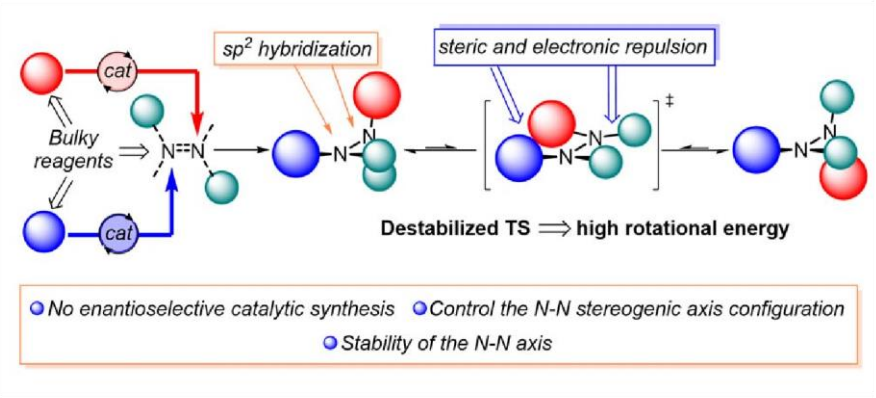
Bencivenni, et al. *Org. Lett.*, **2019**, *21*, 3013.

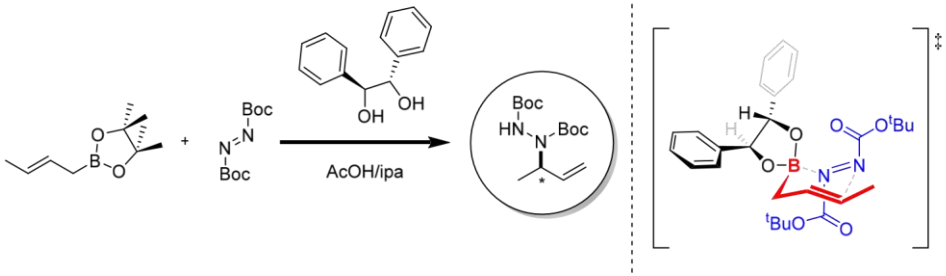
Asymmetric Synthesis Lab

Current projects

OCSA – Organic Catalysis Structural Analysis

- Asymmetric synthesis and computational studies of N-N atropisomers.





- Asymmetric crotylation of di-*tert*-butyl azodicarboxylates.

OCSA – Organic Catalysis Structural Analysis

Organic Spectroscopy

Prof. Andrea Mazzanti - andrea.mazzanti@unibo.it
Dr. Michele Mancinelli - michele.mancinelli@unibo.it

Synthesis of atropisomers.

NMR

- ^{1}H-NMR, ^{13}C-NMR, NOESY and bidimensional experiments, Dynaimc Nuclear Magnetic Resonance (D-NMR).
- DFT and TD-DFT calculations associated with chirooptical methods (ECD and VCD) can provide the

ECD

OCSA – Organic Catalysis Structural Analysis

Research on the conformational analysis of organic molecules. absolute configuration of organic molecules.

VCD

BF Laboratory

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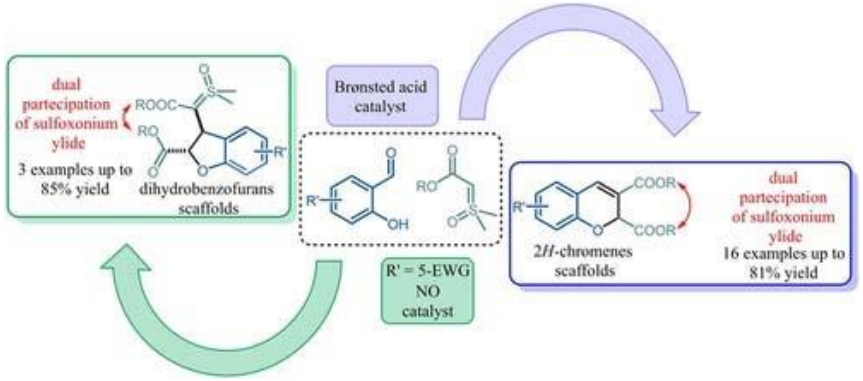
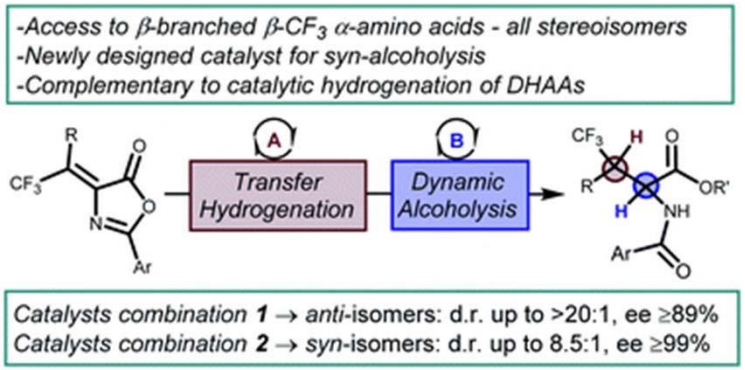
Prof. Mariafrancesca Fochi - mariafrancesca.fochi@unibo.it

PhD Giorgiana Denisa Bisag - denisa.bisag@unibo.it

OCSA – Organic Catalysis Structural Analysis



Bernardi et al. Advanced Synthesis & Catalysis, 2021, 363, 3053 – 3059.



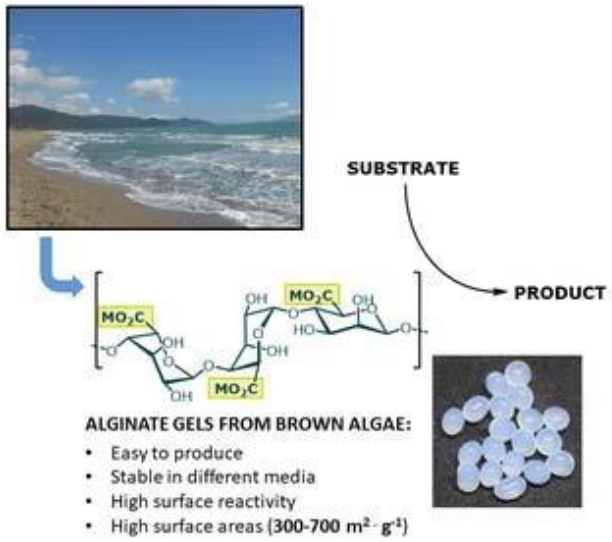
Bernardi et al. Chemical Science, 2021, 12, 10233 – 10241.

BF Laboratory

Blue chemistry: valorisation of marine biomass (polysaccharides)

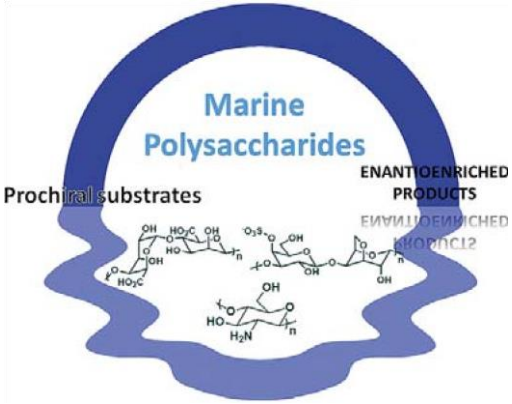
From sea to flask!

OCSA – Organic Catalysis Structural Analysis



In collaboration with Dr. Nathalie Tanchoux (CNRS, Montpellier, France).

Use of aginates from brown algae in enantioselective catalysis.



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MATERIAL PORTFOLIO 2022

Chimica Organica per i Materiali Avanzati (ComesFranchini –Sambri)

Dipartimento di Chimica Industriale ‘‘Toso Montanari’’

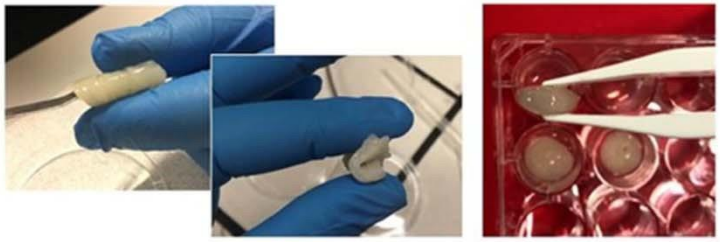
Advanced Smart Organic Materials (ASOM)

Sviluppo di materiali organici innovativi derivanti da fonti naturali aggiungendo funzioni “smart” quali la conduttività, la piezoelettricità e la fotoluminescenza

3D PRINTING

Bio-based luminescent resins for SLA printers.

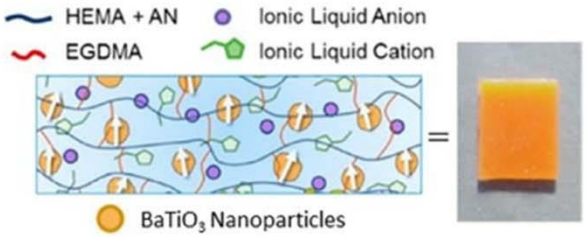
Application: scaffold bone regeneration



3D BIOPRINTING

Bio Inks based on biopolymers for tissue engineering

Application: tissue regeneration



ORGANIC ELECTRONICS

Piezoelectric/conductive nanoparticles as additives for advanced gels

Application: wearable sensor for healthcare

SMART DRUG DELIVERY

Nanocellulose as carrier for selective drug loading and release

Application: Slow prolonged drug release

Additive Manufacturing (3D-PRINTING)

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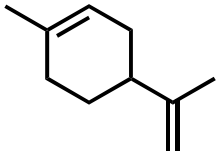
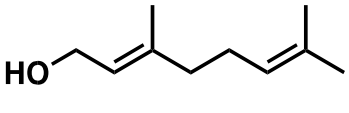
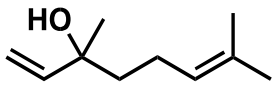
Additive Manufacturing (3D-printing) utilizzando resine biobased derivanti da molecole del pool naturale quali carboidrati, proteine, terpeni.



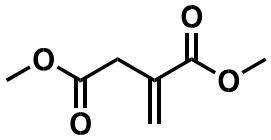
Limonene



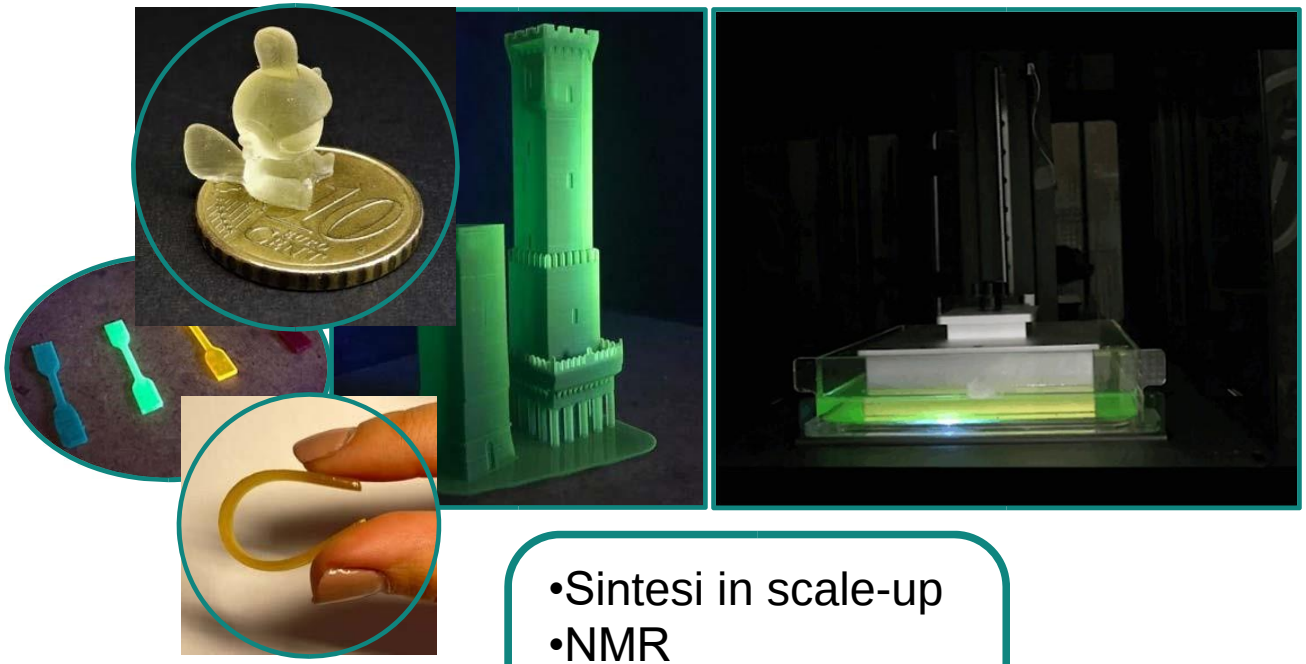
Geraniol



Linalool



Dimethyl itaconate



Stampanti 3D SLA (LCD e laser)

- Sintesi in scale-up
- NMR
- GPC
- Reologia
- Prove Meccaniche

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3D-Bioprinting

Bio-ink partendo da Cellulosa, Zein per applicazioni in tissue regeneration

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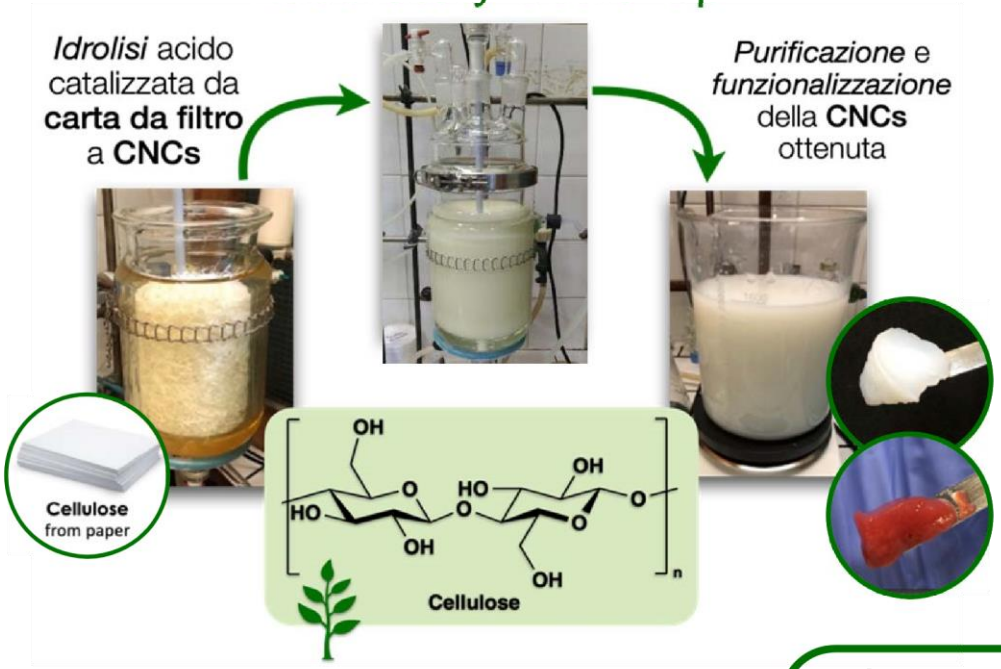
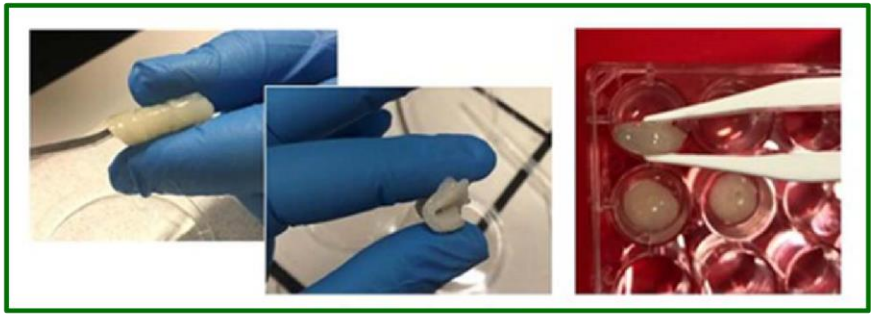
Laboratory Scale-Up





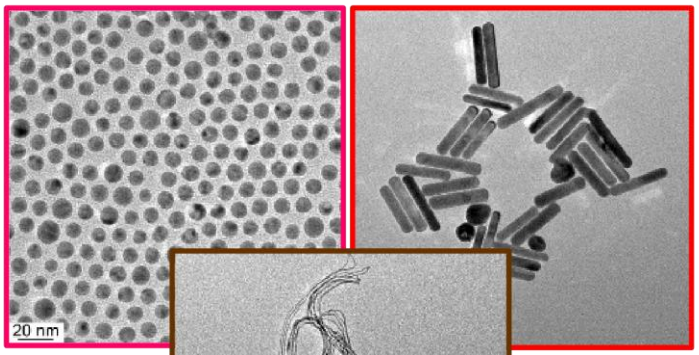
- Lavoro in cappa sterile
- Dialisi
- Liofilizzazione
- DLS
- SEM

Organic Electronics

Nanostrutture metalliche oro, argento, c-nanodots e molecole luminescenti per applicazioni sensoristiche o di imaging

Gold Nanoparticles

Gold Nanorods



Gold Nanoropes

Red-emitting Carbon Nano-Dots

Molecole Luminescenti

- UV-Vis
- Assorbimento atomico (AAS)
- Inductively coupled plasma mass spectrometry (ICP-MS)
- Spettrofluorimetro
- TEM/SEM
- Raggi X

Drug Delivery in NANOMEDICINE

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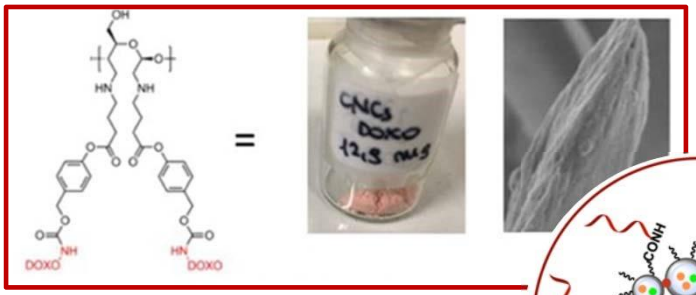
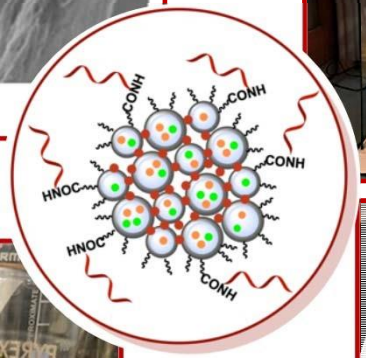
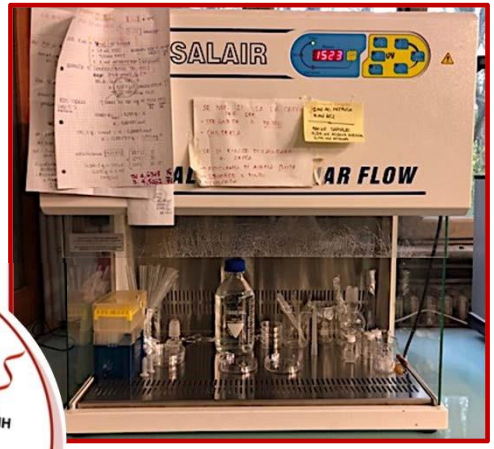
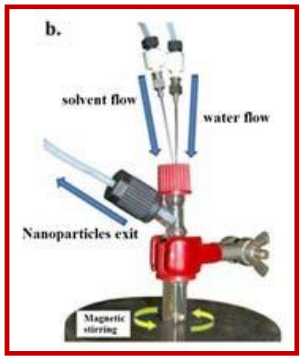
Smart Drug Delivery utilizzando materiali quali nanocellulosa, caseina o PLGA-*b*-PEG per creare carrier per il trasporto e il rilascio prolungato di farmaci (*lipofilici o idrofilici*).

- Nanoprecipitazione
- Ultrasonicazione
- Lavoro in cappa sterile
- Dialisi
- Centrifuga
- Dynamic Light Scattering (DLS)
- Spettrofluorimetro
- UV-Vis









Nanoprecipitazione

Ultrasonicatore

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Federica Mariani	Mariam
Andreas Lesch	Maisuradze …..
Marco Giorgetti	
Barbara Ballarin	

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ELEKTRO ANALYTICAL

DOCENTI

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TEMA DI RICERCA : IDROSSIDI DOPPI A STRATO (LDH)

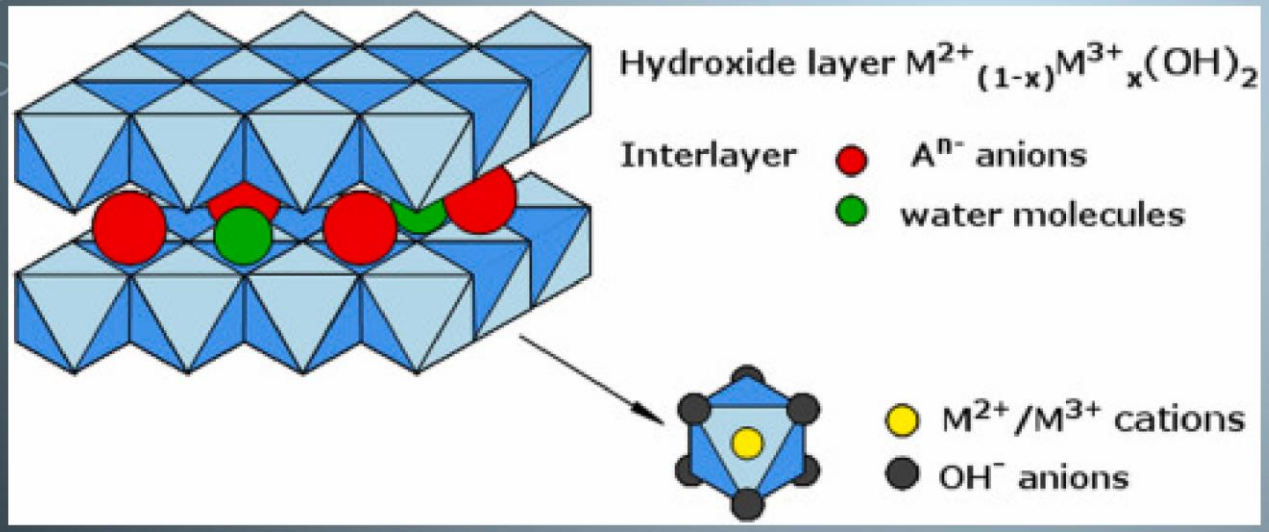


Immagine SEM di un LDH

Modifica di substrati elettrodici (Pt, Au, Grafoil) con LDH contenenti cationi metallici in vario rapporto ed eventuali specie intercalate

SINTESI ELETTROCHIMICA → CARATTERIZZAZIONE → ELETTROCHIMICA / FISICA

TEMA DI RICERCA : IDROSSIDI DOPPI A STRATO (LDH)

LDH

SENSORI

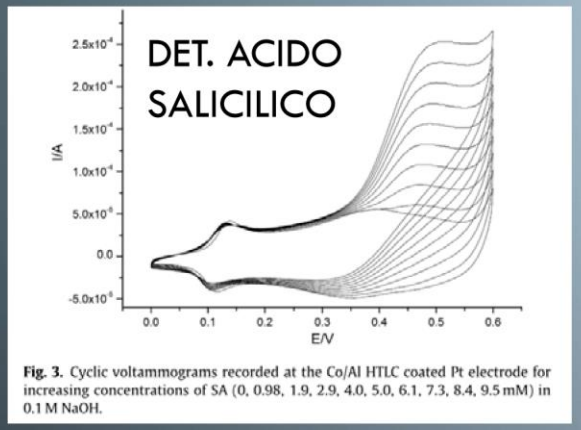
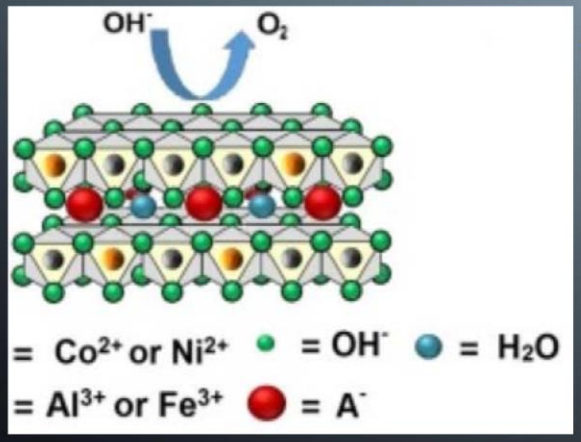
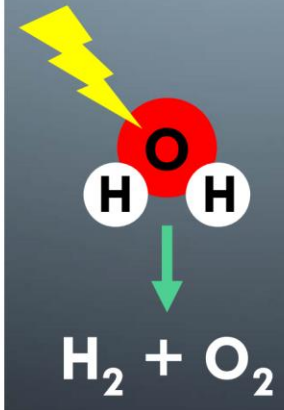


Fig. 3. Cyclic voltammograms recorded at the Co/Al HTLC coated Pt electrode for increasing concentrations of SA (0, 0.98, 1.9, 2.9, 4.0, 5.0, 6.1, 7.3, 8.4, 9.5 mM) in 0.1 M NaOH.

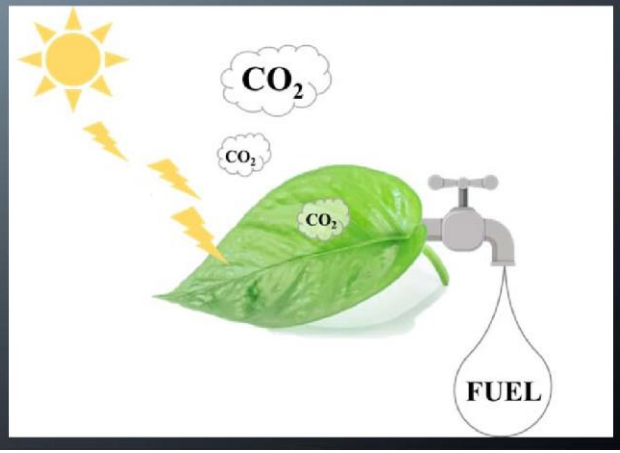
ENERGY STORAGE

WATER SPLITTING

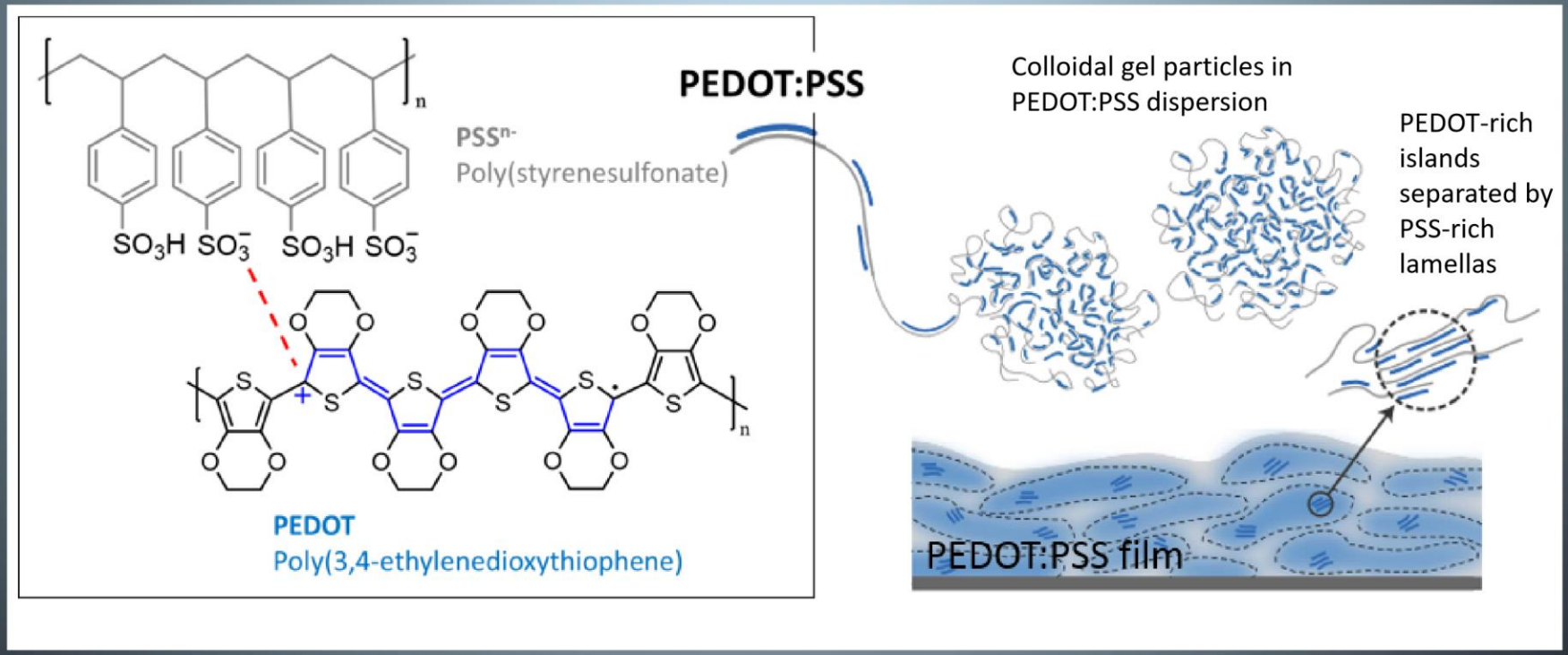




ELETTRORIDUZIONE CO_2

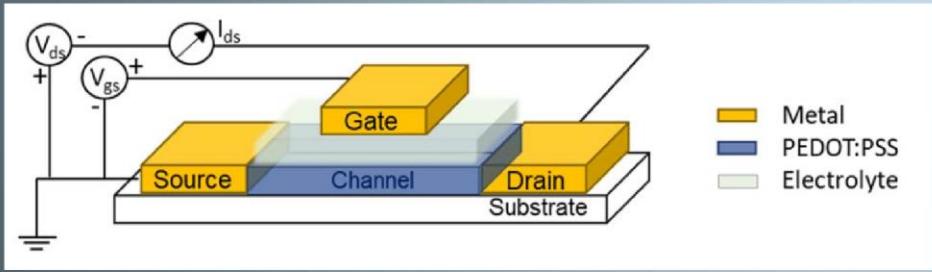


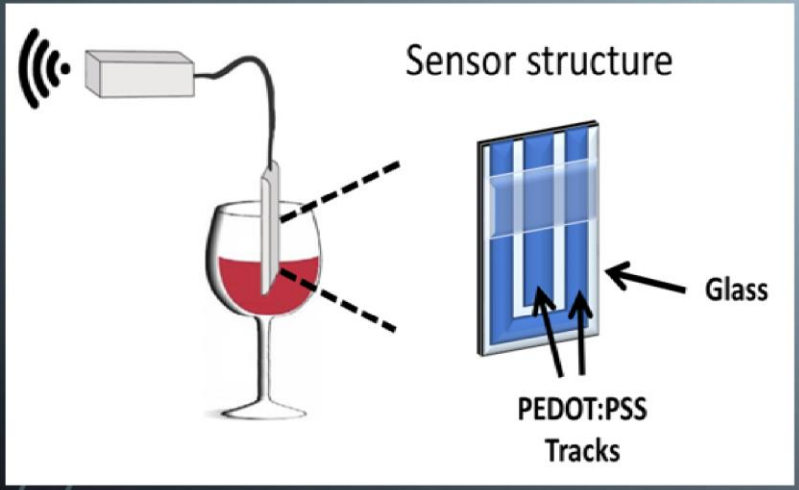
TEMA DI RICERCA : BIOELETTRONICA ORGANICA



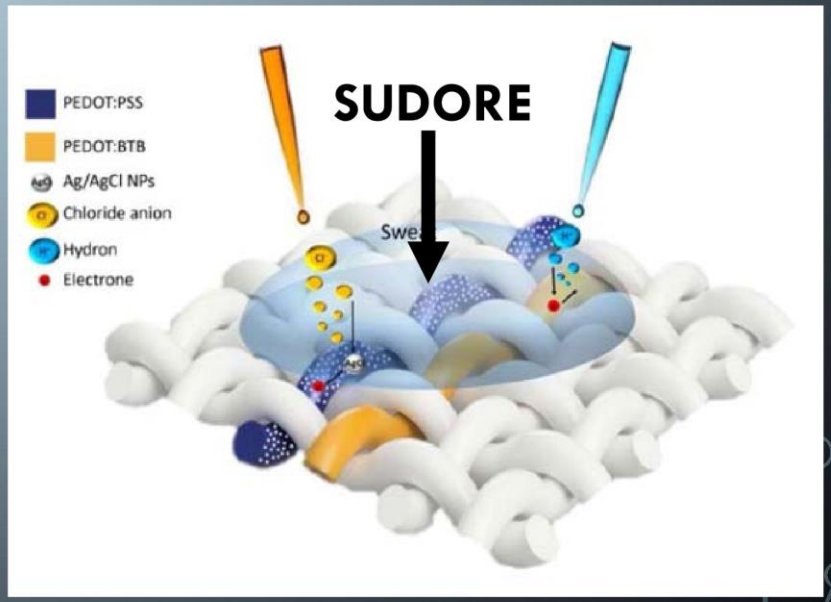
- Solido con basso Modulo di Young
- Biocompatibile
- Conduttore misto (conversione tra corrente ionica ed elettronica)
- Particolarmente adatto alla formazione di film sottili
- Leggero & flessibile

TEMA DI RICERCA : BIOELETTRONICA ORGANICA





Sensori per la determinazione di specie chimiche in matrici alimentari e gas pericolosi nell'ambiente

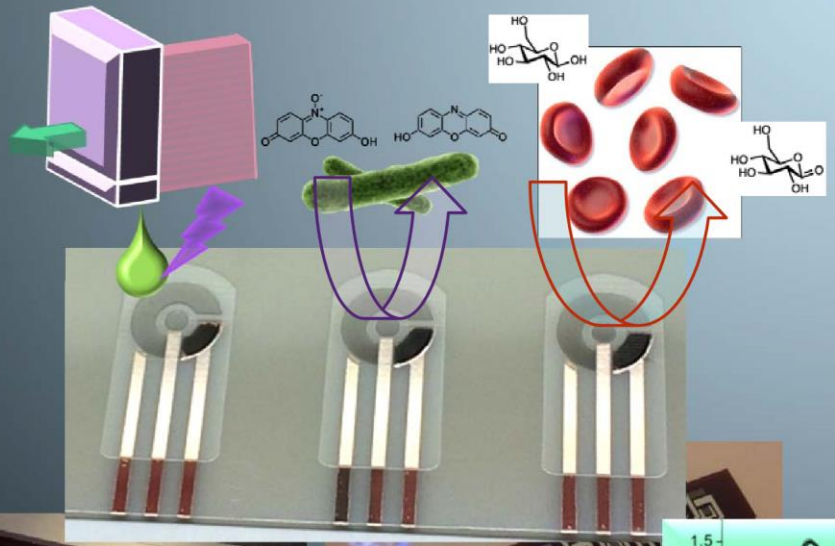


Sensori tessili indossabili: determinazione analiti di interesse biologico in campo medico e sportivo

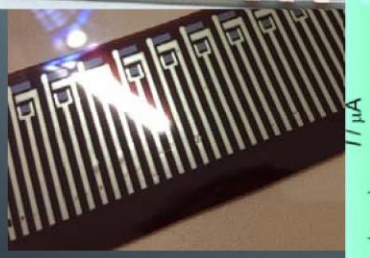
TEMA DI RICERCA : SENSORI INKJET PRINTED

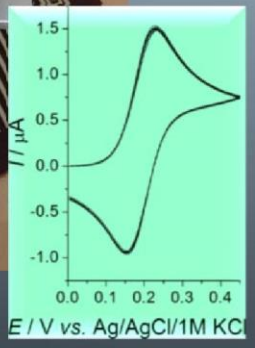
di tipo amperometrico e potenziometrico

Produzione dei sensori



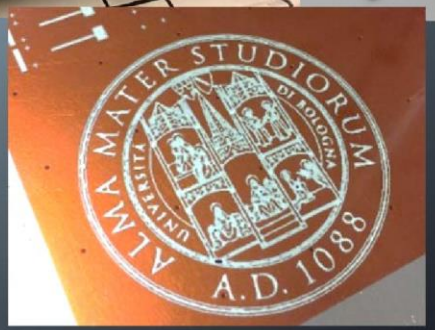
Biosensori elettroanalitici





Stampante a getto d'inchiostro nel laboratorio

Goccioline espulse



Inchiostro preparato nel laboratorio

TEMA DI RICERCA : MICROSCOPIA A SCANSIONE ELETTROCHIMICA

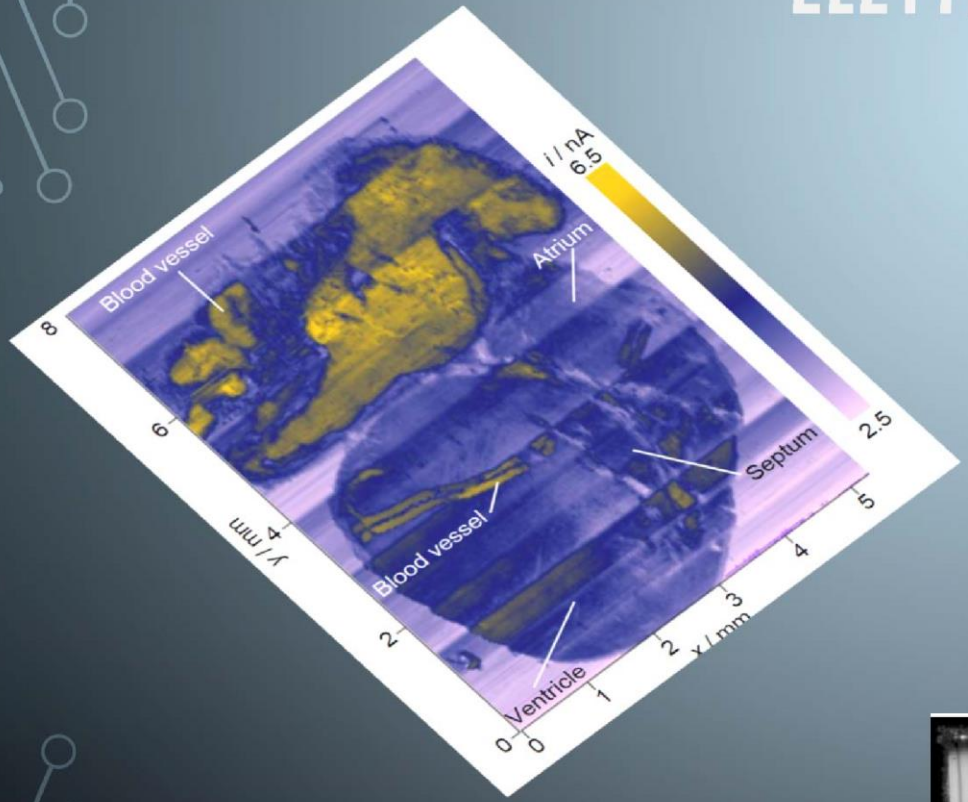
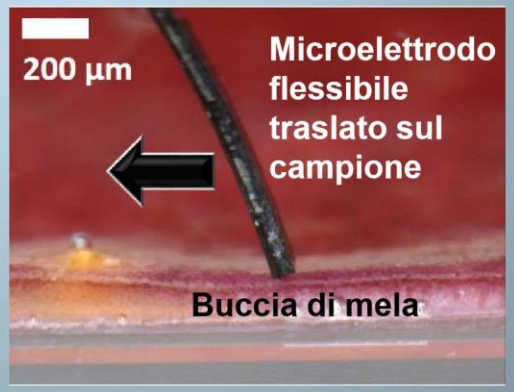
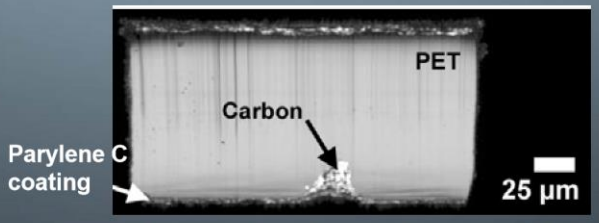


Immagine ottenuta con la microscopia elettrochimica: Distribuzione delle proteine nei tessuti biologici

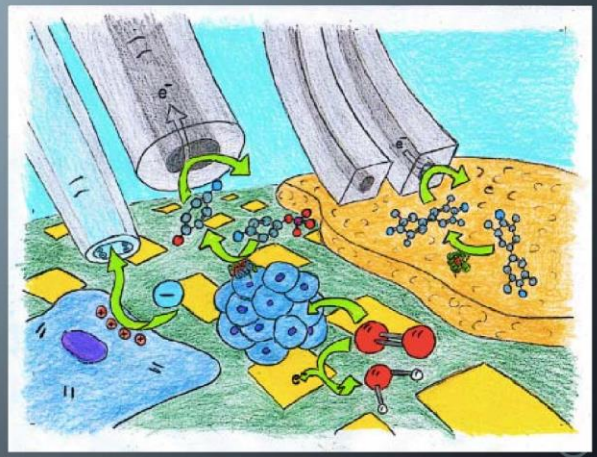


Microelettrodo flessibile su una buccia di mela per rilevare la distribuzione di antiossidanti



Microelettrodo di carbonio flessibile (Sezione trasversale)

Microscopia a scansione elettrochimica per studi sul cancro



Micro e nanoelettrodi

TEMA DI RICERCA : BATTERIE & SPETTROSCOPIA A RAGGI X

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Mariam Maisuradze (PhD student)
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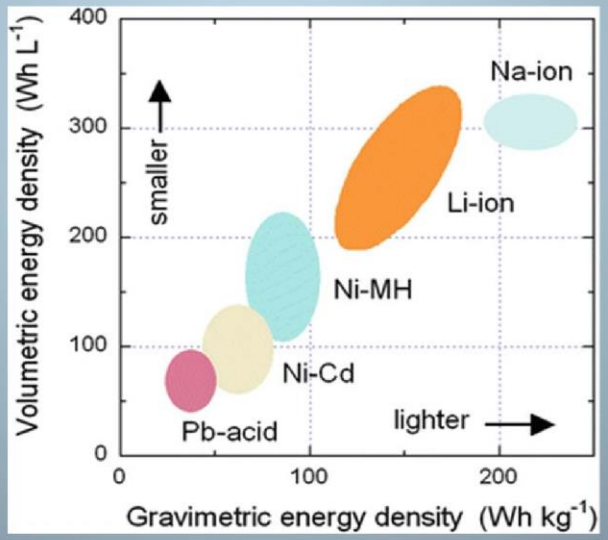
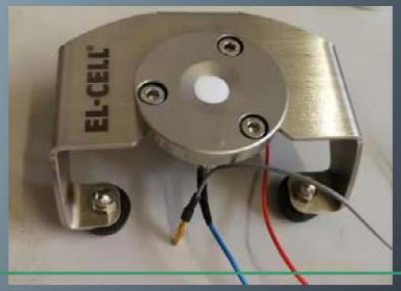
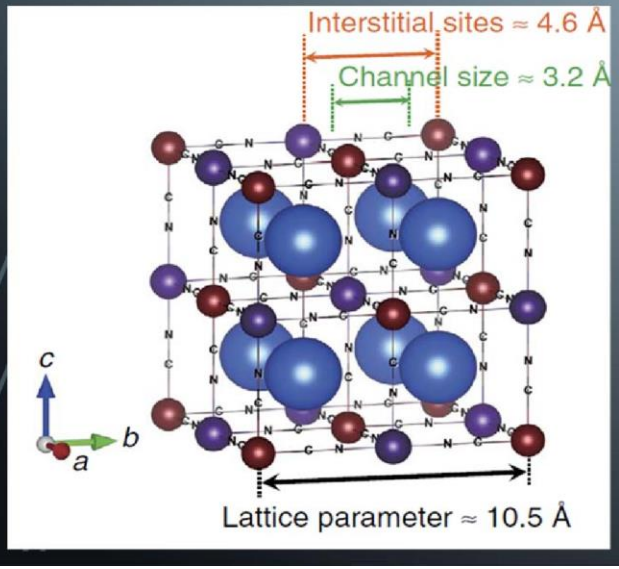


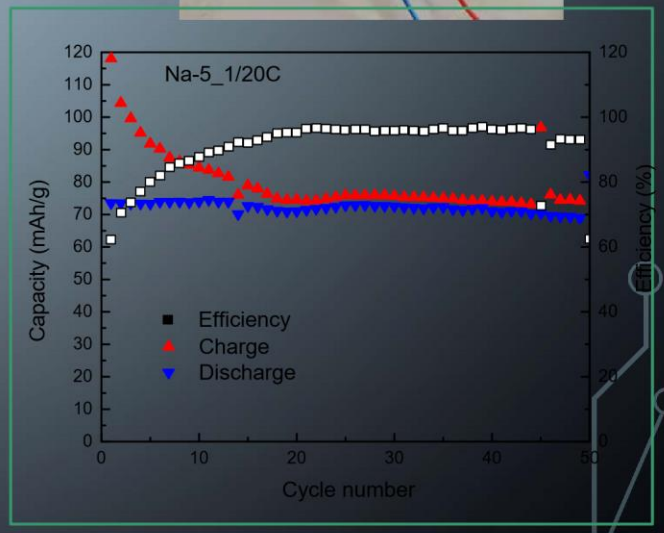
Sviluppo e caratterizzazione batterie Na-ion, K-ion, Zn-ion:





Sintesi di analoghi del Blu di Prussia come materiale elettrodico

Coin Cell



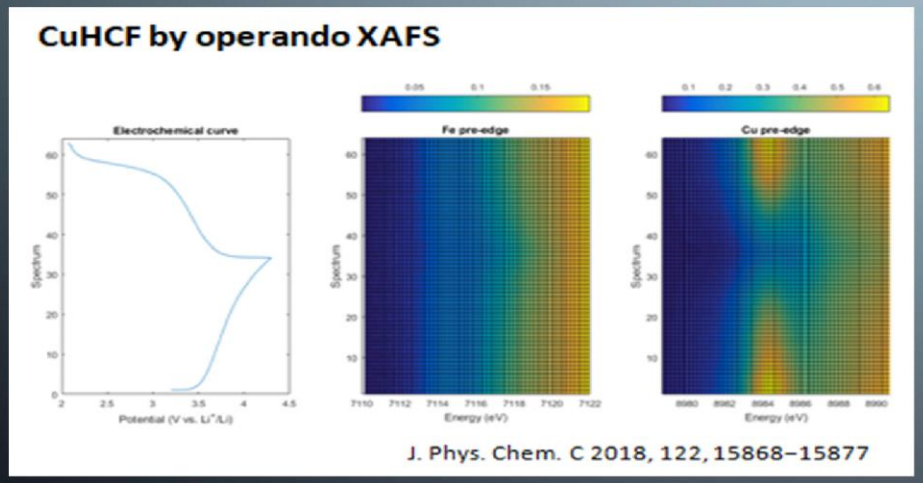
Prove di stabilità

TEMA DI RICERCA : BATTERIE & SPETTROSCOPIA A RAGGI X

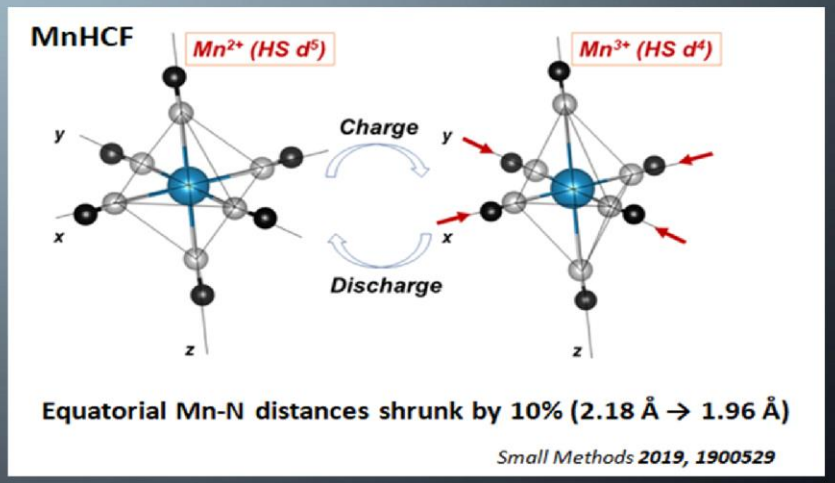
Tecniche a raggi X:

1) X-ray absorption spectroscopy (XAS)
2) Synchrotron X-Ray Powder diffraction (XRPD)
3) X-ray fluorescence (XRF)
4) X-ray photoelectron spectroscopy (XPS)

Elettra Sincrotrone Trieste



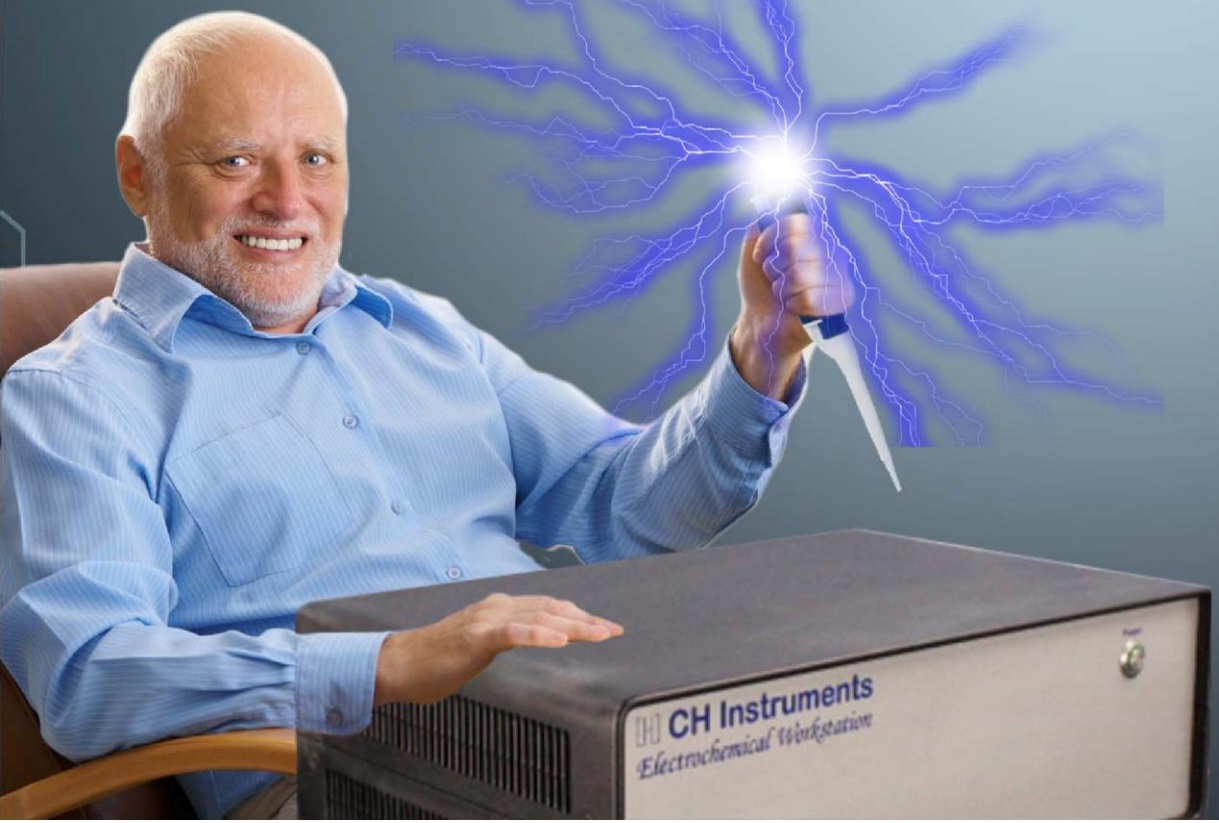
Identificazione dell'attività elettrochimica dei metalli



Quantificazione effetto Jahn-Teller

DYHWH#GXEEL#R#QH#YROHWH#VDSHUH#GL#SIÑB

CONTATTATECI!



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Ivano Vassura	Francesco Arfelli
Fabrizio Passarini	Massimiliano Boccarossa
Daniele Cespi	Gianluca Torta
Luca Ciacci	

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Linea di Ricerca: Ambiente e Beni Culturali

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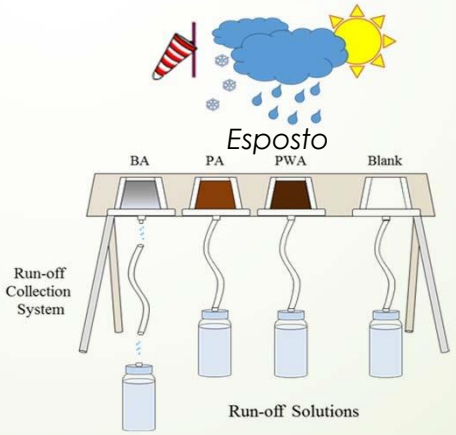
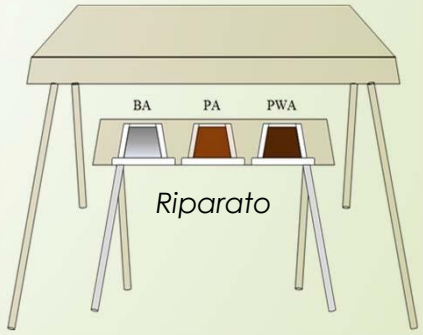
Studio dell'influenza dell'ambiente sul degrado di materiali e sui prodotti protettivi utilizzati per applicazioni architettoniche, artistiche o industrialiper:

→ comprendereimeccanismididegrado
→ svilupparеadeguatestrategiediprotezione
→ valutareprestazioni/durabilitàdinuovimateriali





✓ **Stazione di esposizione outdoor -Rimini**

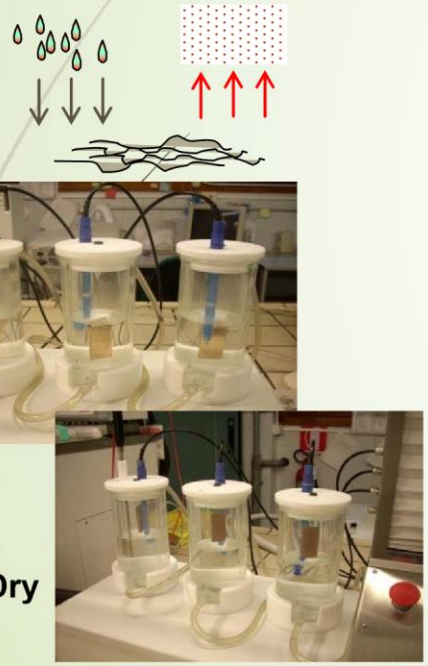
✓ Laboratorio per Invecchiamenti Accelerati - Bologna

Studio dei meccanismi di degrado e di efficienza/durabilità di prodotti protettivi o nuovi materiali attraverso simulazione di diverse condizioni di esposizione e livelli di inquinamento:

WET&DRY TEST

Test per immersioni alternate

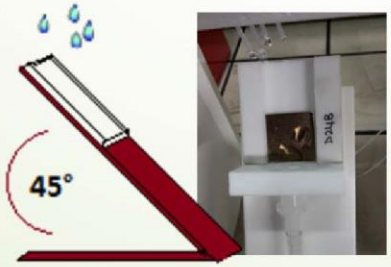
Simula esposizione in condizioni
RIPARATE DALLA PIOGGIA BATTENTE



4 Mori (1626), Livorno

DROPPING TEST

Simula esposizione in condizioni di
PIOGGIA BATTENTE



TEST IN CAMERA CLIMATICA

Simula esposizione in condizioni di
T, RH%, IRRAGGIAMENTO UV
variabili

Ambienti di invecchiamento:

- Condizioni di invecchiamento definite sulla base di dati ambientali.
- Piogge e particolato atmosferico riprodotti in laboratorio o campionati in ambiente

Pianificazione dei test effettuata, ove opportuno, anche attraverso DoE

Caratterizzazione di:

- Materiali invecchiati
- Ambiente di invecchiamento

PROCRAFT
PROtection & Conservation of Heritage airCRAFT

Esempi di alcuni materiali indagati:

- Metalli e Leghe (bronzo, weathering steel, Al)
- Materiali lapidei (pietre e terrecotte)
- Materiali polimerici (resine per integrazioni)

Studio multidisciplinare, spesso in collaborazione con altri gruppi UniBo

✓Strumentazione utilizzata

TECNICHE MICROSCOPICHE

- Microscopia ottica
- Microscopia elettronica
- SEM/FEG
- SEM/EDS

TECNICHE CROMATOGRAFICHE

- Cromatografia ionica (IC)
- Cromatografia liquida (HPLC)

TECNICHE SPETTROSCOPICHE:

- Assorbimento atomico (AAS)
- Emissione atomica al plasma (MP-AES)
- IR
- Raman

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rif. Prof. Ivano Vassura: ivano.vassura@unibo.it

Tecnopolo di Rimini –attività di Ricerca Gruppo Ambiente

La chimica in un'economia circolare

Il controllo degli inquinanti ambientali

- Monitoraggio in comparti ambientali (aria, acqua, suolo)
- Studio delle emissioni di contaminanti emergenti e non da impianti di depurazione acque
- Microplastiche nell'ambiente: tecniche di determinazione tramite pirolisi analitica

- **Analizzare il ciclo di vita delle risorse nei sistemi antropici**

Quanta materia è disponibile per riuso, recupero e riciclo?
Dove si trova?

- **Stimare l'impatto ambientale di prodotti e processi**

Qual è la soluzione più sostenibile?

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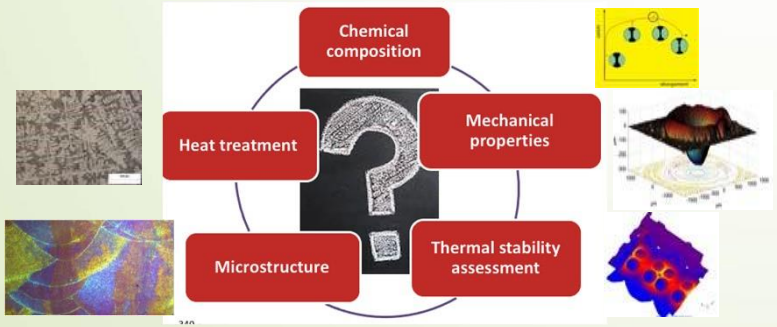
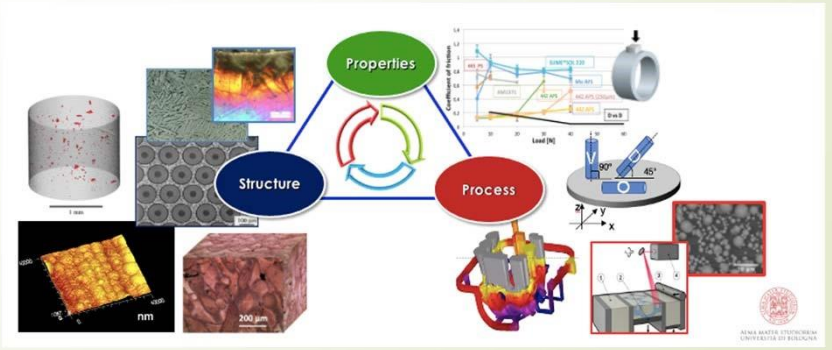
Argomenti di tesi (Gruppo Metallurgia, Dip. DIN)

- Studio **microstrutturale** e **meccanico** (prove di trazione, durezza, fatica, attrito ed usura) di materiali metallici (massivi, modificati superficialmente o compositi):
  - **prodotti mediante tecnologie additive** (*additive manufacturing*, noto anche come stampa 3D)
  - sviluppati in ottica di **alleggerimento strutturale veicoli (riduzione consumo energetico ed emissioni CO_2)**
  - per **limitazione consumo materie prime critiche**





Progetti recenti e in corso

- **NEWMAN** (EIT KIC RawMaterials, KAVA 6 - Upscalingprojects2020: « **Nickel frEepoWdersfor high perforMAncecompoNents**» **2020-21**)
- **ACMEC** (POR-FESR «**Additive manufacturing and Cyber-physicaltechnologiesfor MEChatronicsof the future**» **2019-21**)
- **RIMMEL** (POR-FESR «**Multifunctional and multiscale coatings for mechanical components produced by additive manufacturing**» **2019-21**)
- **PAR**-ENEA (ItalianNational Agency for New Technologies, Energy & SustainableEconomic Development «**Tribologicalstudyof alloysfor the electricalsystemproducedby additive manufacturing**» **2020-21**)
- **PROCRAFT** (JPI-CH «**PROtection and conservation of Heritage AirCRAFT**» **2020-23**)

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Ilenia Giarnieri

Alessandro Manna

Claudio Monaco

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Alejandro Natoli

Pio Gramazio

Francesca Liuzzi

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CATALYSIS FOR RENEWABLES AND INNOVATIVE PROCESSES «CARE IN PROCESS»

Alessandro Allegri

Gabriele Galletti

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

WHO WE ARE

Prof.ssa Stefania Albonetti

Prof. Francesco Basile

Prof.ssa Patricia Benito

Prof. Fabrizio Cavani

Prof. Nikolaos Dimitratos

Prof. Giuseppe Fornasari

Prof Carlo Lucarelli (UnInsubria)

Dott. Andrea Fasolini

Dott. Tommaso Tabanelli

4 ResearchFellows

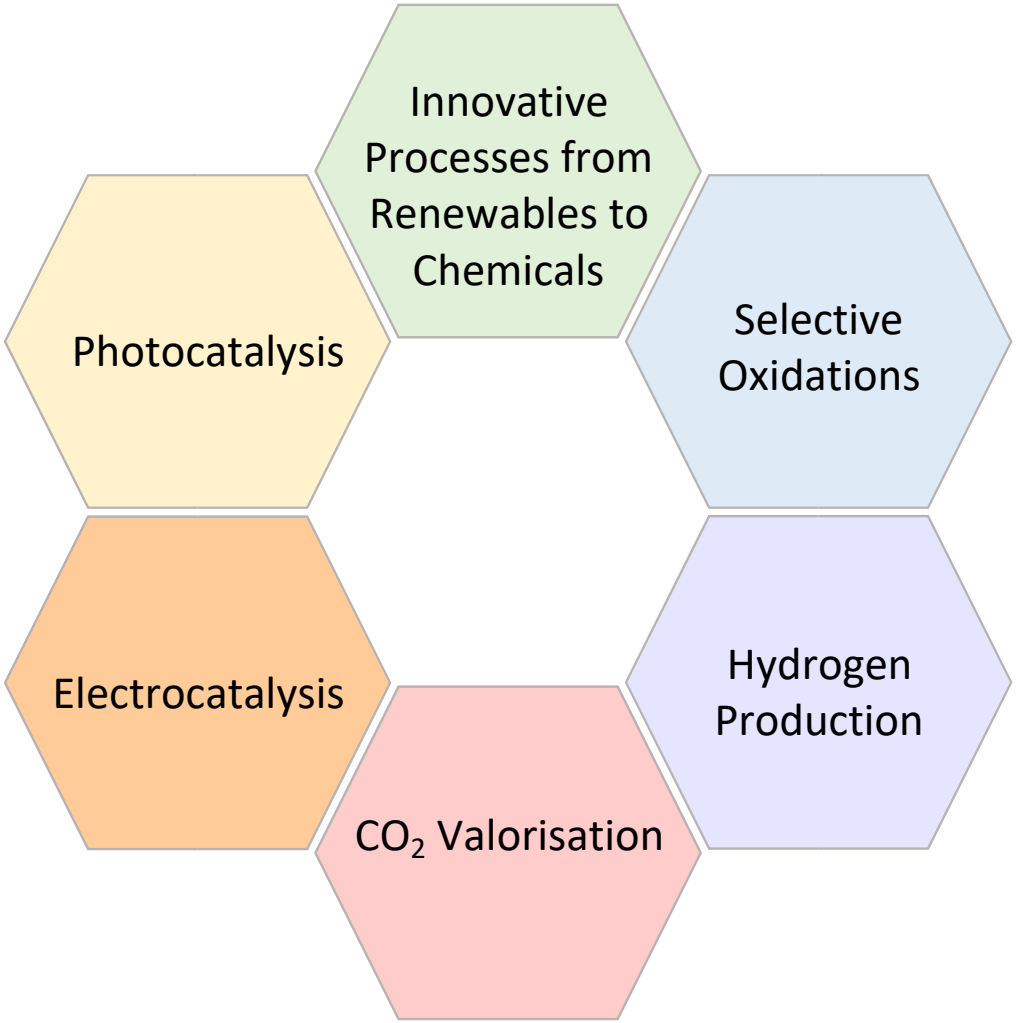
12 PhD Students

3 Post-Doctorate ResearchFellows

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

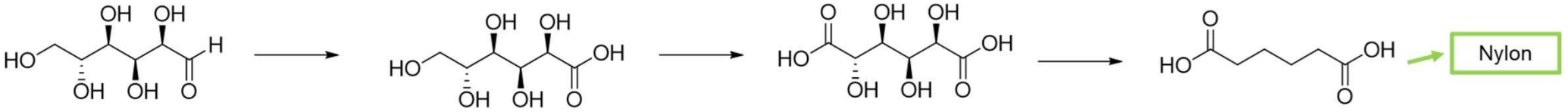
RESEARCH LINES

RESEARCH LINES



Innovative

RESEARCH LINES



D-Glucose

D-Gluconic acid

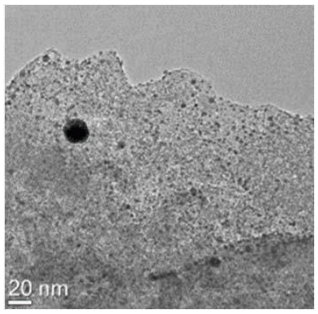
D-Glucaric acid

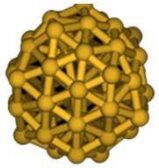
Biobased Adipic acid

Processes from Renewables to Chemicals

RESEARCH LINES

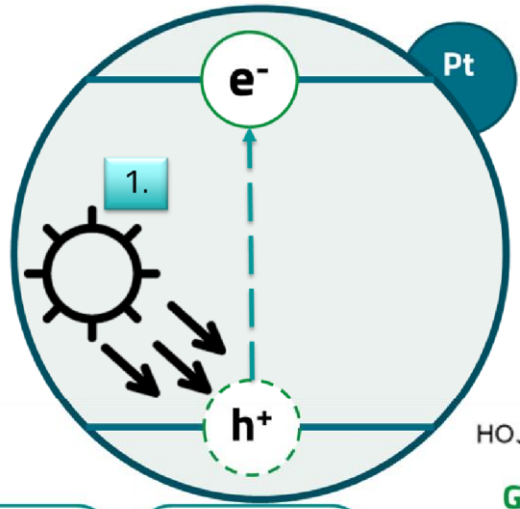
Catalyst: Au/C



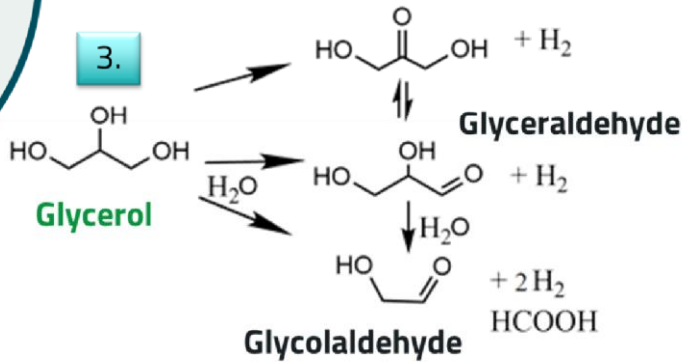


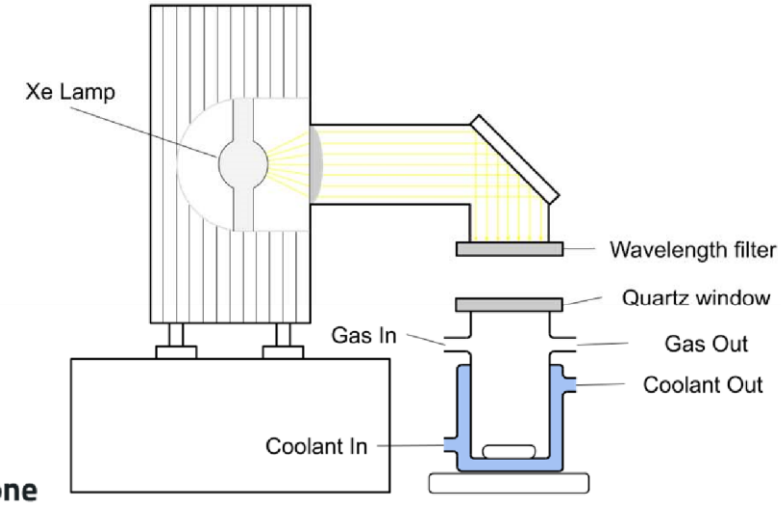
RESEARCH LINES

Photocatalysis



2. $2H^+ \rightarrow 2H_2$





1. Renewable Energy Source

2. Hydrogen production

3. Valorization of **glycerol** towards production of chemicals

RESEARCH LINES

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Selective
Oxidations

RESEARCH LINES

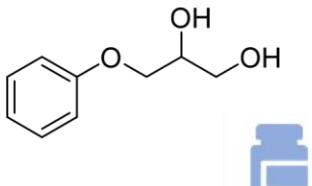
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Electrocatalysis

RESEARCH LINES

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

CO_2
Valorisation

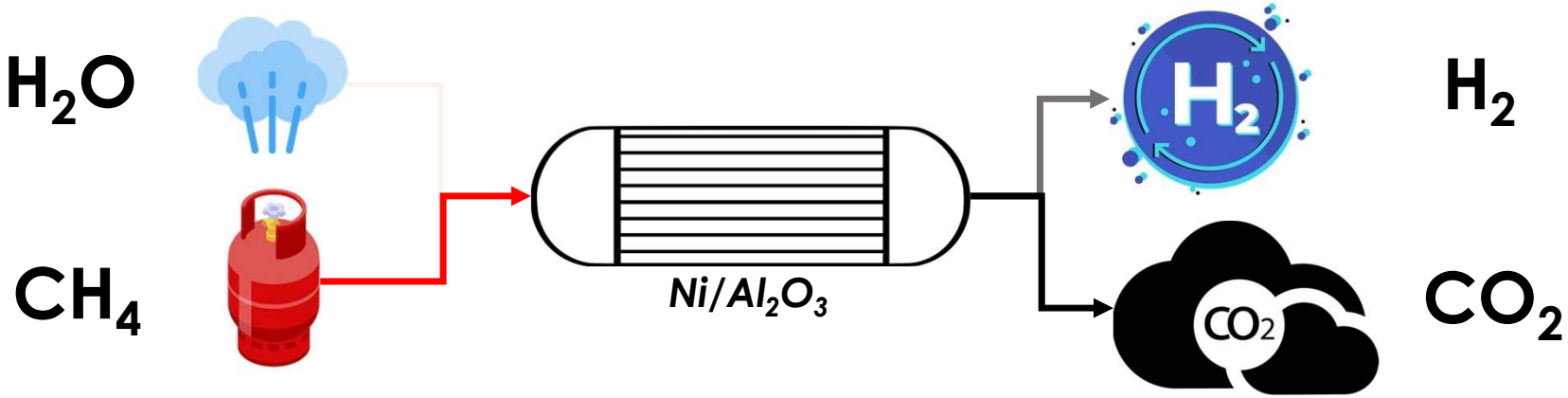


RESEARCH LINES

Hydrogen Production

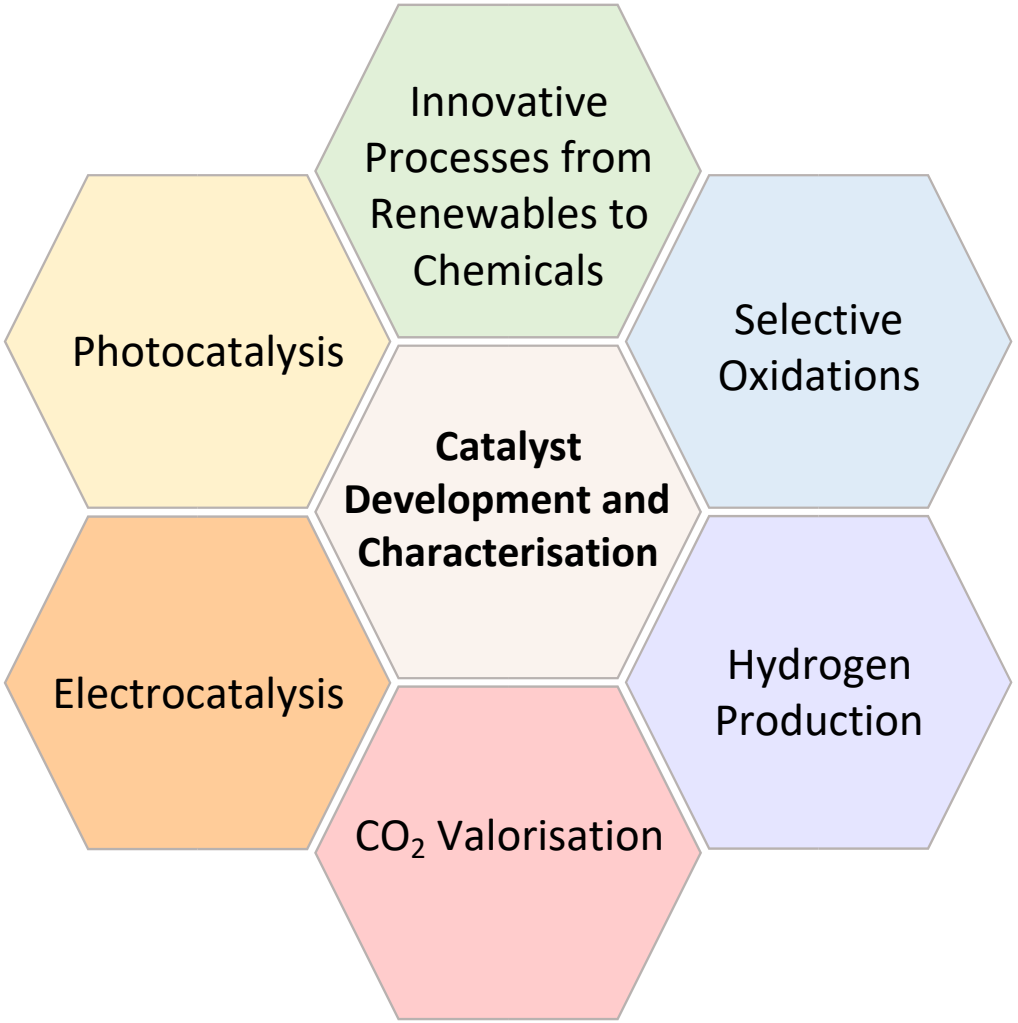
Methane Steam Reforming

$$CH_4 + 2H_2O \rightleftarrows 4H_2 + CO_2 \quad \Delta H = 164{,}6 \text{ kJ/mol}$$



RESEARCH LINES

GENERAL APPROACH



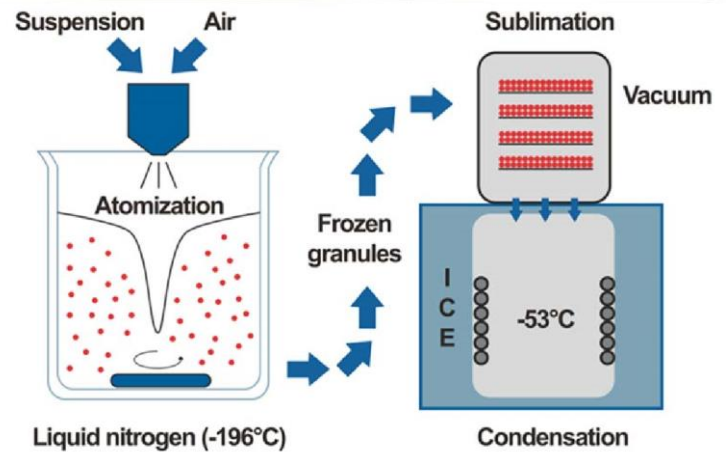
GENERAL APPROACH

Catalyst Preparation

(Co-)Precipitation

Sol Immobilization
Incipient Wetness Impregnation

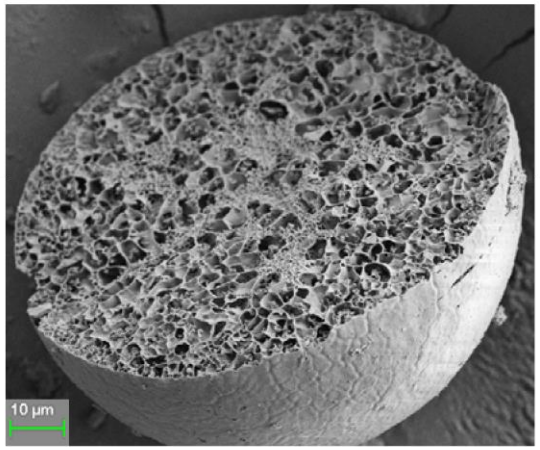
Spray-Freeze Drying



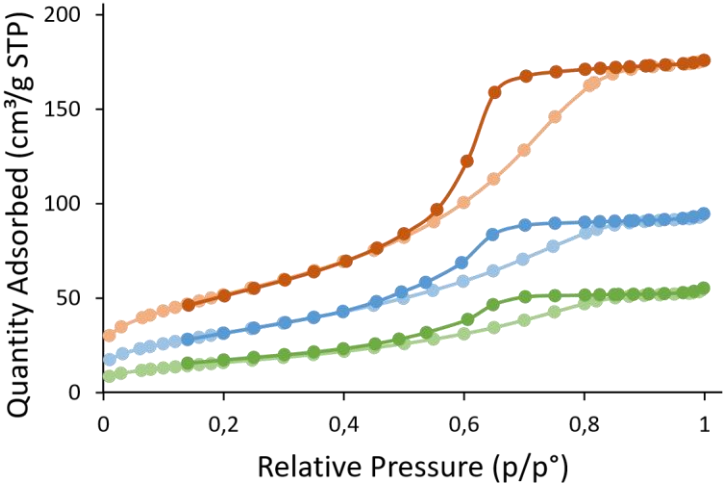
GENERAL APPROACH

Catalyst Preparation → Catalyst Characterization

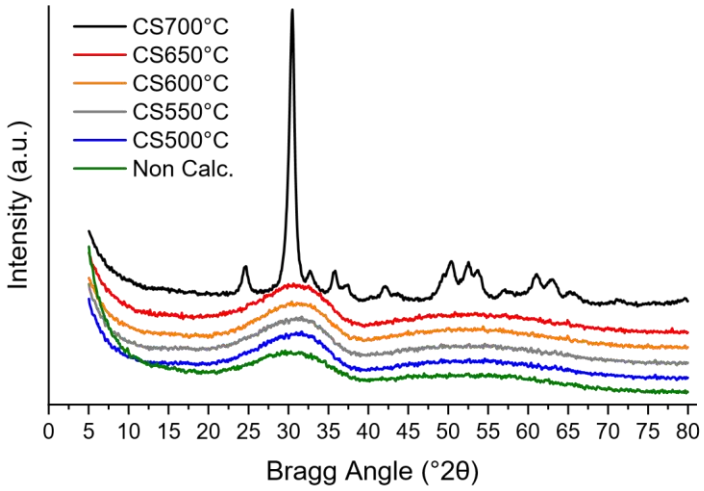
SEM



N_2 Adsorption-Desorption



XRD

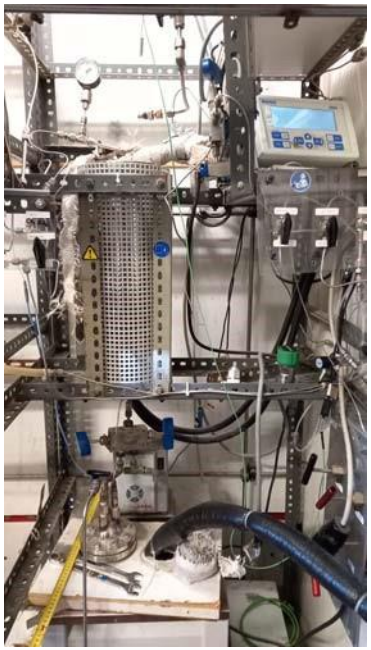


...and others like:
XRF, TPD-R-O,
(DR)UV-Vis, etc.

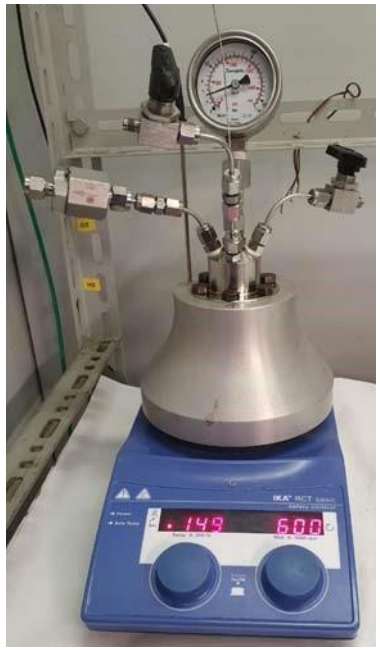
GENERAL APPROACH

Catalyst Preparation → Catalyst Characterization → Catalyticactivity

Gas Phase
Continuous Flow Reaction



Liquid Phase
Batch Reaction



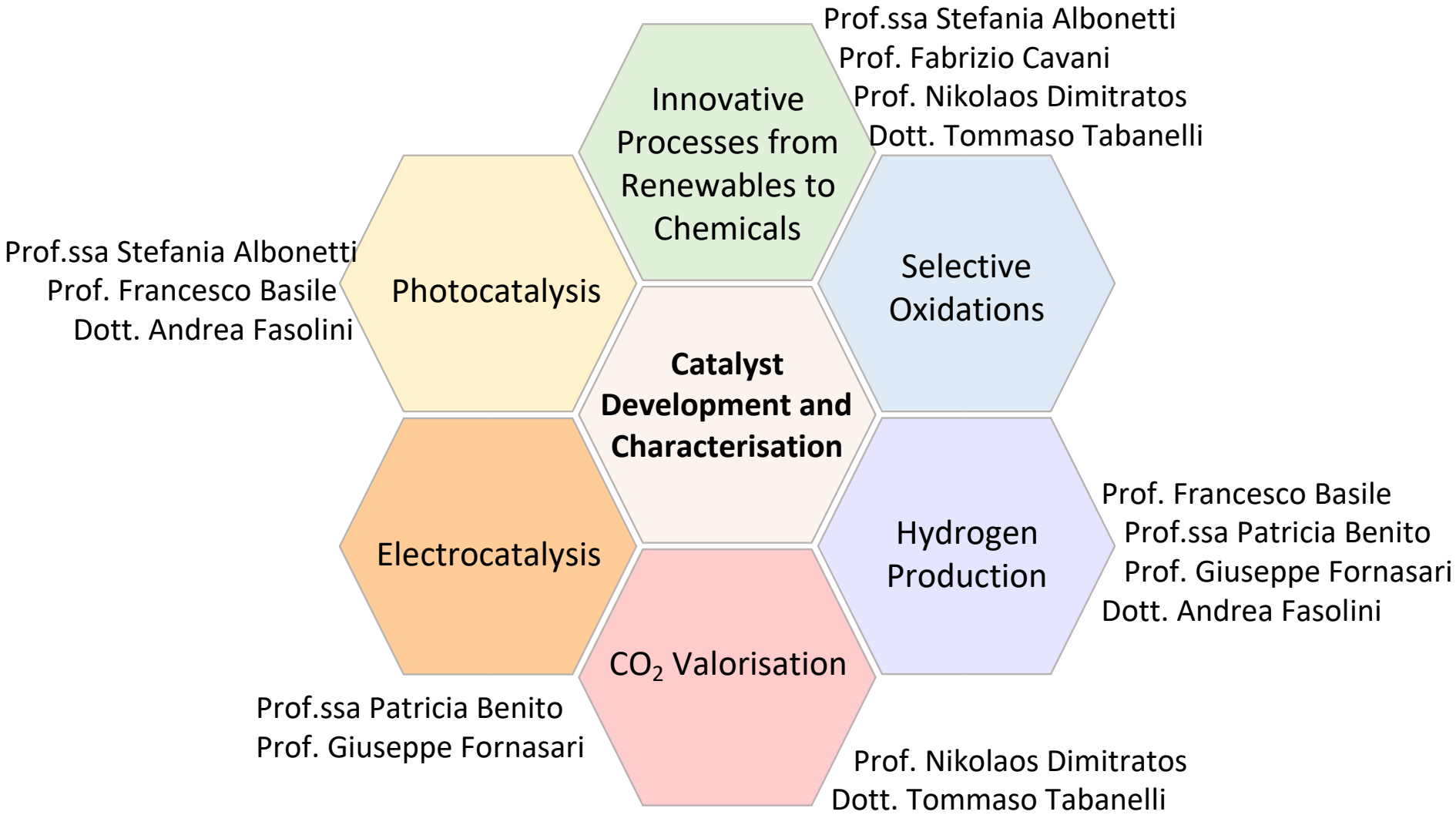
Liquid Phase Continuous
Flow Reaction

GENERAL APPROACH

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Catalyst Preparation → Catalyst Characterization → Catalyticactivity → Reac Outc Anal

RESEARCH LINES


Innovative Processes from Renewables to Chemicals
Prof.ssa Stefania Albonetti
Prof. Fabrizio Cavani
Prof. Nikolaos Dimitratos
Dott. Tommaso Tabanelli
Photocatalysis
Prof.ssa Stefania Albonetti
Prof. Francesco Basile
Dott. Andrea Fasolini
Selective Oxidations
Catalyst Development and Characterisation
Electrocatalysis
Prof.ssa Patricia Benito
Prof. Giuseppe Fornasari
Hydrogen Production
Prof. Francesco Basile
Prof.ssa Patricia Benito
Prof. Giuseppe Fornasari
Dott. Andrea Fasolini
CO_2 Valorisation
Prof. Nikolaos Dimitratos
Dott. Tommaso Tabanelli

CATALYSIS FOR RENEWABLES AND INNOVATIVE PROCESSES «CARE IN PROCESS»

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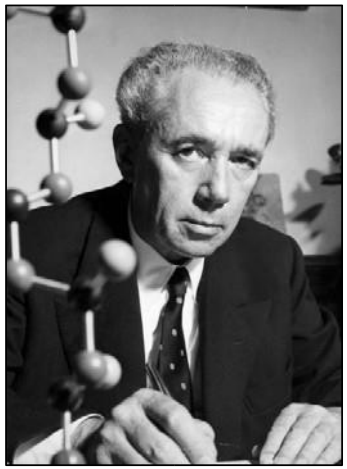
Prof. Francesco Basile	f.basile@unibo.it
Prof.ssa Patricia Benitopatricia.benito3@unibo.it	
Prof. Fabrizio Cavani	fabrizio.cavani@unibo.it
Prof. Nikolaos Dimitratos	nikolaos.dimitratos@unibo.it
Prof. Giuseppe Fornasari	giuseppe.fornasari@unibo.it
Prof Carlo Lucarelli (UnInsubria)	carlo.lucarelli2@unibo.it
Dott. Andrea Fasolini	andrea.fasolini2@unibo.it
Dott. Tommaso Tabanelli	tommaso.tabanelli@unibo.it
Alessandro Allegri	alessandro.allegri2@unibo.it
Gabriele Galletti	gabriele.galletti5@unibo.it

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

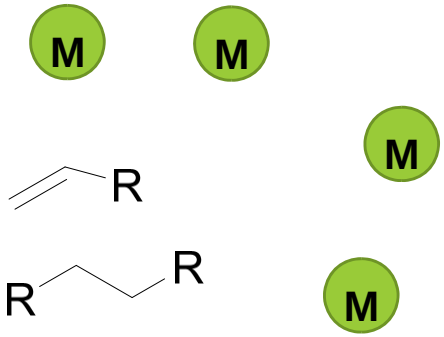
Chimica Industriale (Polimeri)

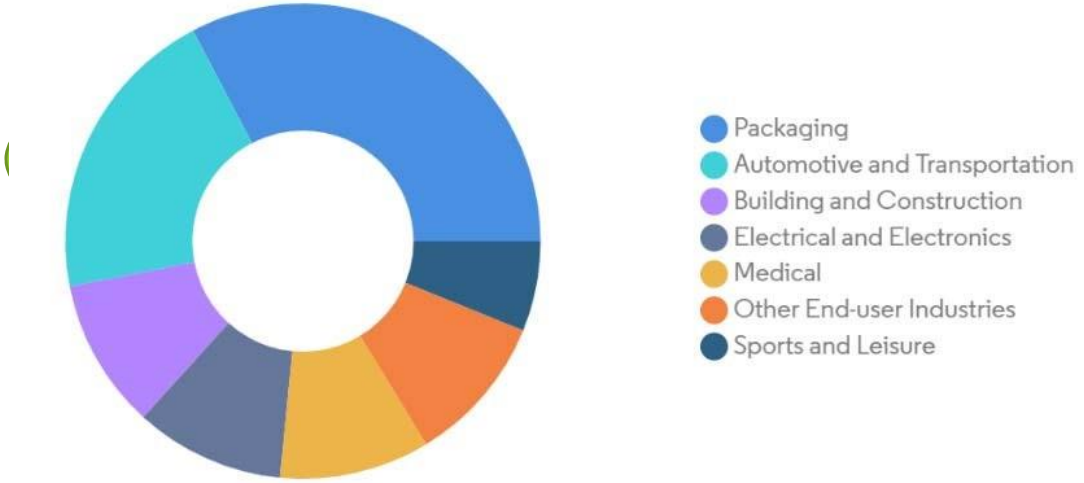
Docenti	Dottorandi/Assegnisti/Borsisti
Daniele Caretti stefano.scurti2@unibo.it	Stefano Scurti
Elisabetta Salatelli	Francesco Prandi
Tiziana Benelli	Debora Quadretti
Loris Giorgini	Martina Marinelli Massimiliano Lanzi Jacopo Ortolani
Laura Mazzocchetti	Vittoria Bottau
Maurizio Toselli	Giulia Vigarani
	Luca Mugnaini
	Filippo Valorosi
	Paola Natali

Gruppo Polimeri

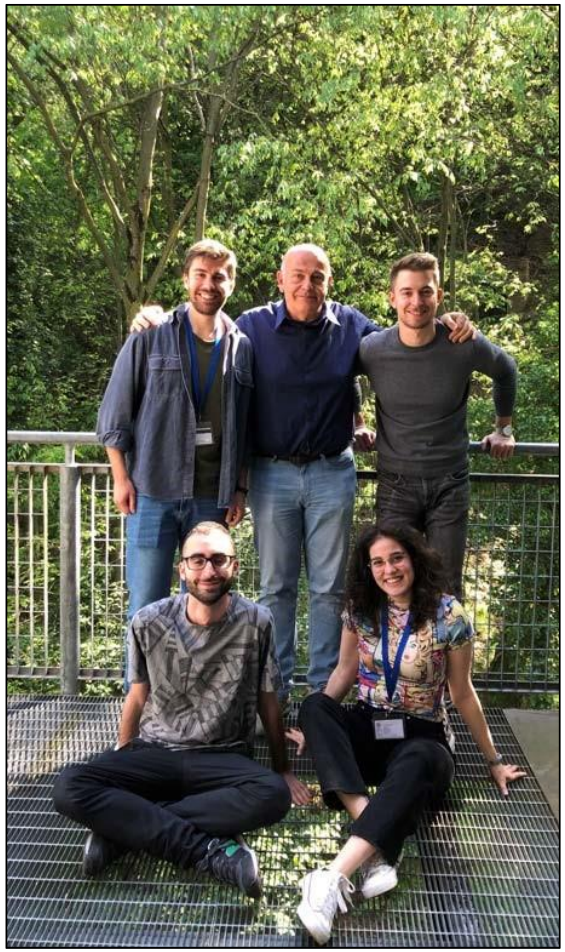


Cosa sono i polimeri?





Gruppo di Ricerca di Polimeri Caretti-Toselli



❖Prof. Daniele Caretti *daniele.caretti@unibo.it*

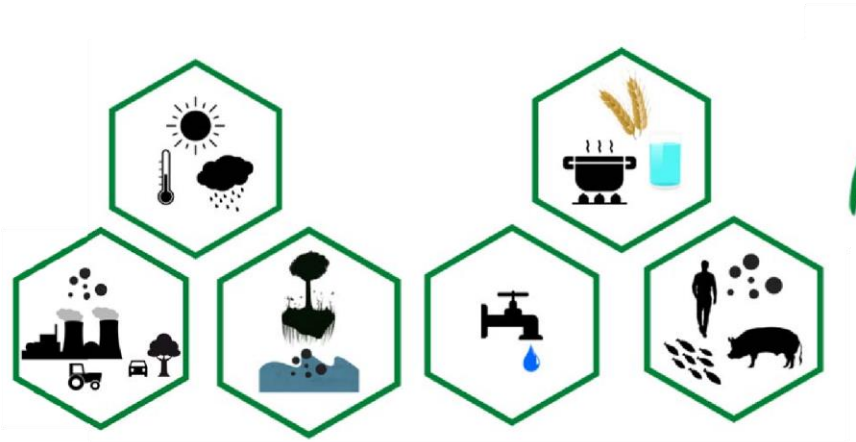
❖Prof. Maurizio Toselli *maurizio.toselli@unibo.it*

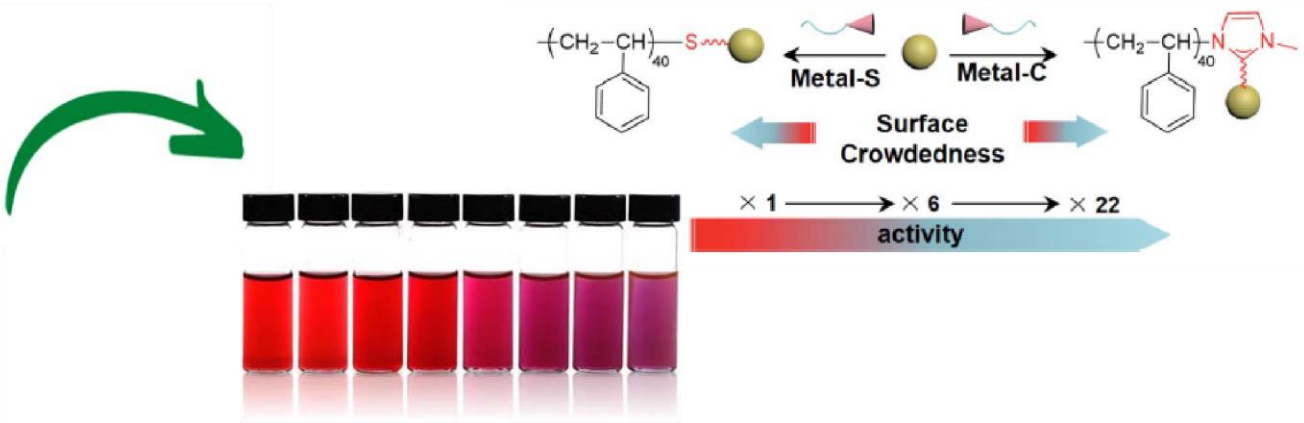
❖ PhD student:
Francesco Prandi (UNIBO-SACMI) francesco.prandi3@unibo.it

Stefano Scurti *stefano.scurti2@unibo.it*

Sintesi di nano-materiali ibridi (metallo-polimero)

per il trattamento delle acque

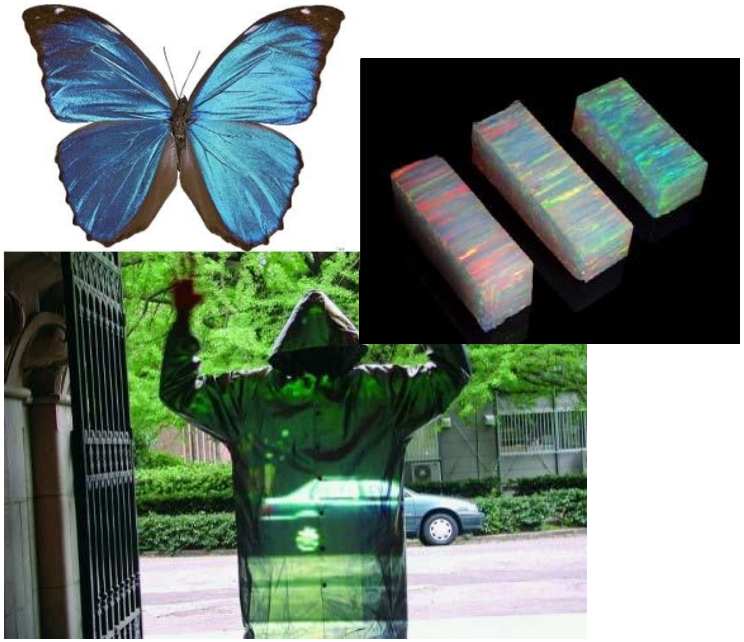




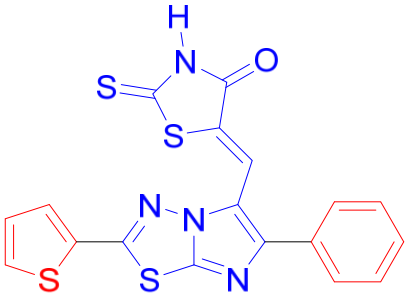
- Sintesi dei monomeri e dei polimeri (NMR, IR, analisi termiche)
- Preparazione dei nanomateriali (sintesi inorganica)
- Valutazione delle proprietà nella rimozione/conversione catalitica degli inquinanti

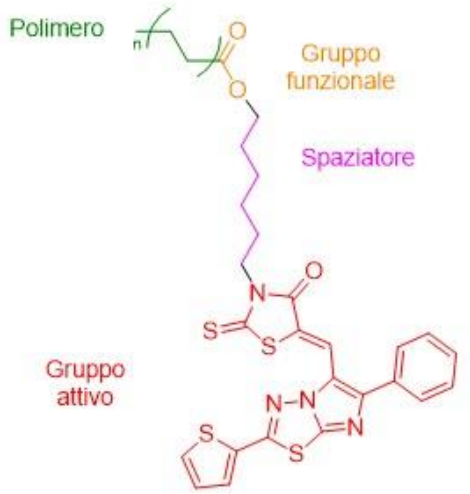
Prof. Daniele Caretti
Daniele.caretti@unibo.it

Polimeri funzionali per applicazioni nell'opto-elettronica



Donatore-Accettore-Donatore





- Sintesi dei monomeri e dei polimeri (NMR, IR, analisi termiche)
- Valutazione delle proprietà ottiche non lineari

PETALS (PRIN 2021) Prof.

Daniele Caretti

Daniele.caretti@unibo.it

UNIVERSITÀ DEL PIEMONTE ORIENTALE

UNIVERSITÀ DEGLI STUDI DI GENOVA

Sviluppo di packaging a base di cellulosa mediante la sintesi di additivi idrofobizzanti:

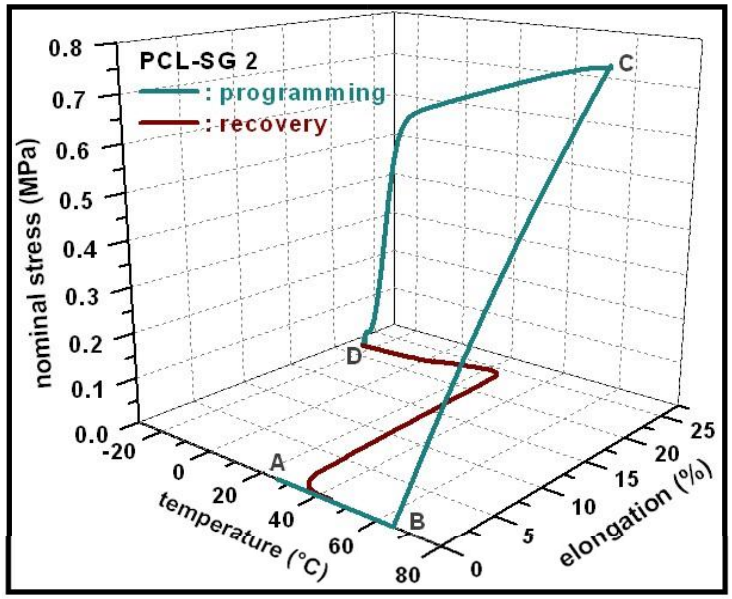
❖Valutazione ed eventuale pretrattamento del materiale cellulosico di partenza

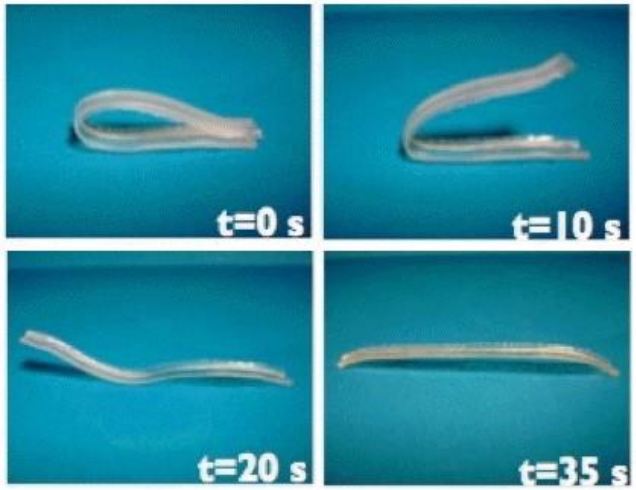
- Sintesi dell’additivo idrofobizzante e modifica della cellulosa
  - Produzione di campioni mediante stampaggio a compressione

- Determinazione delle proprietà meccaniche, termiche, ecc. del provino ottenuto

Prof. Daniele Caretti
Daniele.caretti@unibo.it

Polimeri a memoria di forma e stimuli responsive

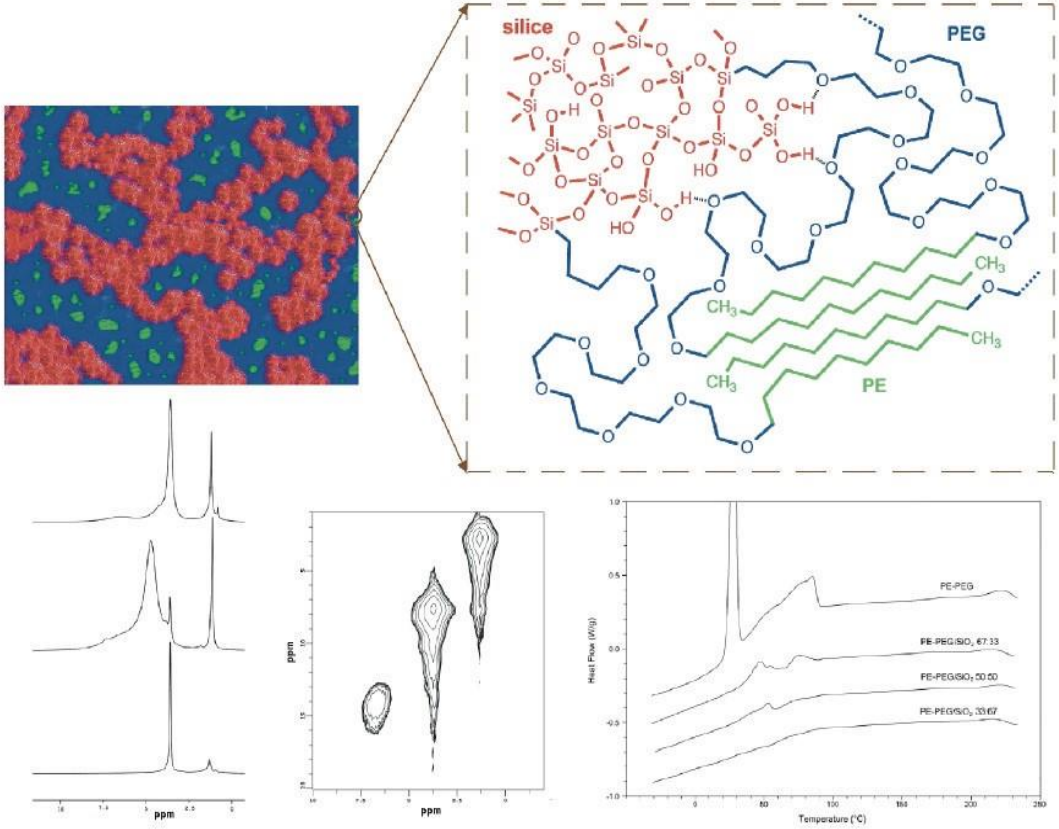


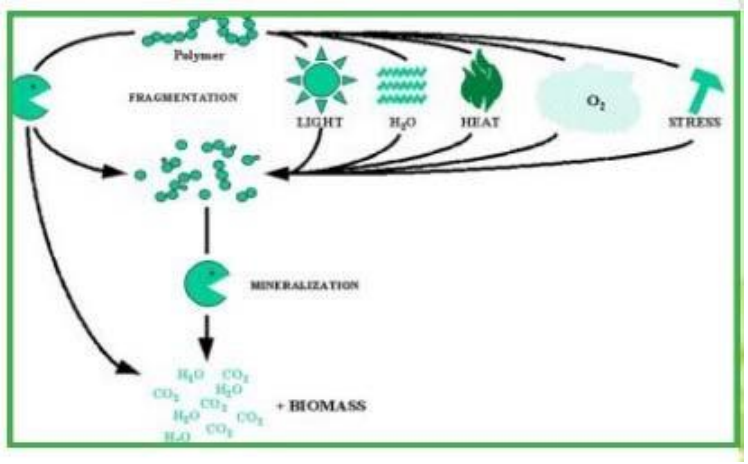


- Sintesi dei monomeri e dei polimeri (NMR, IR, analisi termiche)
- Valutazione delle proprietà del materiale

Prof. Maurizio Toselli
Maurizio.toselli@unibo.it

Coating ibridi organici-inorganici





- Sintesi dei monomeri e dei polimeri (NMR, IR, analisi termiche)
- Preparazione dei coating ibridi
- Valutazione delle proprietà di resistenza alla luce UV

Prof. Maurizio Toselli
Maurizio.toselli@unibo.it

Gruppo di Ricerca

Materiali polimerici e compositi (CHIMIND)

❖Pro. Loris Giorgini loris.giorgini@unibo.it

❖Prof.ssa Tiziana Benelli

❖Prof.ssa Laura Mazzocchetti

❖4 PhD student

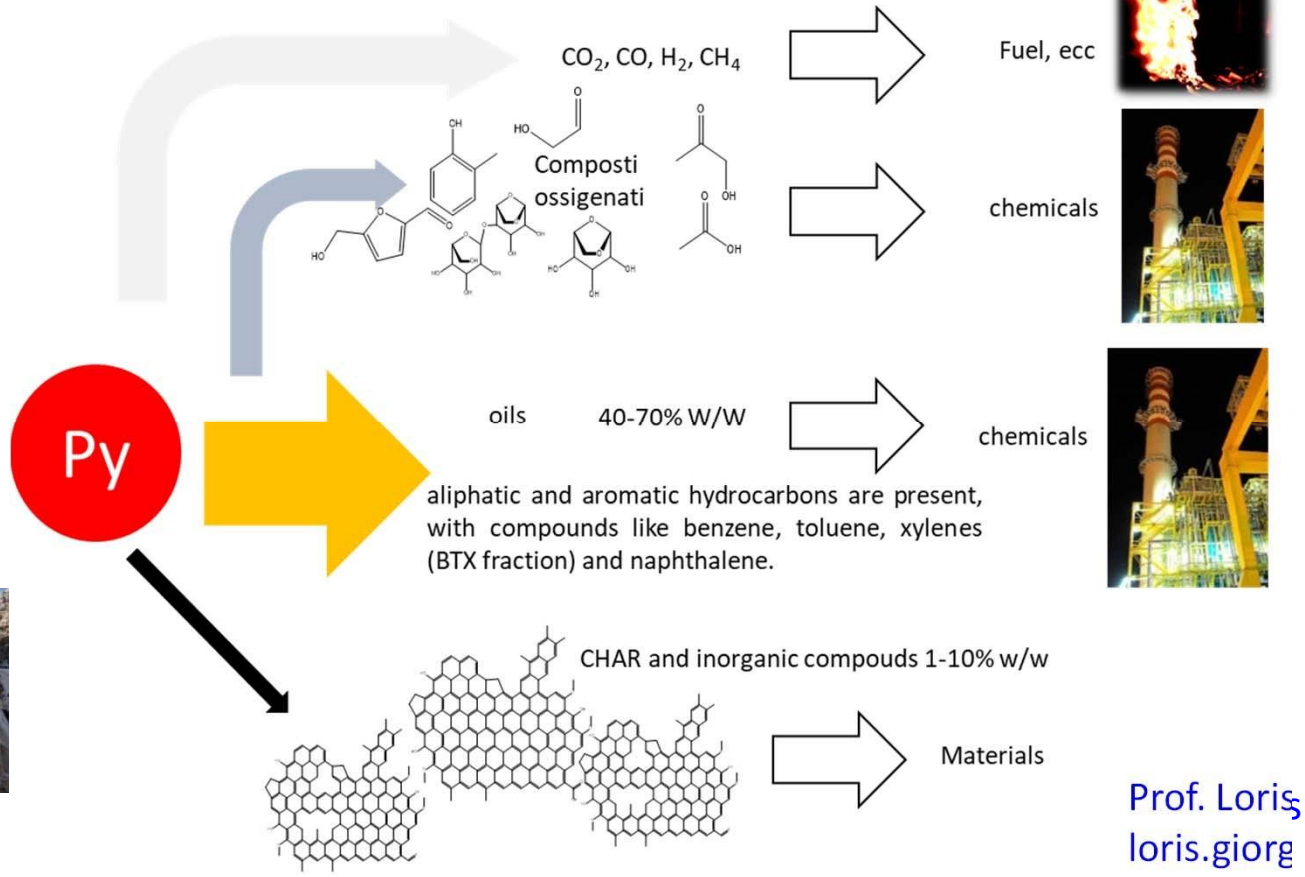
❖2 Indutrial PhD student ❖2 Assegnisti di ricerca

- 12 laureandi magistrale
- 3 laureandi triennale

PYROLYSIS of PLASMIX (mix of plastic materials e.g. Corepla)

Our approaches for Recovery Carbon (C) weight % in oil

loris.giorgini@unibo.it

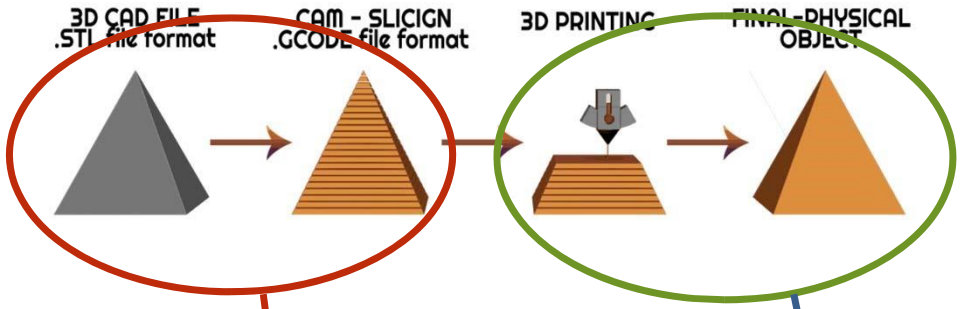


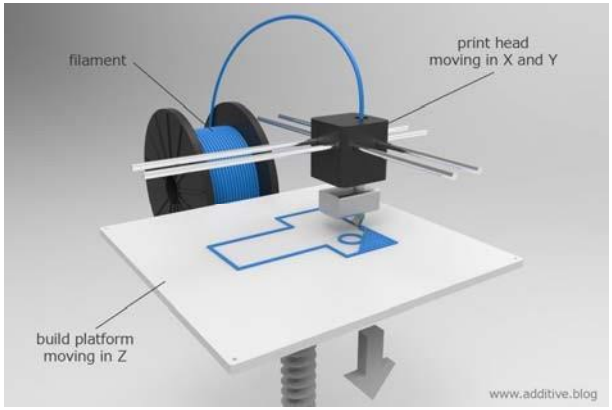
Prof. Loris Giorgini
loris.giorg

loris.giorgini@unibo.it

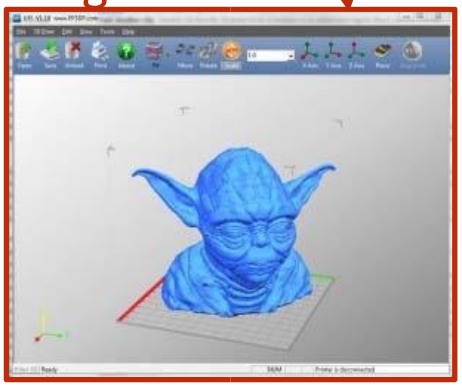
3D printing - Fused deposition modeling (FDM)

loris.giorgini@unibo.it





Progettazione



Disegno CAD

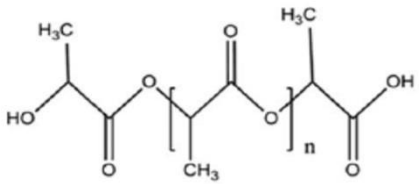
Stampa 3D

Prof. Loris Giorgini

loris.giorgini@unibo.it

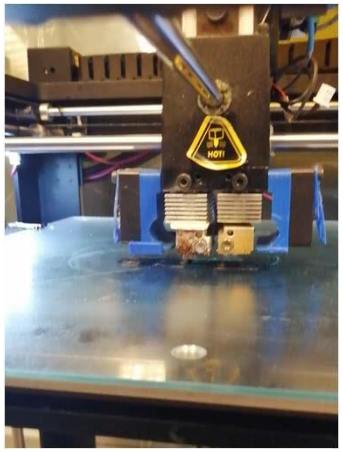
Stampa 3D di compositi termoplastici

loris.giorgini@unibo.it



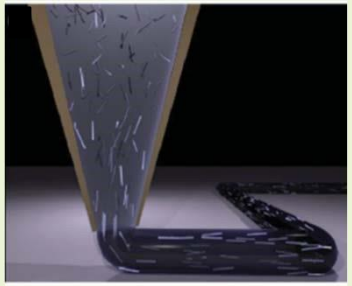
Polylactic acid (PLA)

***v*CF** = fibre di carboniovergini
***r*CF** = fibre di carbonioriciclate



Stampa con fibre di carbonio corte

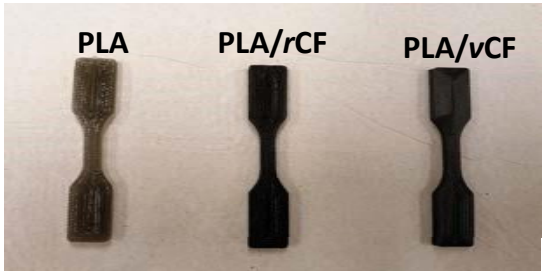
- Lunghezza fibre < 500 µm
- Allineamento delle fibre con il flusso



Analisi delle proprietà meccaniche su stampati:

Analisi dinamico-meccanica (DMA)
Test di trazione

Stampa 3D



Filamentodi PLA puro

FilamentoPLA/CF

In collaborazione con DIFA e DISTAL

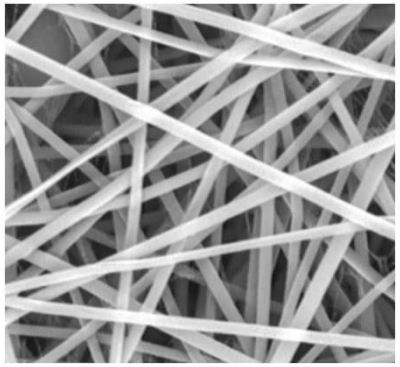
Prof. Loris Giorgini

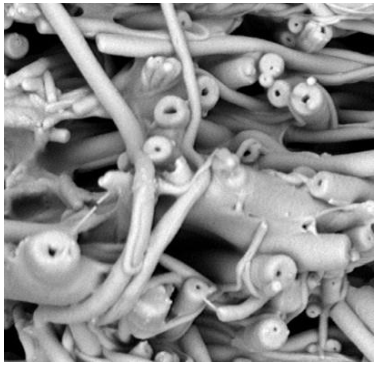
loris.giorgini@unibo.it

Macchina per elettrofilatura

rullo collettore

In collaborazione con il DIN





Nanofibre

4 aghi

blocco aghi traslante

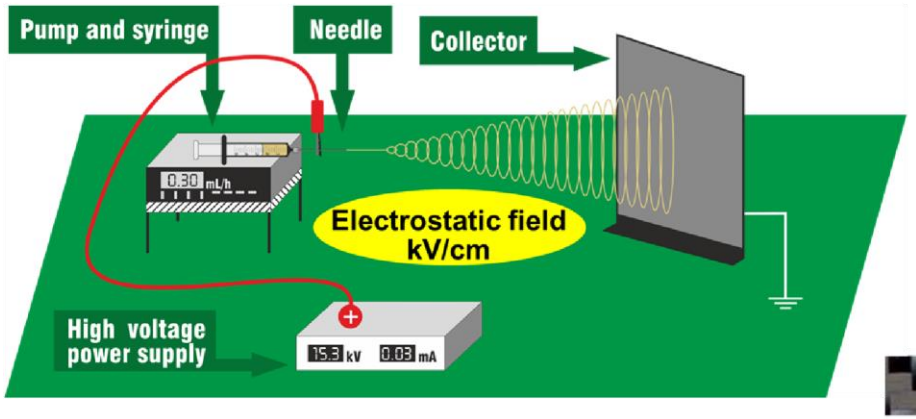
Parte della tesi da svolgersi

presso il Lazzaretto

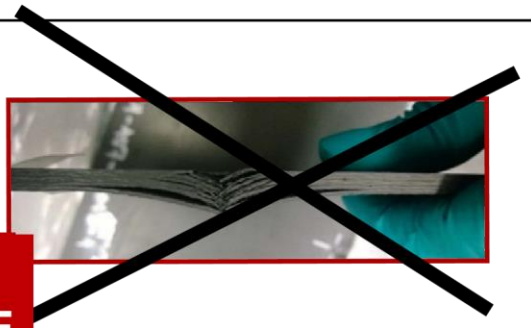
Core-shell

Laminati e nanofibre

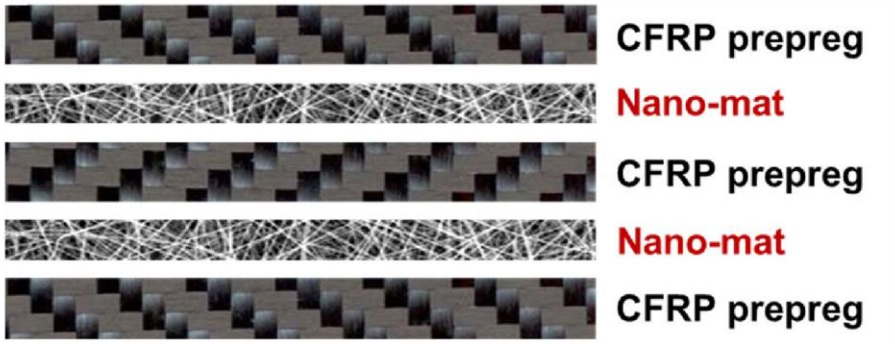
Processo di elettrofilatura per la produzione di membrane nanofibrose



membrane nanofibrose intercalate tra le lamine di CFRP



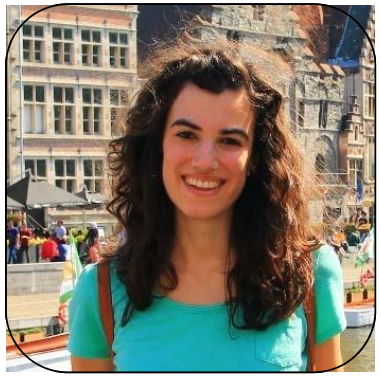
PREVIENE LA DELAMINAZIONE



La propagazione della cricca è ostacolata

Gruppo di Ricerca di Polimeri
Lanzi - Salatelli






Prof. Massimiliano Lanzi
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Prof.ssa Elisabetta Salatelli
elisabetta.salatelli@unibo.it

Dott.ssa Martina Marinelli
Assegnista di Ricerca

Dott.ssa Debora Quadretti
Dottoranda

KATHOLIEKE UNIVERSITEIT LEUVEN

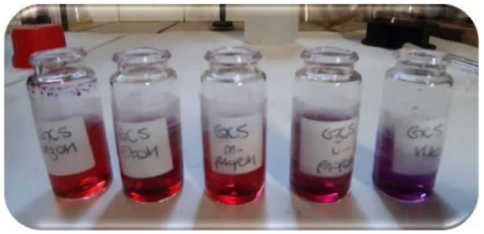
IPPT PAN Institute of Fundamental Technological Research Polish Academy of Sciences

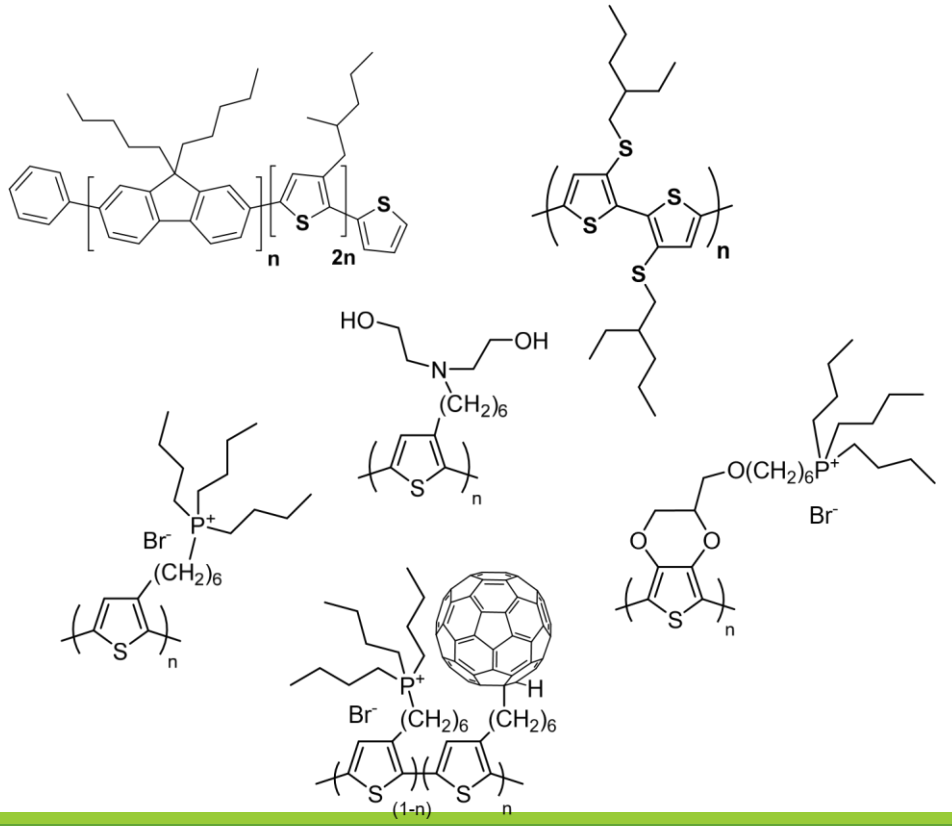
ISOF CNR - BOLOGNA

DICAM DIPARTIMENTO DI INGEGNERIA CIVILE, AMBIENTALE, AEROSPAZIALE, DEI MATERIALI

Temi di Ricerca

❖ *Sintesi di polimeri semiconduttori*





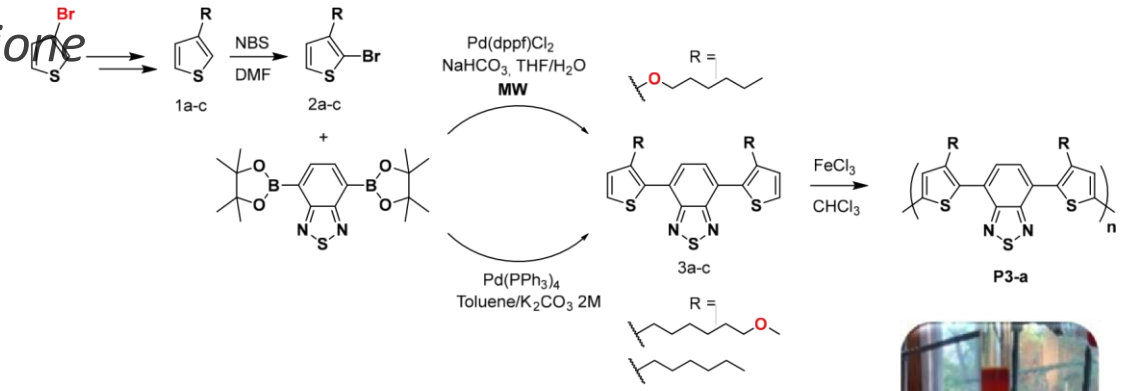
(in particolare politiofeni)

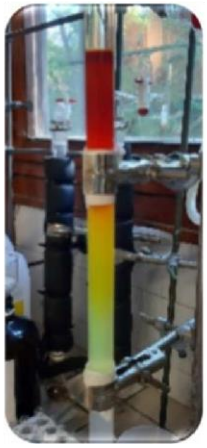
- *Ottimizzazione delle sintesi*
- *Caratterizzazione dei materiali*
- *Applicazione in dispositivi fotovoltaici*

Sintesi

- *Sintesi dei monomeri a partire da reagenti commerciali*

❖ *Utilizzo di diversi sistemi di reazione*

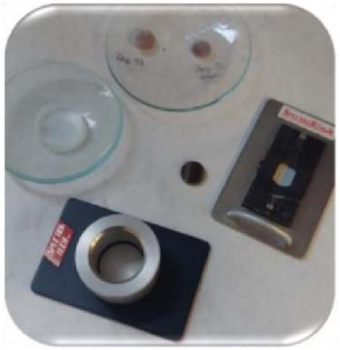




- *Polimerizzazioni regiospecifiche e non*
- *Varie tecniche di purificazione (cristallizzazione, colonna cromatografica, distillazione in vuoto)*
- *Identificazione dei prodotti*

Caratterizzazione

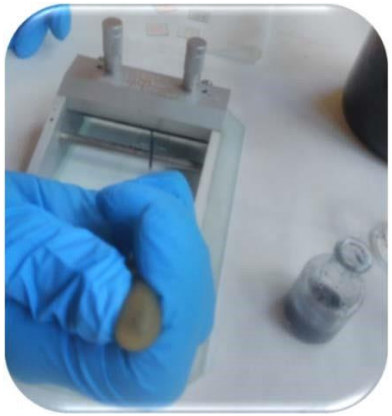
- *^{1}H-NMR, IR (identificazione)*

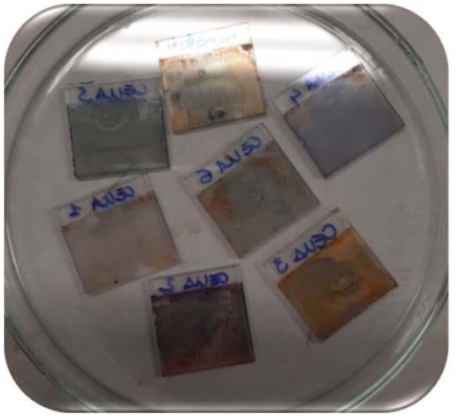


- *GPC (peso molecolare medio)*
- *UV-Vis (proprietà ottiche)*
- *TGA, DSC (proprietà termiche)*

Realizzazione di celle solari

- *Il polimero sintetizzato viene testato come strato fotoattivo in un dispositivo fotovoltaico su piccola scala*



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