ASSOLOMBARDA
Confindustria Milano Monza e Brianza

La ricerca dei nuovi materiali al dipartimento di Chimica, Materiali e Ingegneria Chimica "G. Natta"

Speaker
Prof. Luigi De Nardo – CMIC Dept.

5 Luglio 2017

CMIC: A sustainable department for a sustainable world

Dipartimento di Chimica, Materiali e Ingegneria Chimica “Giulio Natta” is the center of the “chemical culture” in Politecnico di Milano

Research interests cover many of the most relevant research fields of:

- **chemistry**
- **chemical engineering**
- **biological – biomechanics**
- **materials science and engineering**

Department ranked 1st in Italy for the quality of research for the period 2001-2010 in the subject "Industrial and information Engineering" by ANVUR –MIUR Agency

CMIC: A sustainable department for a sustainable world
Main figures

CMIC department

- ↘ 120 faculties (113 permanent)
- ↘ 50 administrative (13) & technical staff (37)
- ↘ 25 laboratories
- ↘ About 90 PhD students
- ↘ more than 120 temporary researchers/year,

Majority of students from

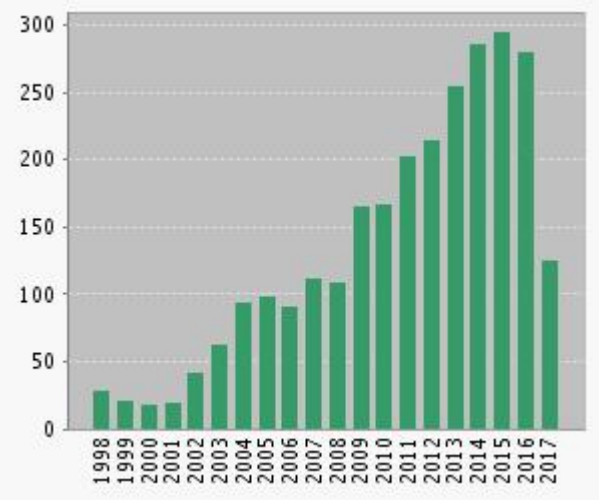
- ↘ “Chemical Engineering”,
- ↘ “Materials Engineering and Nanotechnology”,
- ↘ “Biomedical Engineering”, “Design”,
- ↘ “Civil & Construction Engineering”

Overall 500 people working in the Department

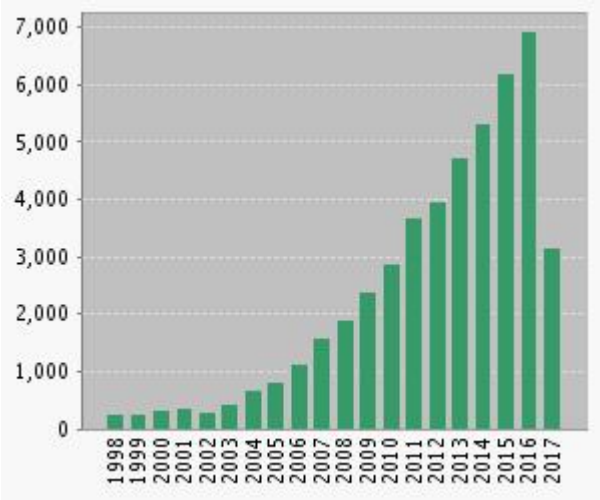
Research and consultancy turnover of about 8M€/year*
(more than 50% from industrial sources)

- ↘ * No salary

CMIC: A sustainable department for a sustainable world
ISI Publications, Patents & Citations



Published of ISI papers



Citations of ISI papers ***h-index = 73***

International patents

2010	2011	2012	2013	2014	2015	2016	2017
14	16	12	4	5	9		

3 ERC projects (active): FoldHalo, NICHOID, MINERVA

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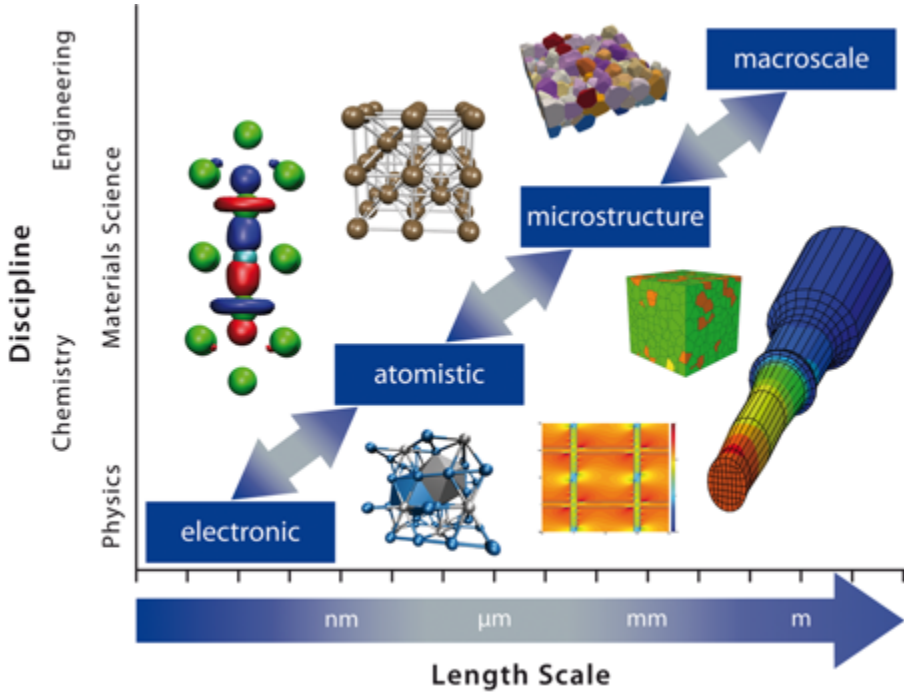
The CMIC dept. conjugates

- ↘ Chemistry
- ↘ Chemical Engineering
- ↘ Biological – biomechanics engineering
- ↘ Materials science and engineering

“A Multiscale department”

- ↘ The scientific development of these disciplines is deeply stimulated by the unique necessity to solve problems on dimensional scales
- ↘ from molecules to large industrial plants
- ↘ 12 orders of magnitude, both in time and space



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The “multiscale approach” is the favorable environment for cooperation with industry: developing technology together is more fruitful than technology transfer: two worlds thinking together instead than independently

- ↘ more than 50% of research and consultancy turnover coming from industrial sources – both corporations & SMEs

CMIC: A sustainable department for a sustainable world

The CMIC Dept. increased its presence in industrial fields away from the merely chemical one

- ↘ energy
- ↘ electronics
- ↘ cultural heritage
- ↘ Biomaterials & biotechnology
- ↘ food
- ↘ material durability & protection,

The increasing importance of the same concepts of sustainability and quality is imposing a strong necessity to evaluate and manage phenomena on progressively smaller scales

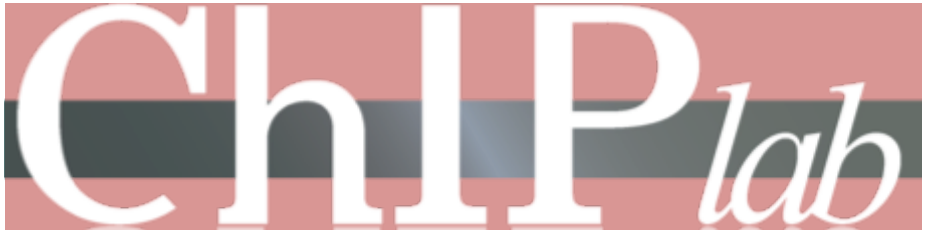
CMIC Labs


FA Lab


concrete
durability
mCD


PoliLaPP


Bio
MAT
Lab

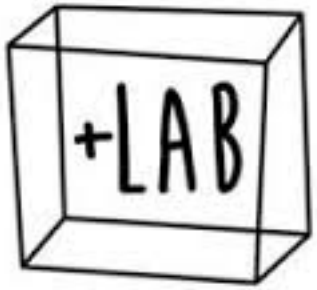

ChIP lab


SAMM
SERVIZIO DI ANALISI MICROSTRUTTURALI DEI MATERIALI


L
C
A


LaBS


LP3
LABORATORIO PROVE POLIMERI
POLITECNICO DI MILANO


+LAB


Fondazione
CEN CentroEuropeo
Nanomedicina


Lab


N
M
F


POLYMER
ENGINEERING
PE
LAB


CREEK


The Protein Factory

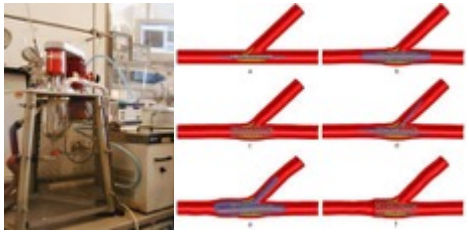
CMIC Labs
Three horizons to serve research and industry needs

Horizon 1: tests and measures

- ↘ LAC, LP3, SAMM
- ↘ Access by fee

Horizon 2: technology development

- ↘ all listed
- ↘ access by a contract with the department



Horizon 3: clear sky research

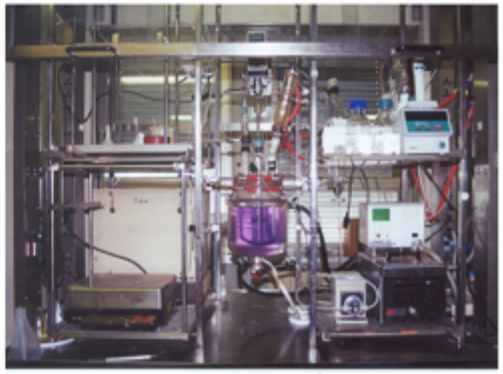
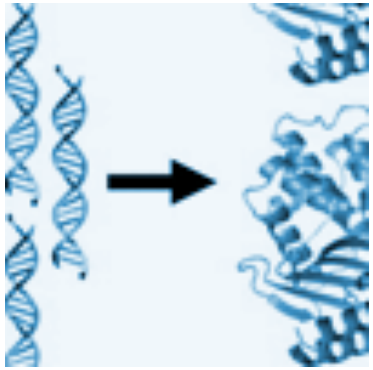
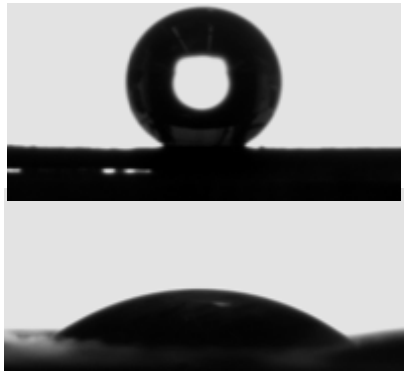
- ↘ all listed
- ↘ access by a contract with the department

CMIC Labs
1. Chemistry-oriented laboratories

Fluorine Laboratory (FLab).

Nanostructured Fluorinated Materials (NFMLab).

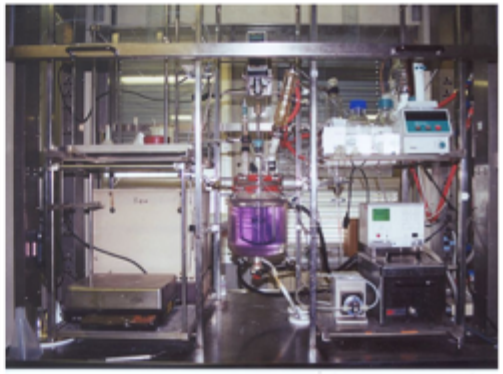
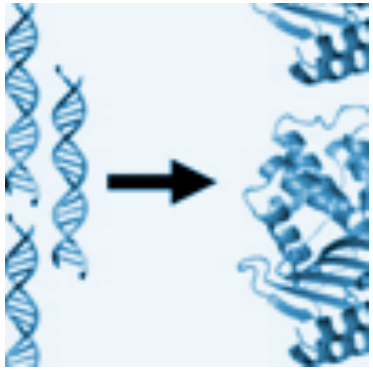
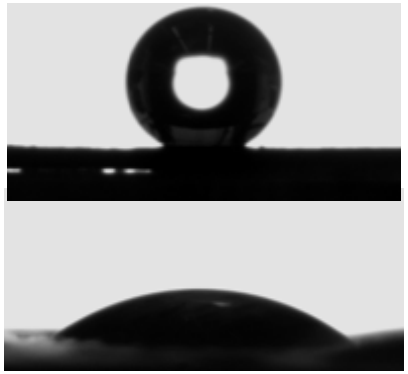
Organic Chemistry Laboratories (OCLabs).

Applied Physical Chemistry Lab (CFALab).

Computational Fluid Dynamics of Reactive and Non-reactive Flows Lab (CREEK Modeling Lab).

Process Systems Engineering laboratory (PSE-Lab)

CMIC Labs
3. Biological and Biomechanics-oriented laboratories

Proteomics Laboratory (ProteoLab)

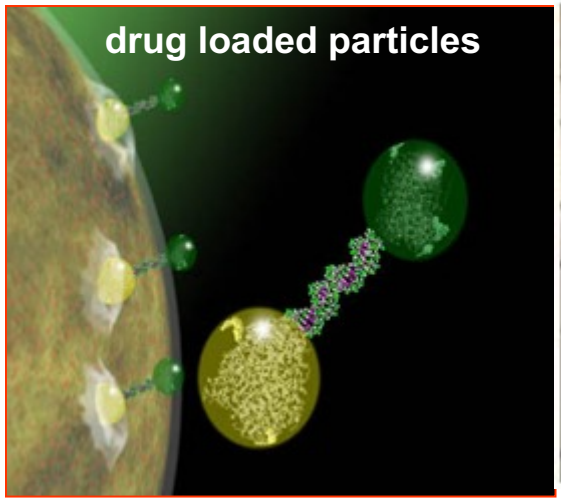
The Protein Factory (PFLab)

Laboratory of Biological Structure Mechanics (LaBS).

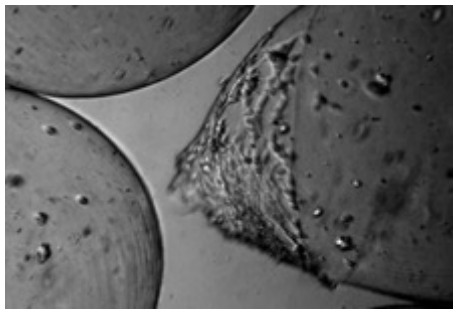
Laboratory of Biomaterials

European Center of Nanomedicine Lab (CEN)

Biocompatibility and Cell Culture Laboratory Lab (BioCell)

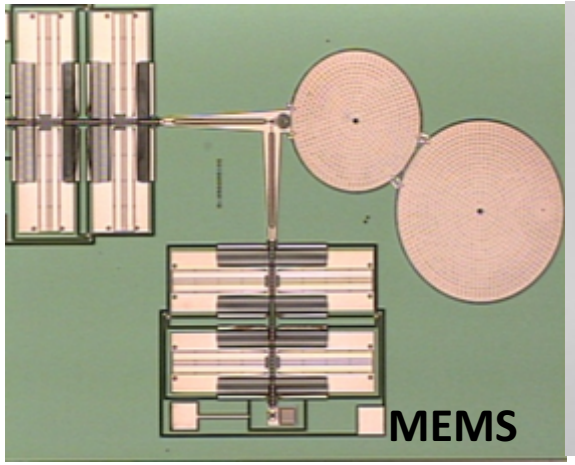


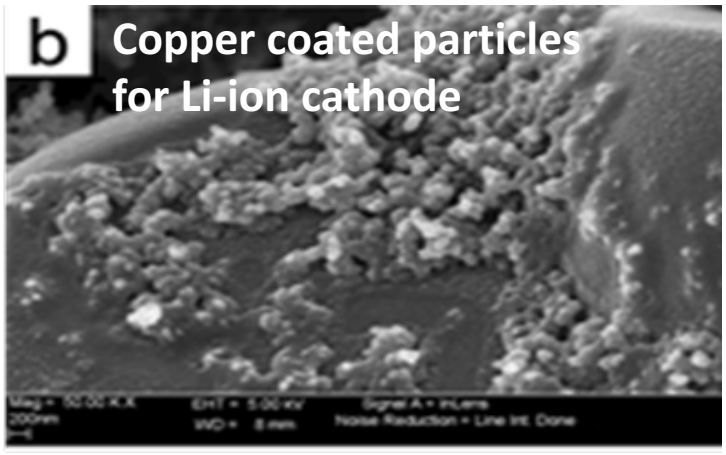
CMIC Labs
4. Materials-oriented Labs



- Cementitious Materials and Durability Lab (MCDLab)
- Chemistry and Characterisation of Innovative Polymers Lab (ChIPLab)
- Functional NanoMaterials Lab (FuNMat)
- Materials Corrosion Lab “Pietro Pedeferri” (PoliLaPP)
- Surface Engineering & Applied Electrochemistry Lab “Roberto Piontelli”
- Materials and Methods for Cultural Heritage Lab (MaMeCH)
- Materials for Energy and Environment Lab (Mat4En2)
- Materials Modelling, Morphology and Structure Lab (MMMoSt)
- Polymer Engineering Laboratory (PEL)
- Polimi-Pirelli Tyre Joint Labs
- Soft Matter Lab
- 3D printing Lab (+Lab)
- NextMaterials Lab

CMIC Labs
4. Materials-oriented Labs





CMIC Labs
5. Measurement-oriented Labs

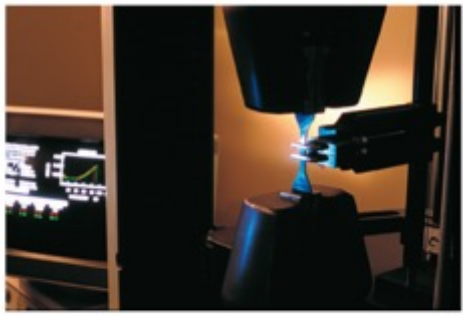
Chemical Analysis Laboratory (LAC).

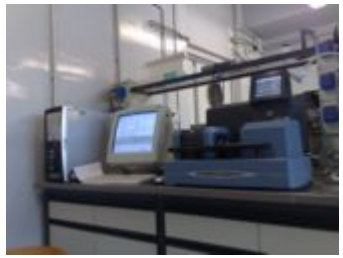
NMR & Large Instrumentation Laboratory

Olfactometric Laboratory

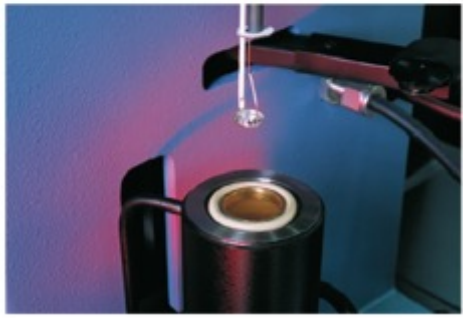
Service for Materials Microstructural Analysis (SAMM)

Polymer processing &Testing Lab (LP3)








CMIC - A sustainable department for a sustainable world
The tag cloud

POLIMI Joint Research Centers

Medium term horizon researches, steady consolidated relationships

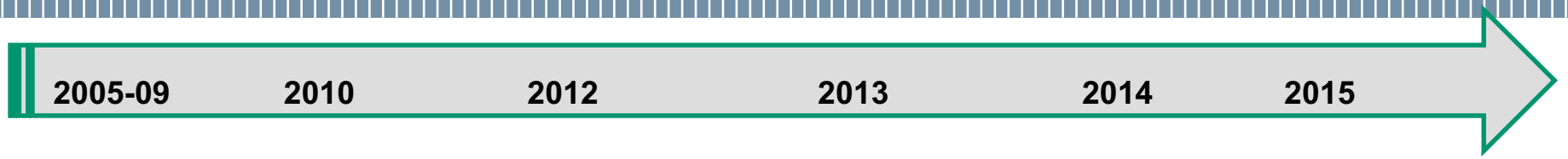
- ↘ All legal aspects (IP, payments, safety, …) already fixed in the general agreement
- ↘ Oder of magnitude of the yearly budget already known
- ↘ Research proposals through “round tables”-procedures to finalize the project without producing a bounce of paperwork

POLIMI Joint Research Centers

Medium term horizon researches, steady consolidated relationships

↘ ENI	Enhanced Oil recovery, Tar Sands, Bunkering, organic PV,
↘ Pirelli	Substitution natural rubber, CNT, ….
↘ Maire Tecnimont	Functionalized Urea
↘ Ferrovie Nord Milano	
↘ Ansaldo Energia	
↘ Solvay	Flex-electronics, Not-conventional Sep.s, nanomedicine
↘ IBM	
↘ MG Chemtex	3rd generation biorefinery
↘ Telecom	
↘ Artsana	aerosol inhalation, syringe needle coating
↘ Enel	
↘ Terna	
↘ Inail	
↘ Whirlpool	Odor control
↘ Veneranda Fabbrica	Monitoring of Duomo Facade

POLIMI Joint Research Centers



Eni

AgustaWestland
A Finmeccanica Company

AnsaldoEnergia
Una Società Finmeccanica

CHEMTEX

ARTSANA GROUP

VENERANDA FABBRICA DEL DUOMO DI MILANO

AnsaldoBreda

STMicroelectronics

Maire Tecnimont

Enel

SOGEFI GROUP

BOMBARDIER
BOMBARDIER TRANSPORTATION

PIRELLI

FERROVIENORD

vodafone

FERROVIE DELLO STATO ITALIANE

TELECOM ITALIA

IBM

TRENITALIA
GRUPPO FERROVIE DELLO STATO ITALIANE

Whirlpool

SOLVAY

To teach the engineers of today:

- ↘ Chemical engineering
- ↘ Materials engineering and nanotechnology
- ↘ Biomedical engineering

From an engineer who is looking for a job to an engineer who creates jobs

- ↘ Teamwork
- ↘ aptitude to project design
- ↘ international environment
- ↘ stages in industry

POLIMI CMIC Teaching

In Italy university curricula are organized as:

Bachelor of Science – 3 years – 180 ECTS credits
Master of Science – 2 years - 120 ECTS credits
PhD – 3 years – 180 ECTS credits

Key title for employment in EU

(1 ECTS credit = 25 h/student, 10 h/teaching)

Freshmen

↘ Chemical Engineering	BS 220+	MS 150+
↘ Materials Engineering and Nanotechnology	BS 220+	MS 150+
↘ Industrial Process Engineering Safety	MS 40+	
↘ Biomedical Engineering	BS 450+	MS 250+

Bachelor + Master of sciences graduates: about 30% /5y – 70% /6y

MSc in English 

CMIC Research & Teaching

PhD programs in the department:

- ❑ Industrial Chemistry and Chemical Engineering
- ❑ Materials Engineering
- ❑ Bioengineering (with Dept Electronics, Information & Bioengineering)

3 years/180 ECTS credits

- ↘ Standard program (fellowship by Polimi & open research)
- ↘ Industrial program (fellowship by an Industry & dedicated topic)
- ↘ Executive program (4 years, dedicated to whom is already working in industry)

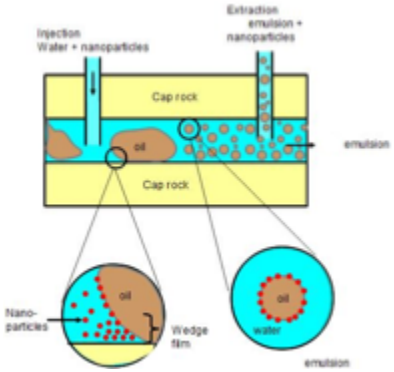
Sviluppo di materiali nanostrutturati e compositi funzionali

Prof. Luigi De Nardo

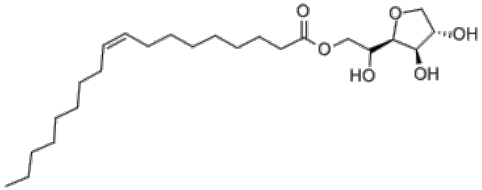
Prof. Maurizio Masi

Sviluppo di Nanoparticelle
Laboratorio di Chimica-Fisica Applicata

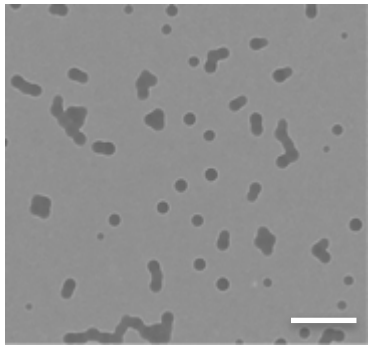
oil and gas



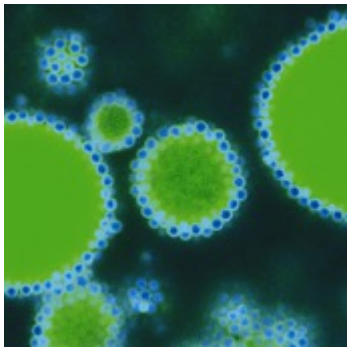
colloidi
e saponi



medicina



polimeri

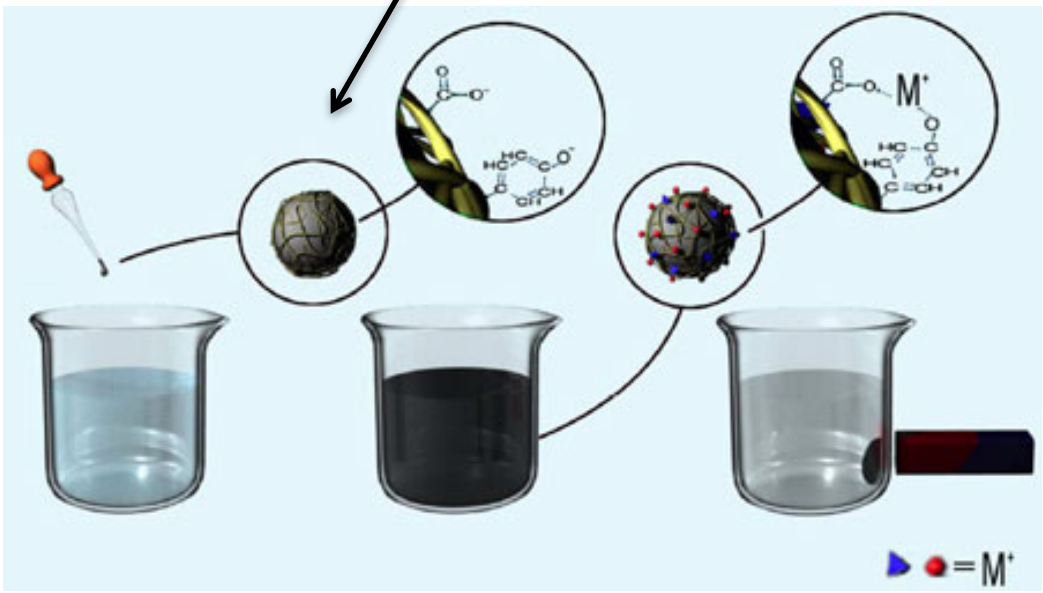


- Emulsioni stabili
- Emulsioni a freddo
- Riduzione sporcamento e adesione a superfici
- Riduzione problemi di corrosione

Sviluppo di Nanoparticelle
Laboratorio di Chimica-Fisica Applicata

- Risoluzione di problematiche legate al rilascio di metalli pesanti (Ni, Pb)

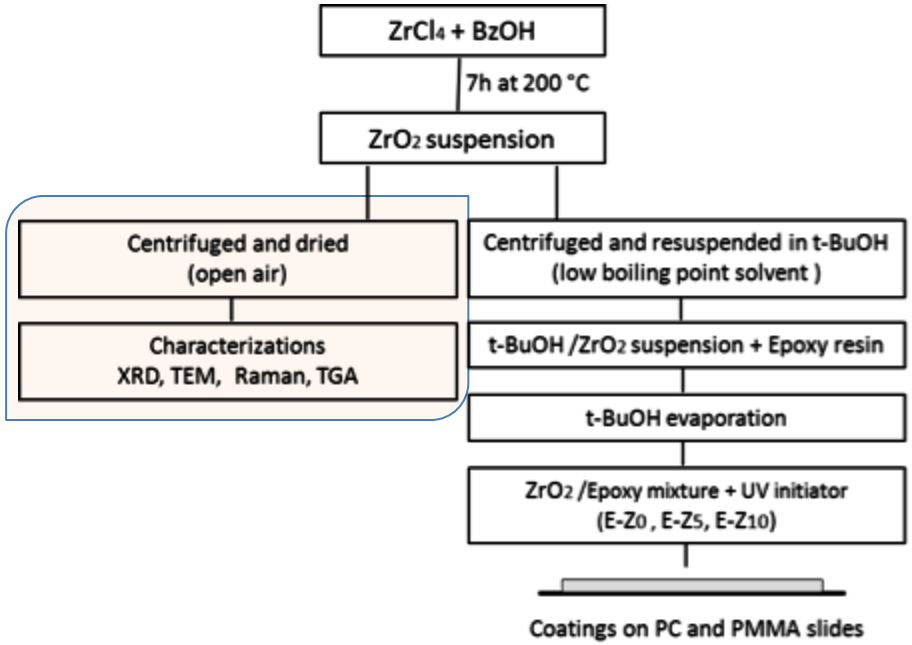
NPs magnetiche funzionalizzate

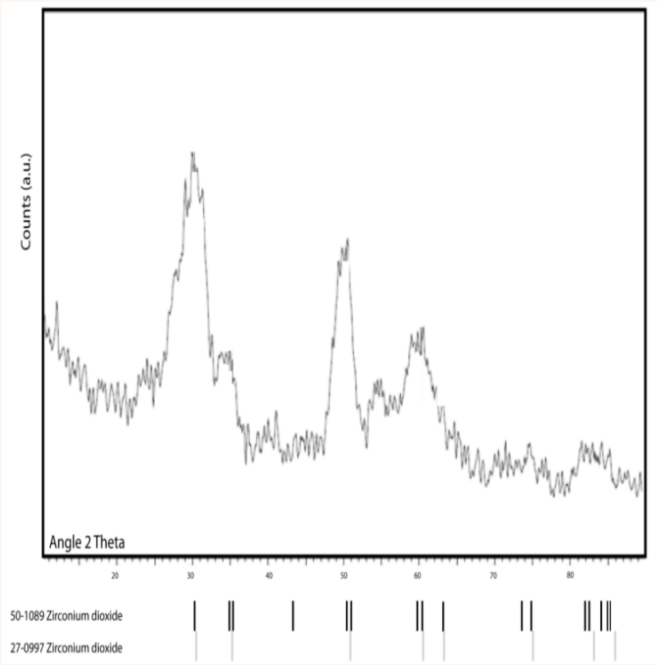


Team di ricerca:

- Prof. Maurizio Masi — maurizio.masi@polimi.it
- Prof. Davide Moscatelli — davide.moscatelli@polimi.it
- Ing. Filippo Rossi — filippo.rossi@polimi.it
- Dott. Simone Gelosa — simone.gelosa@polimi.it

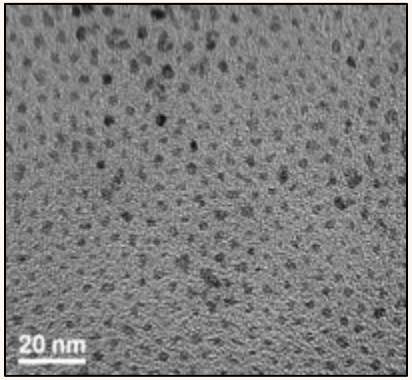
ZrO_2 as nanofiller for antiscratch coatings

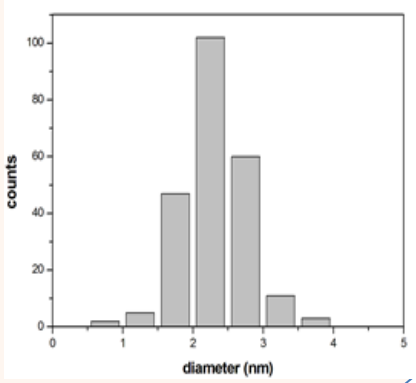




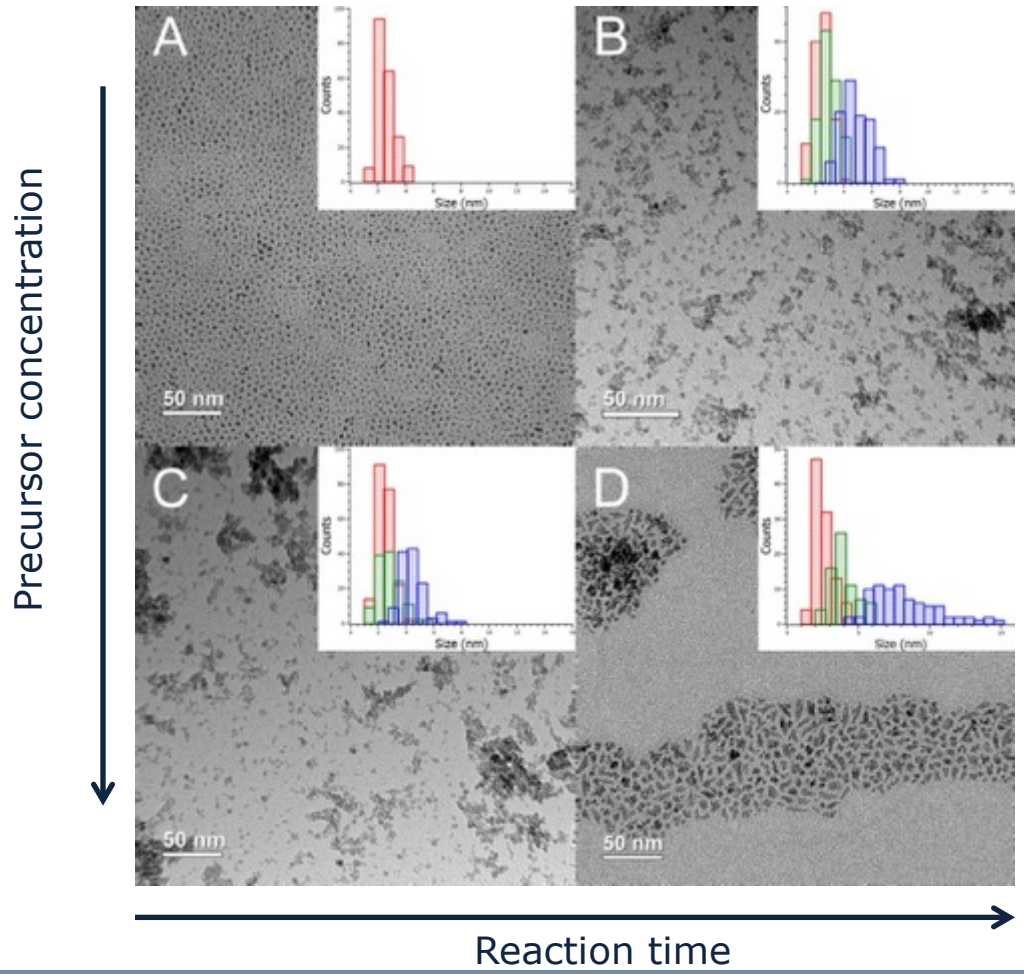
XRD: peak broadening, cubic and tetragonal peaks overlap in XRD → amorphous phase or nano-dimensions of analysed powders

TEM images: showed pseudo-spherical nanoparticles of around 2 nm and uniform size distribution



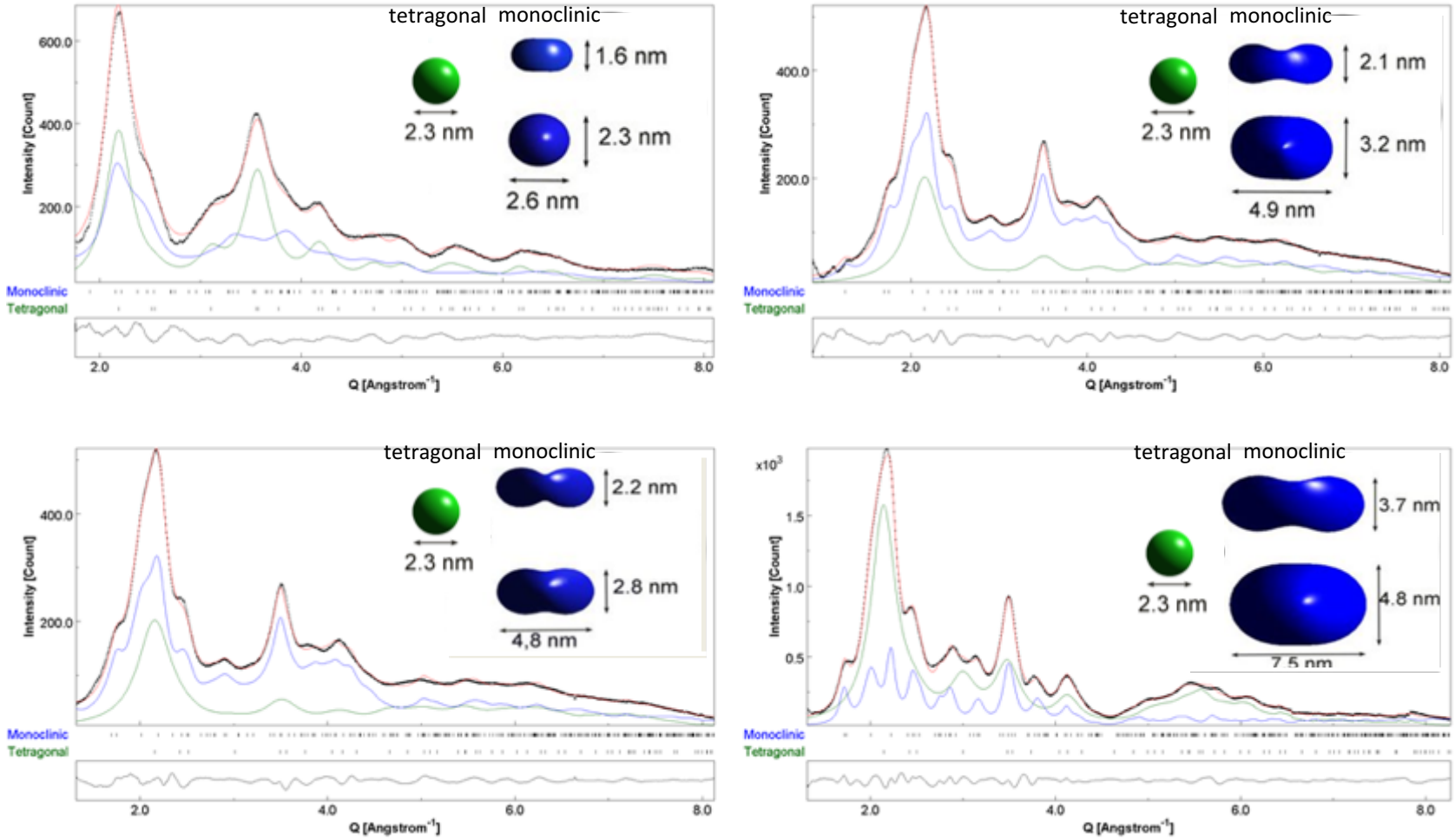


ZrO_2 modified synthesis
TEM characterization



ZrO_2 modified synthesis
TEM characterization

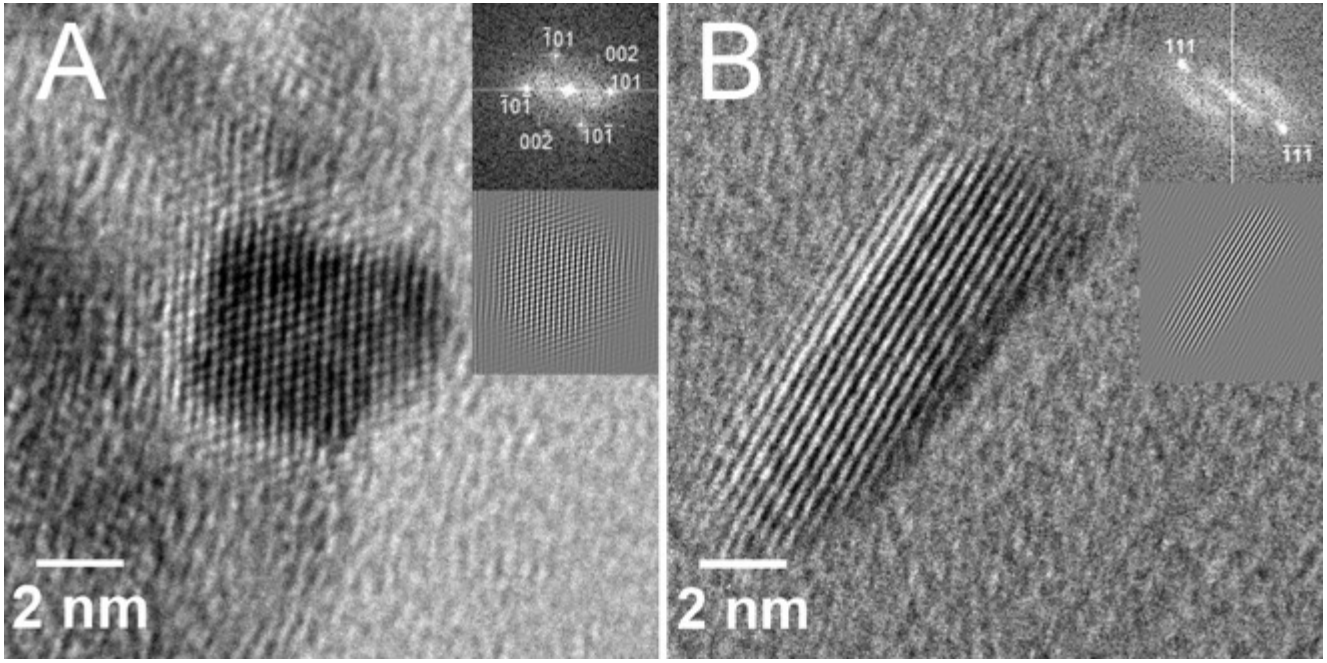
Rietveld refinement on electron powder diffraction were carried out in MAUD software (Material Analysis Using Diffraction) and allowed obtaining a model of zirconia particles shape



TEM analyses were performed by Andrea Serafini using MAUD software implemented by prof. Lutterotti (Università di Trento)

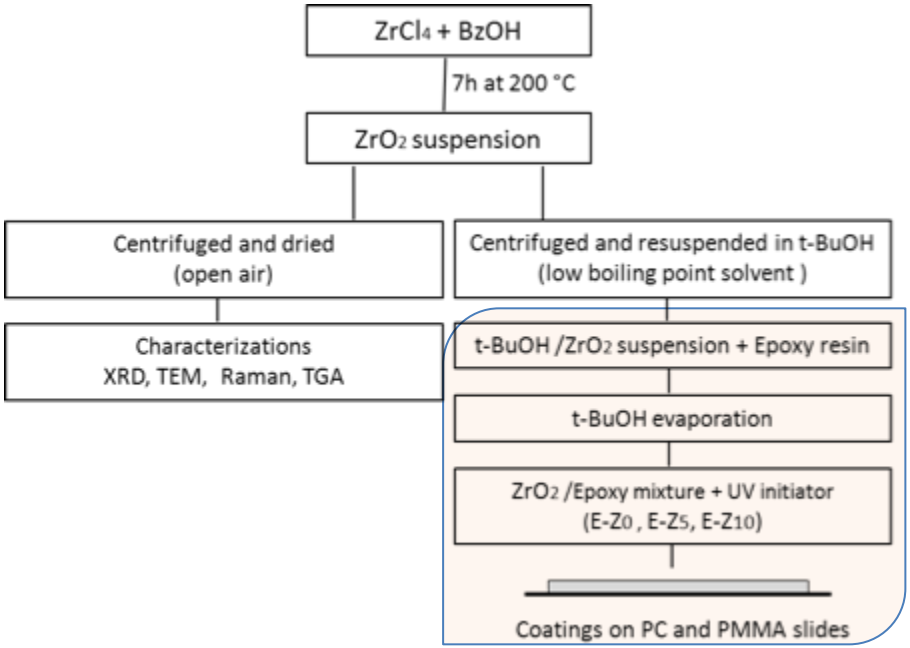
ZrO_2 modified synthesis
HRTEM characterization

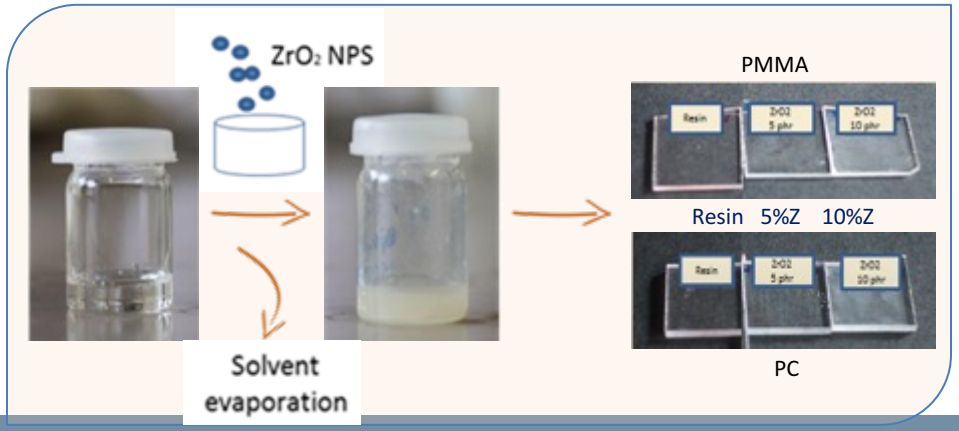
Correlation between particle crystalline phase and their morphological features confirmed that monoclinic particles possess mainly elongated shape in comparison with the tetragonal ones.



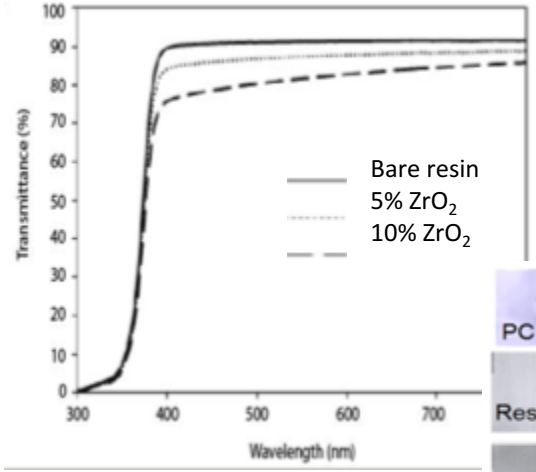
Tetragonal **Monoclinic**

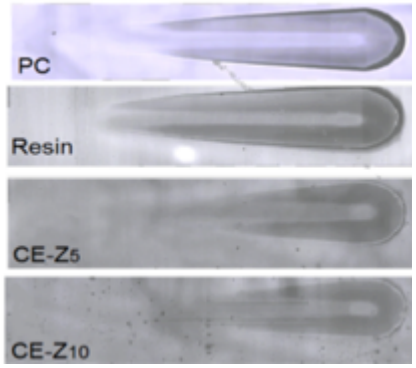
ZrO_2 as nanofiller for antiscratch coatings



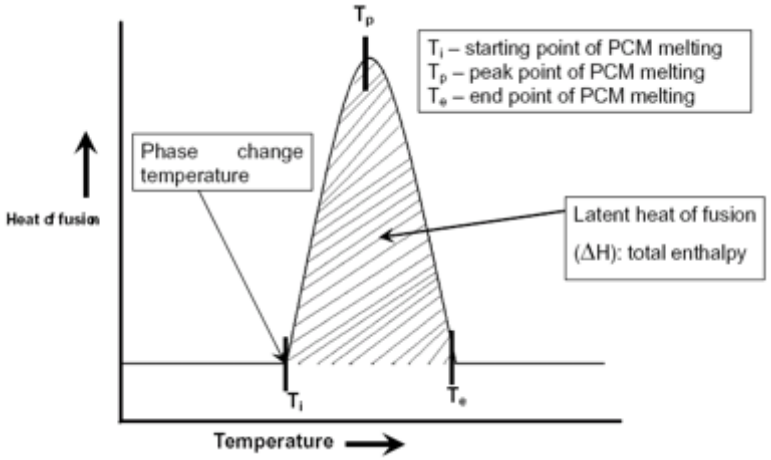


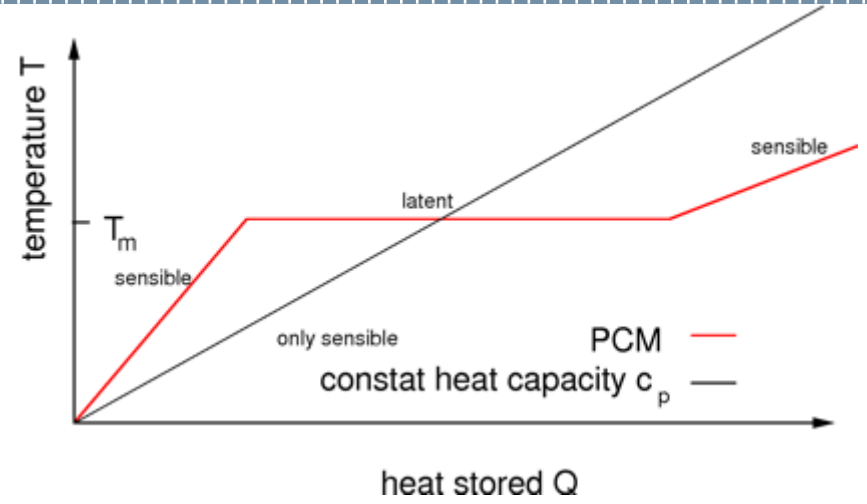
UV-visible and scratch measurements on coatings





Phase Change Materials
Theoretical principles





Applied Thermal Engineering 28 (2008) 1536–1550

Latent heat storage (LHS) is based on the heat absorption or release when a storage material undergoes a phase change

- ↘ from solid to liquid
- ↘ liquid to gas

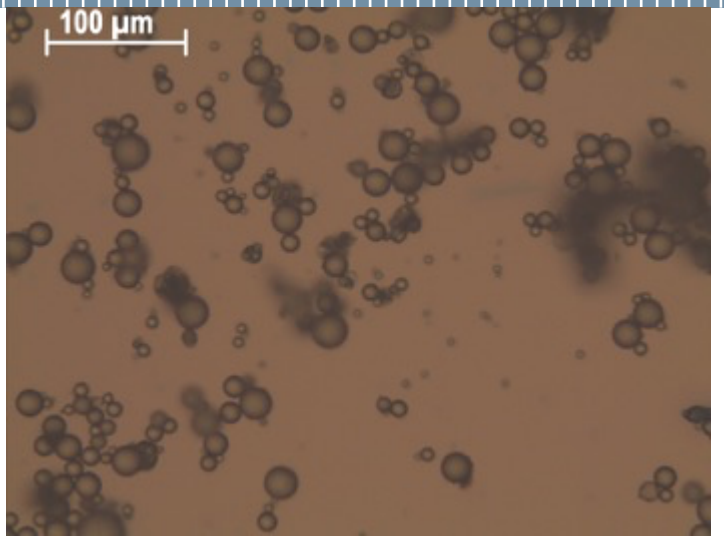
$$Q = \int_{T_i}^{T_m} mC_p \, dT + ma_m \Delta h_m + \int_{T_m}^{T_f} mC_p \, dT$$

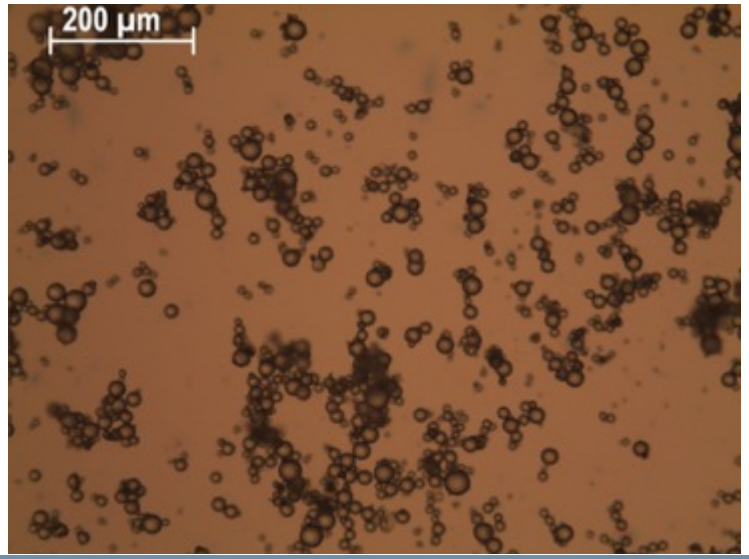
$$Q = m[C_{sp}(T_m - T_i) + a_m \Delta h_m + C_{lp}(T_f - T_m)]$$

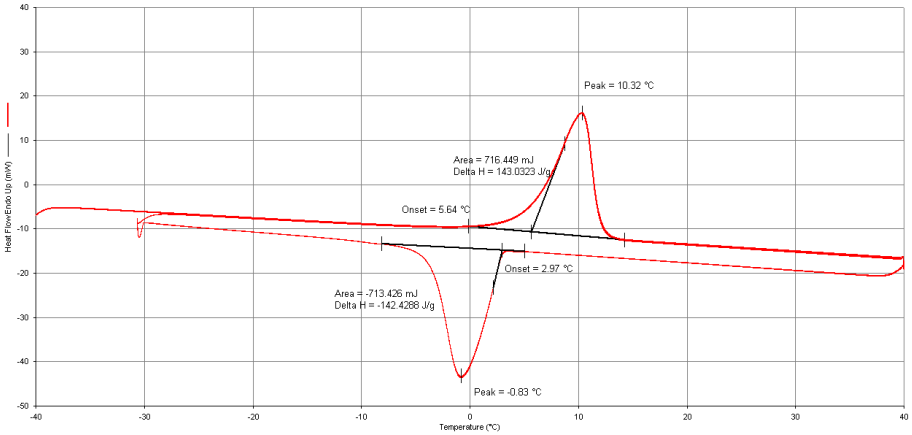
Phase Change Materials microparticles experimental

PCM μparticles:

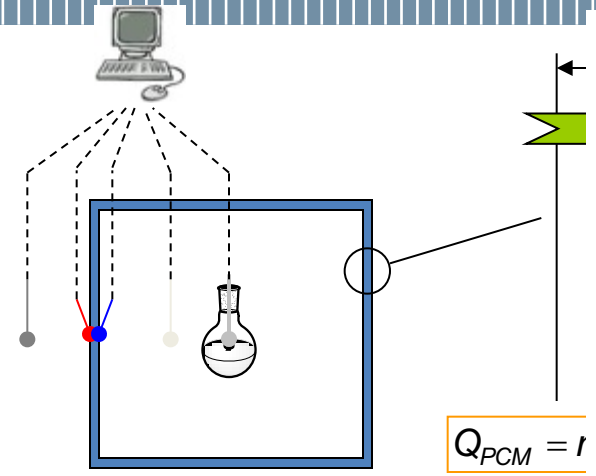
- ↘ Tm = 6-10 °C
- ↘ Easily suspended in common hydrophilic solvents
- ↘ Good dimension dispersion







Phase Change Materials
Towards pratical applications



$\Delta T \approx 10 \div 15°C$

$Q_{PCM} = I$

$Q_{PCM} = (0.$

Applied Energy 89 (2012) 339–345

Contents lists available at SciVerse ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

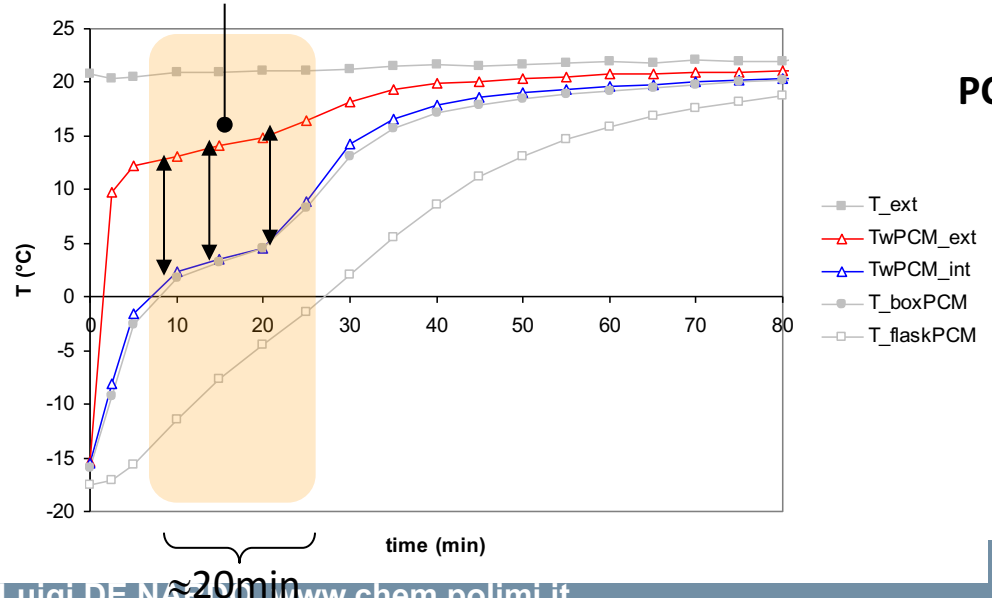
)0J

Phase change material cellulosic composites for the cold storage of perishable products: From material preparation to computational evaluation

Lucio Melone [a], Lina Altomare [a], Alberto Cigada [a,b], Luigi De Nardo [a,b,*]

[a] Dipartimento di Chimica, Materiali e Ingegneria Chimica "Giulio Natta", Politecnico di Milano, Via Mancinelli 7, 20131 Milano, Italy

[b] Local Unit, Istituto Nazionale di Scienza e Tecnologia dei Materiali, INSTM, Firenze, Italy



PCM's really buffer the conductive heat flux

Prolunged buffering times can be obtained reducing the k/L ratio

- higher **L**
- lower **k**

1. **Materials**
2. **Packaging design**

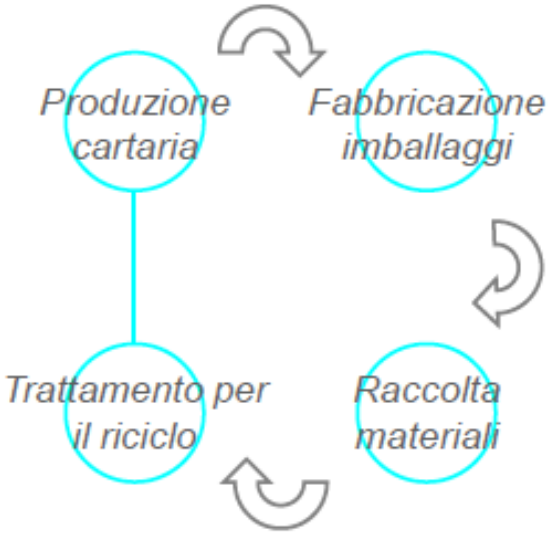
Approccio proposto
Compositi contenenti PCM

Imballaggi cellulosici immessi al consumo in Italia: oltre 4.000.000 t/anno

Tasso di riciclo: 78,7%

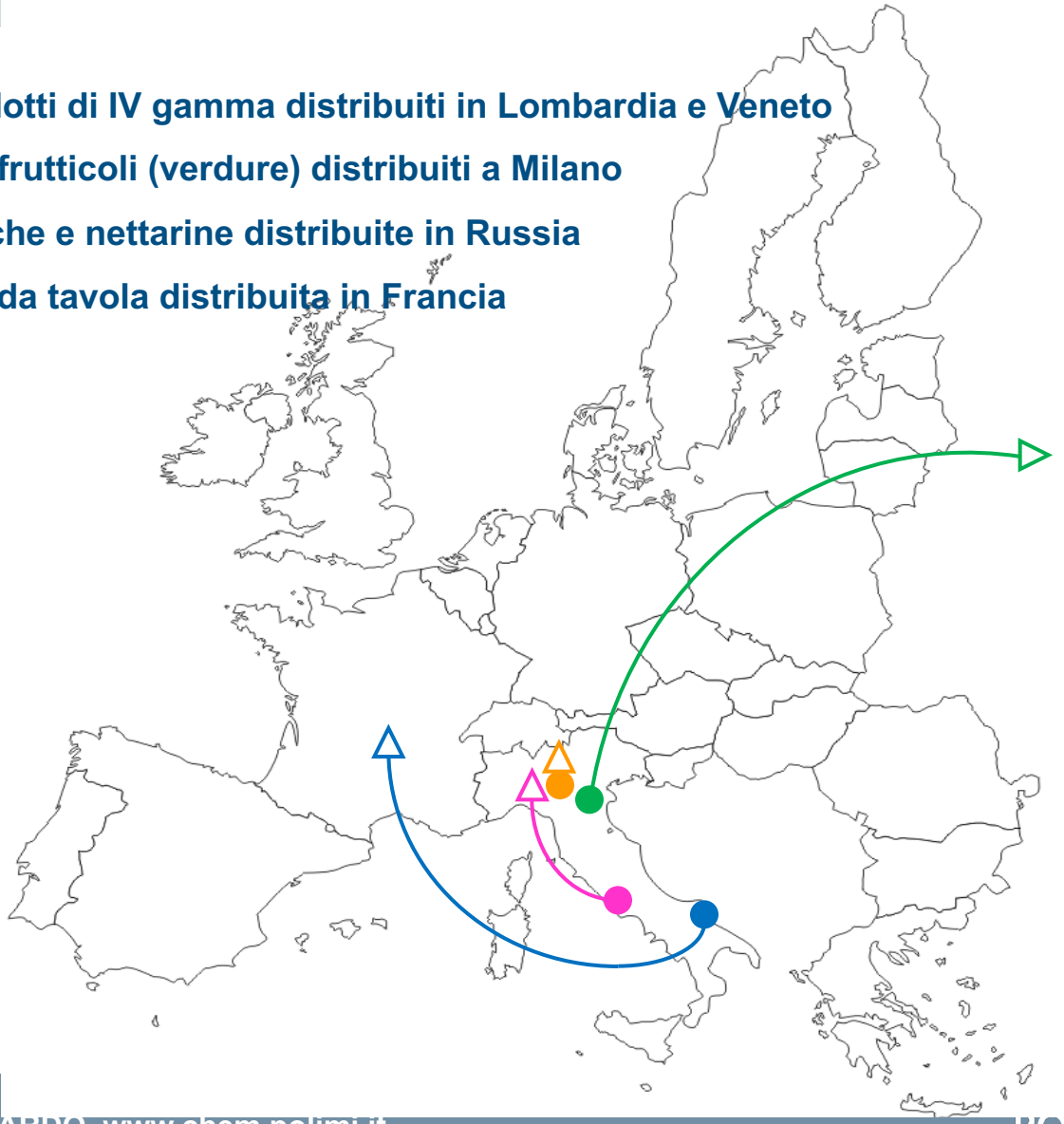
Recupero complessivo (compresa la quota di recupero energetico): 87,1%

(Comieco, 2011)



Sperimentazione
Attività su campo

- Prodotti di IV gamma distribuiti in Lombardia e Veneto
- Ortofrutticoli (verdure) distribuiti a Milano
- Pesche e nettarine distribuite in Russia
- Uva da tavola distribuita in Francia



Sperimentazione su campo
Fasi del Progetto

Fase 1: **Sviluppo di un processo di produzione industrializzabile per la realizzazione di imballaggi a mantenimento termico**

Fase 2: **Prove su campo**

Fase 3: **Prove sperimentali in laboratorio**

Aziende che hanno collaborato allo sviluppo delle prime fasi del progetto:

Fase 2
Test su campo

26 Luglio

Bergamo

40 Vassoi

Verona

28 Vassoi:

- 7 PCM
- 7 TOP
- 14 STD

Como

12 Vassoi:

- 3 PCM
- 3 TOP
- 6 STD

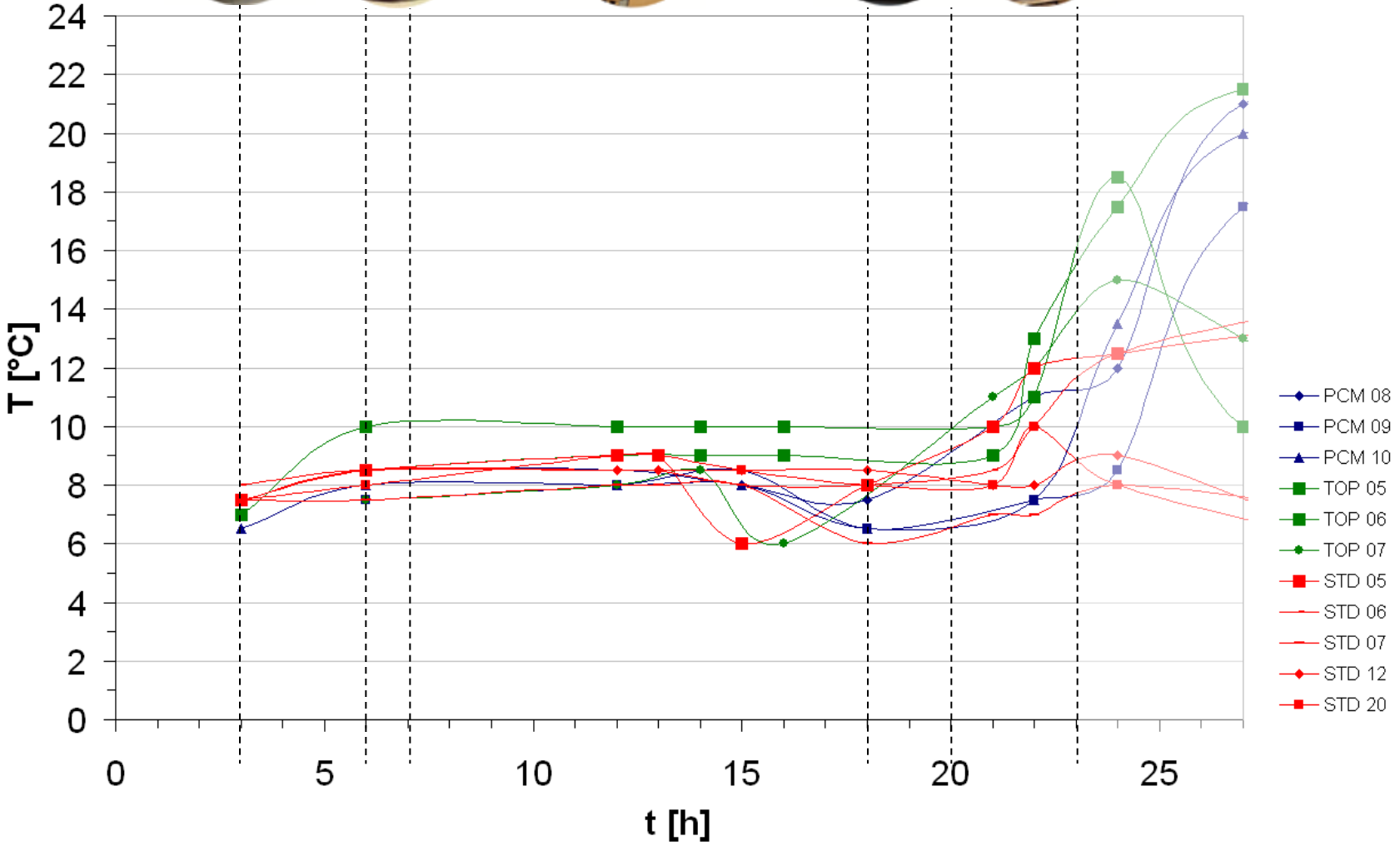
19 Punti Vendita

7 Punti Vendita

27 Luglio

Recupero Tracciatori di temperatura (39 di 40)

Fase 2
Risultati

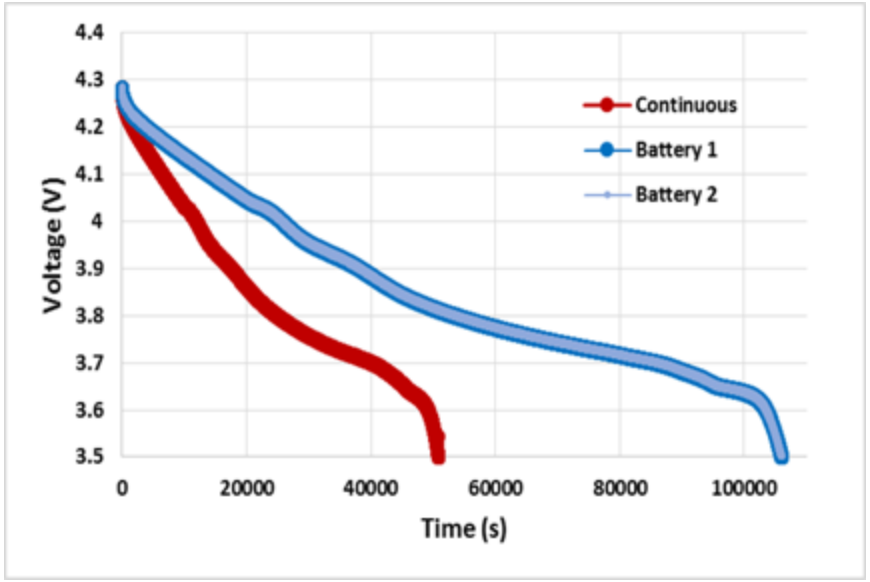


Storage: Device for improving charging/discharging and energy exchange in batteries and storage

The device is a tool which can be integrated into any electrolytic generators able to improve the efficiency and performances of the generator itself. It allows:

- to **consume less energy** for the same time of use at constant electrical load, generating more electrical power;
- at constant electrical load, it **prolongs the power supplied by the generator**;
- at equal consumption, it allows to use less energy for the recharging of the generator;
- in **storage**, it allows minimization of energy losses;
- to decrease materials degradation and to **improve safety**

Increased peformances for Li ions batteries



Patents pending:
PCT/EP2015/058889
PCT/EP2016/059209

Storage: Device for improving charging/discharging and energy exchange in batteries and storage

➢ If integrated into any electrolytic generators device allows:

For the same time of use:
- **to consume less energy**→ batteries discharge decreased;
- to generate **more electrical power.**

At constant electrical load:
- **prolong the power supplied by the generator**

At equal consumption
- **to use less energy for the recharging of generator.**

➢ Achievable advantages are dependent on the batteries:

- **Rechargeable batteries**: increase achieved **4-10%**;
- **Non-rechargeable batteries**: up to **900%**.

→ **INCREASED BATTERY EFFICIENCY**

➢ **The gained advantages depend** on: applied electrical load; kind of generator; time of use

Ongoing activities @CMIC

Studio, sintesi e caratterizzazione di materiali micro e nanostrutturati

- ↘ Sintesi di nano particelle (polimeri, ceramici, ibridi)
- ↘ Sviluppo di compositi funzionali

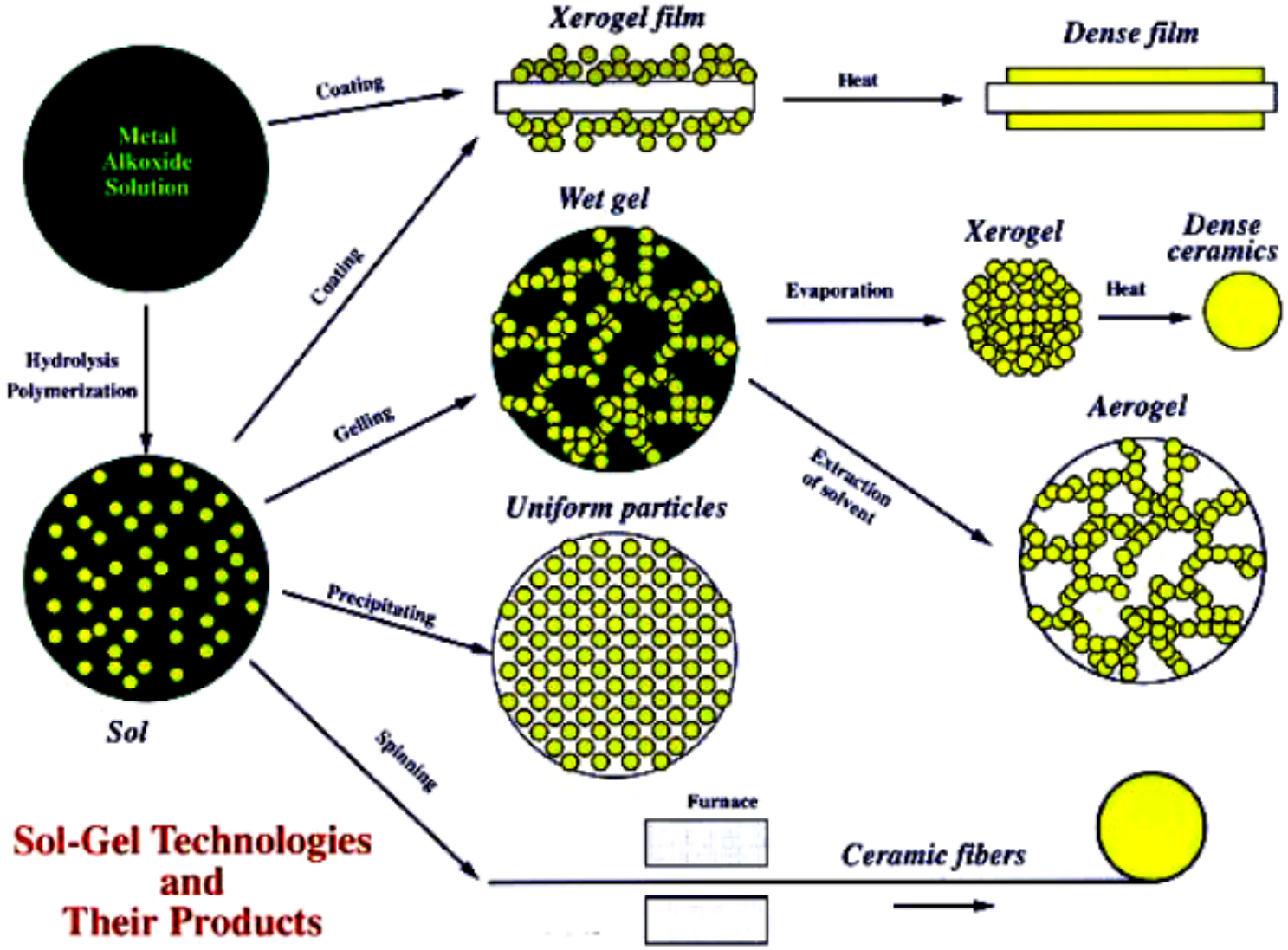
Applicazioni

- ↘ Medicale
- ↘ Energia
- ↘ Packaging (alimentare, medico, elettronico)
- ↘ Meccanica/costruito (edilizia)

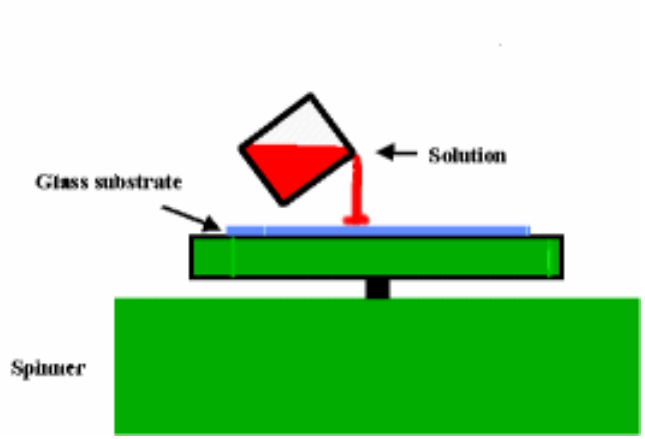
Sviluppo di materiali funzionali di superficie

Prof. Luigi De Nardo
Prof. Maurizio Masi

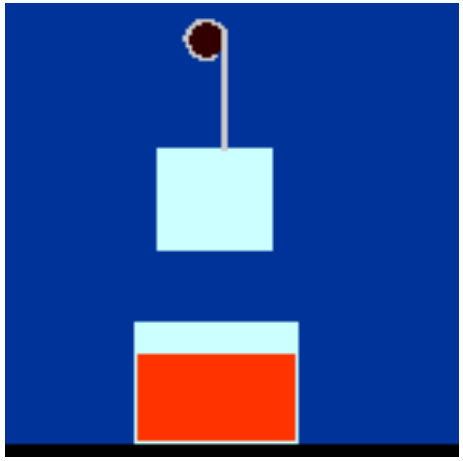
Lo schema del processo sol-gel



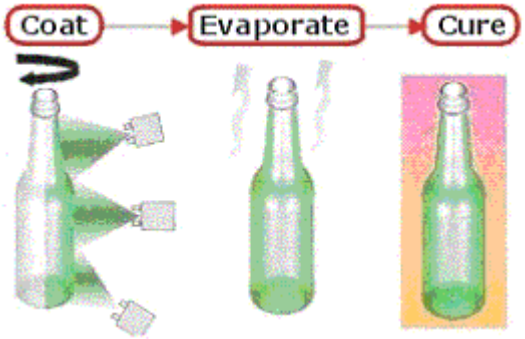
Tecniche di deposizione



Spin coating

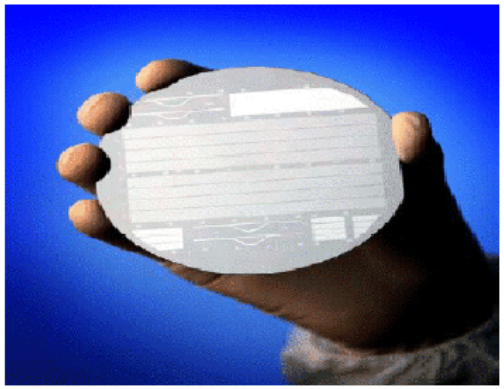


Dip coating



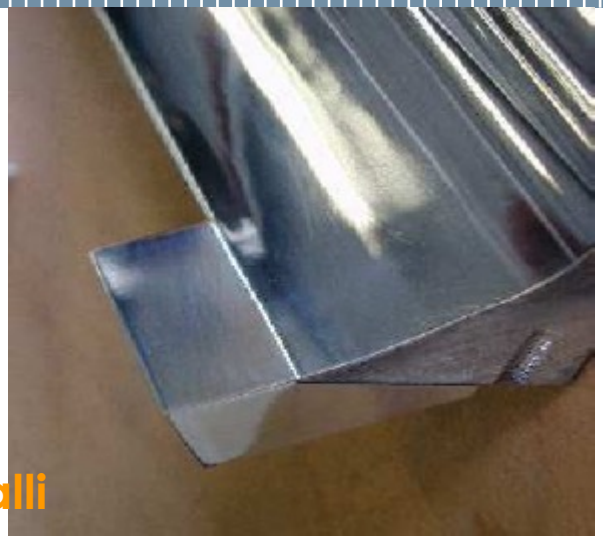
Spray coating

substrati trattabili

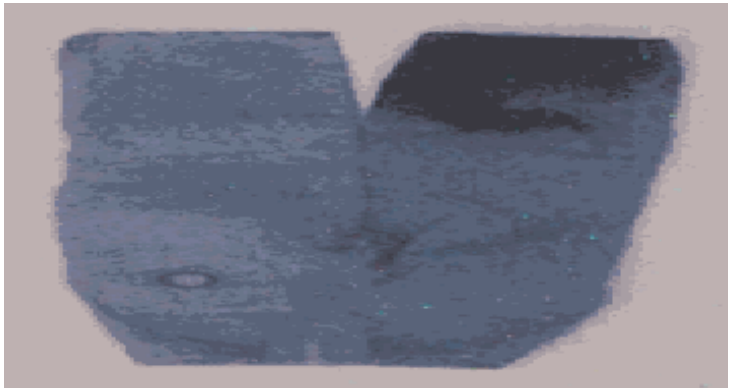


SOLICA™ PLC wafer with test structures

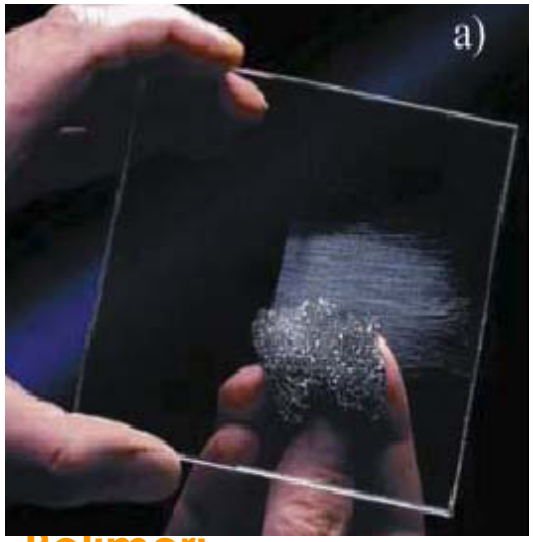
Ceramici



Metalli



Tessuti naturali e artificiali

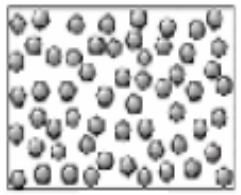


Polimeri

cosa si può fare…

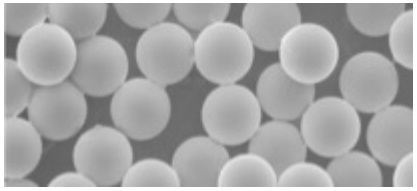
precursori

film-coatings

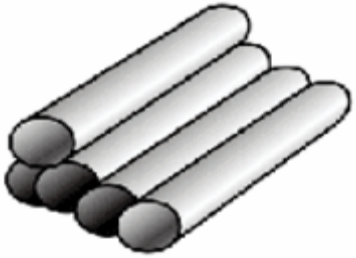


sol

aerogel



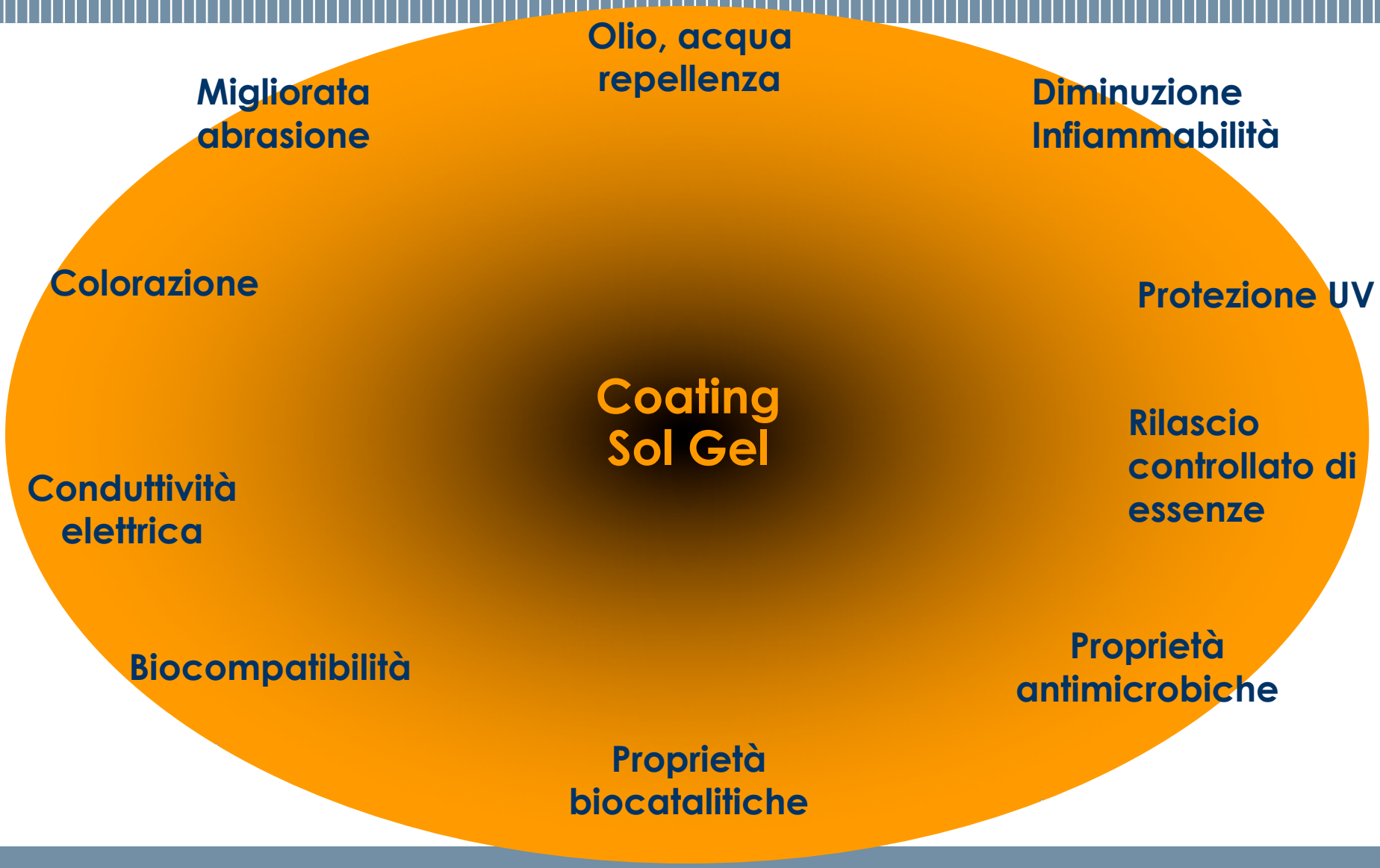
particelle monodisperse



fibre

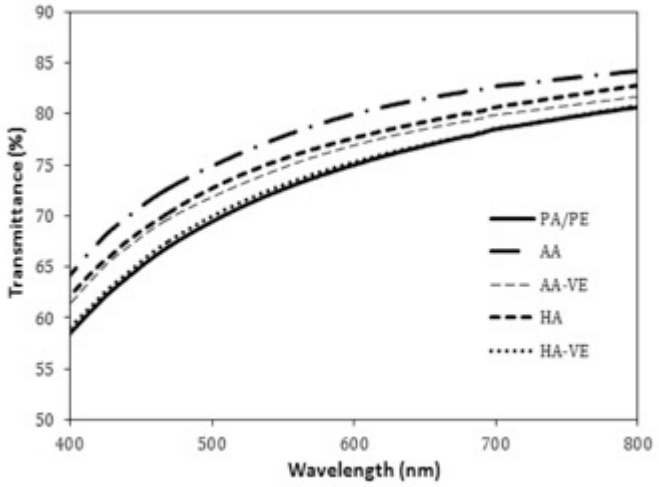
monoliti

film ottenibili



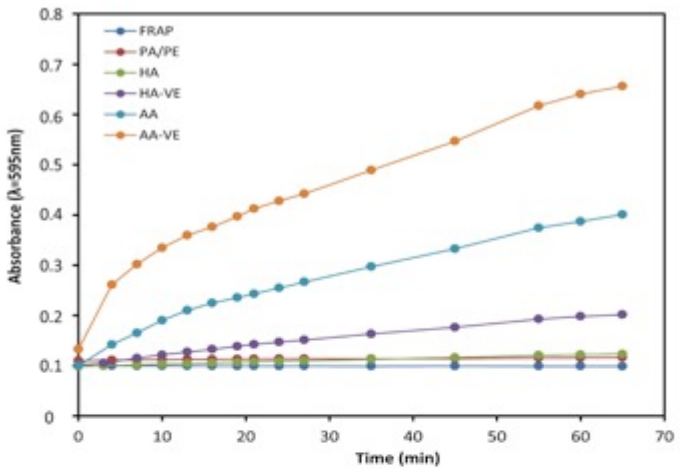
Films for active packaging
Vitamin E

a)

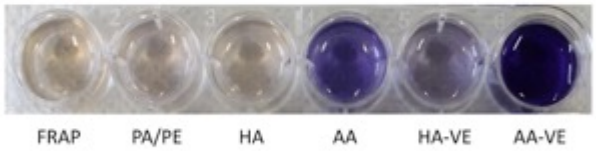


b)

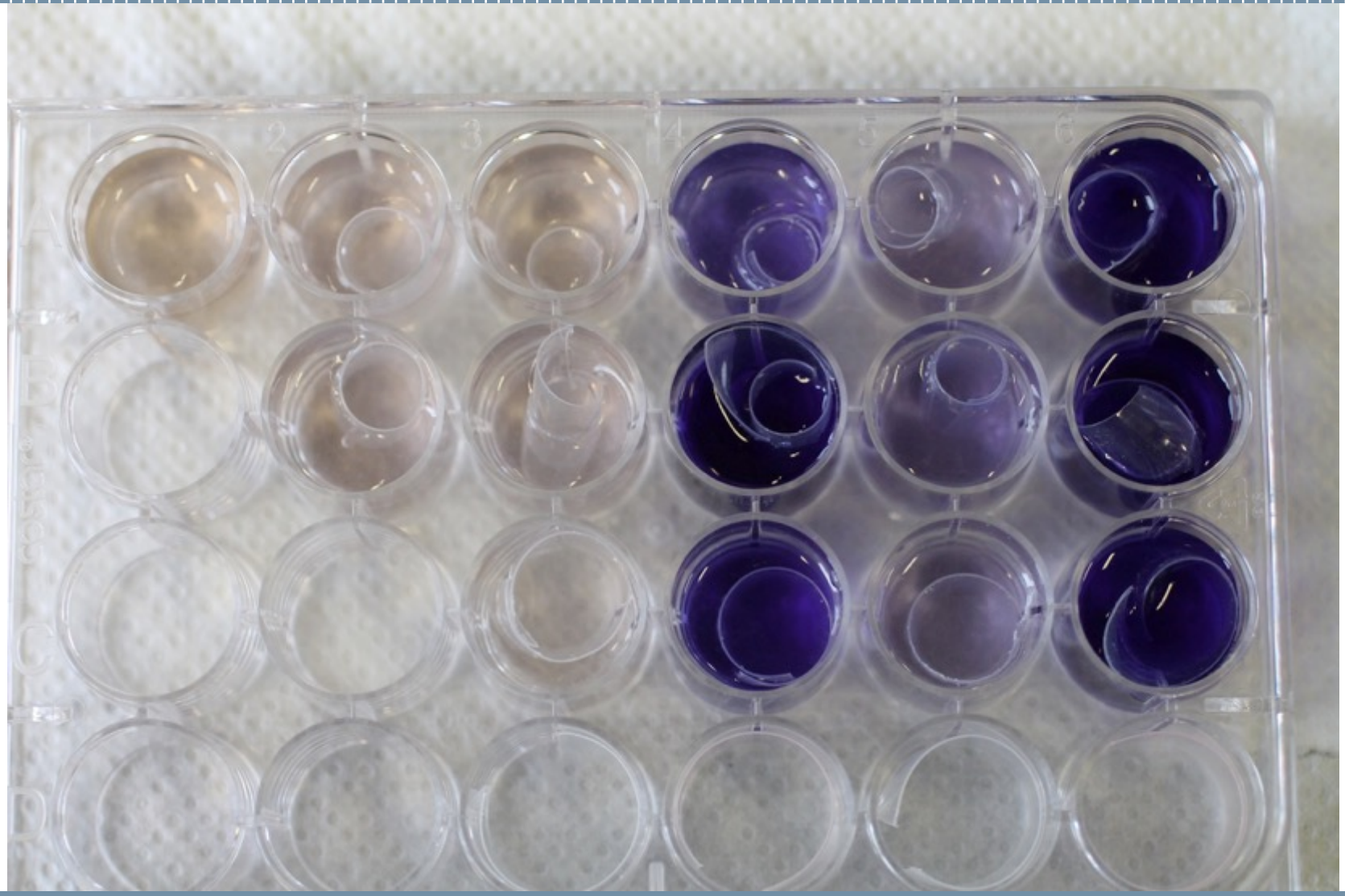
a)



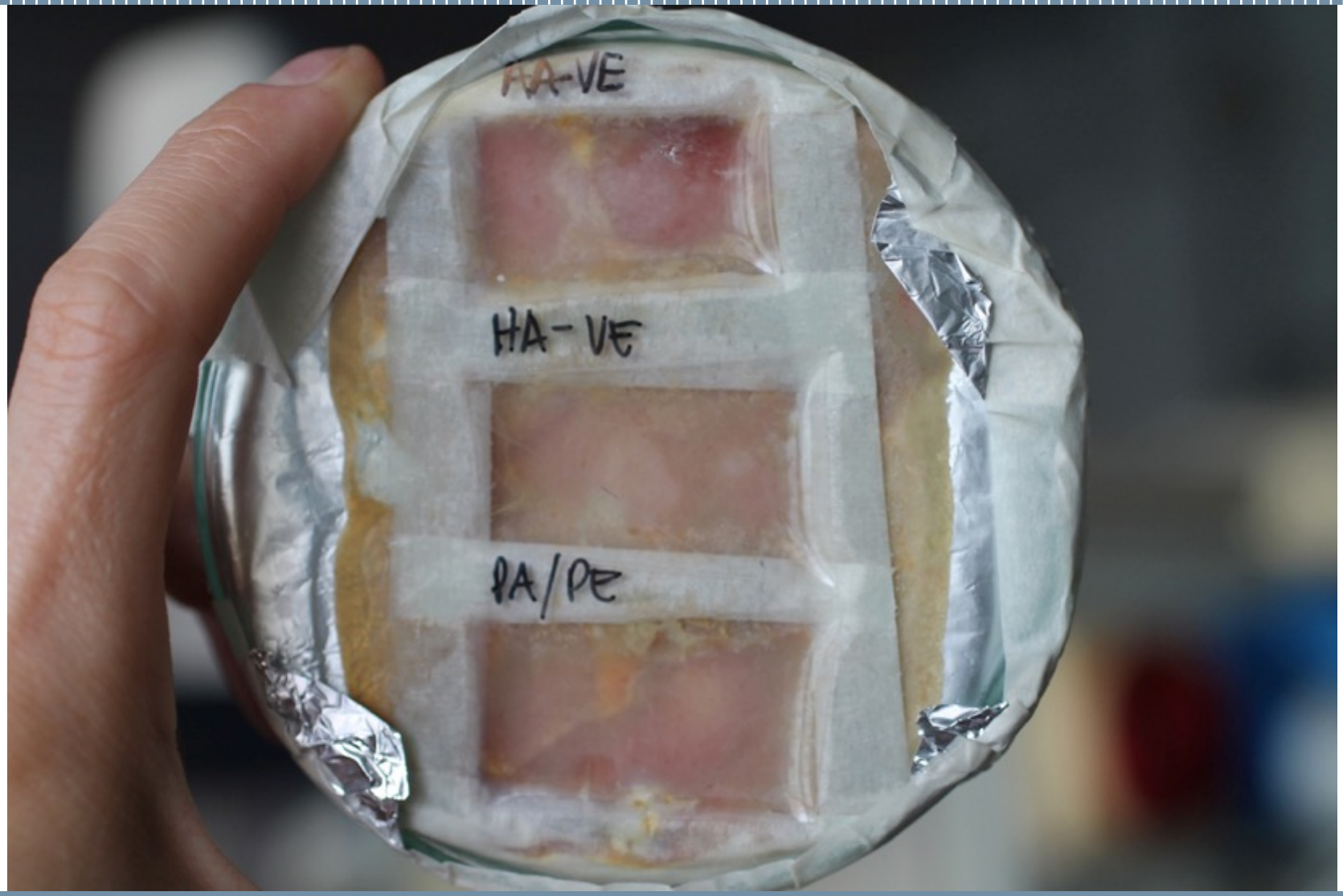
b)



Films for active packaging
Vitamin E – After 120 DD



Films for active packaging
Vitamin E

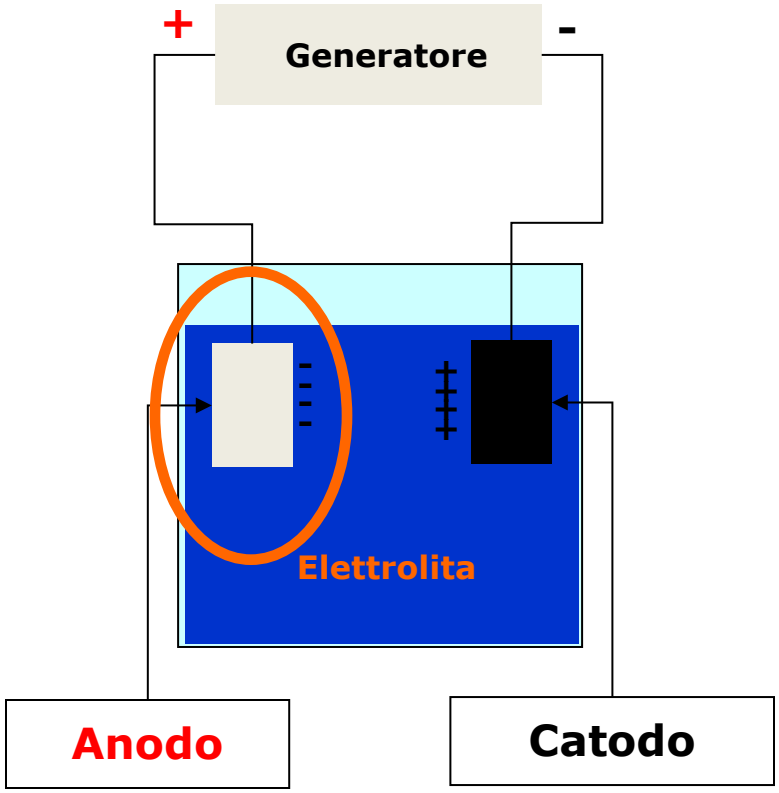


Anodizzazione del titanio

Il titanio deve la sua resistenza alla corrosione alla formazione di un film di ossido di pochi nanometri di spessore

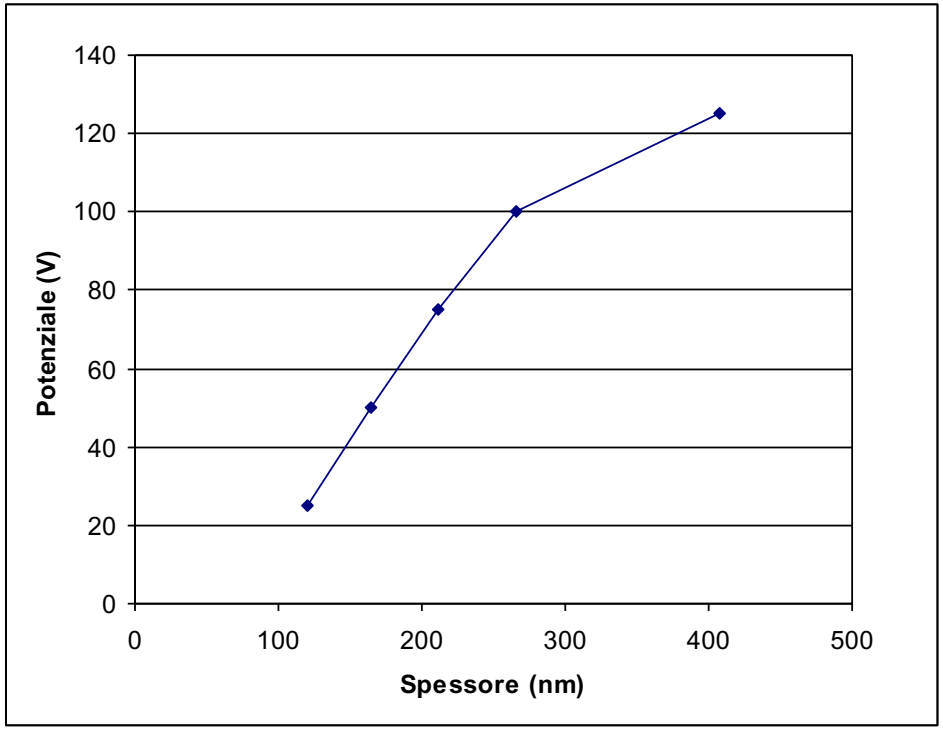
Mediante tecniche elettrochimiche di ossidazione anodica è possibile far crescere lo spessore del film di ossido fino ad alcune centinaia di nanometri

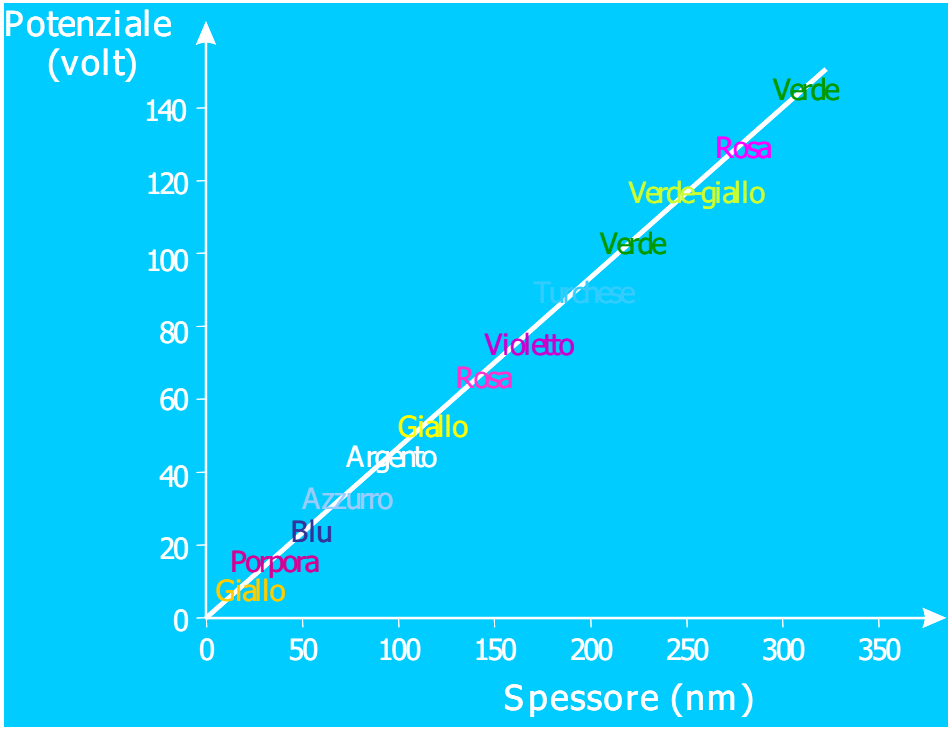
Le proprietà di resistenza alla corrosione e atossicità risultano migliorate



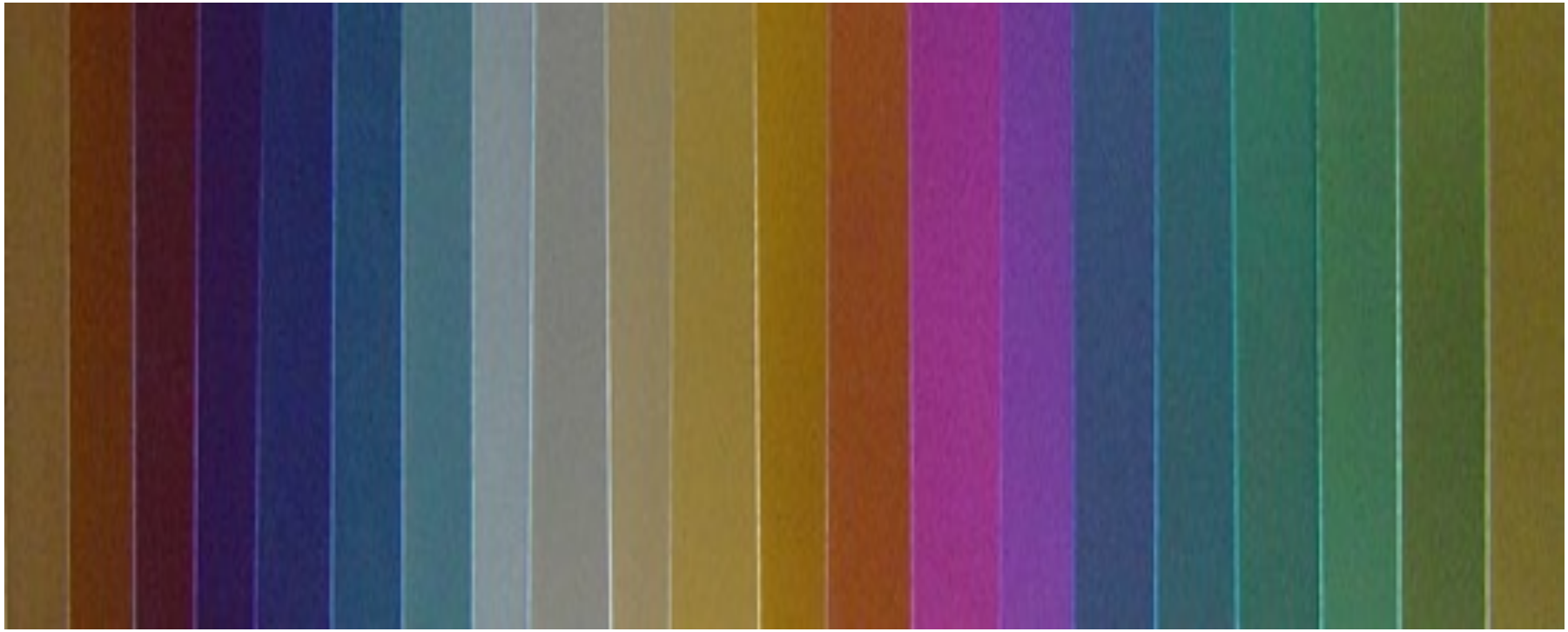
Anodizzazione e colore nel titanio

Esiste una precisa e riproducibile correlazione tra potenziale applicato, spessore del film di ossido e colorazione di interferenza acquisita





Anodizzazione e colore nel titanio



Colori saturi e brillanti con film aderenti possono essere ottenuti solo facendo precedere l'anodizzazione da particolari pretrattamenti che governano la formazione del primo film di ossido

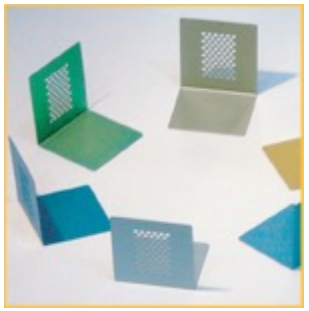
Colorazione elettrochimica del Ti

Resistenza alla corrosione

Colori brillanti e luminosi

Saturazione elevata del colore

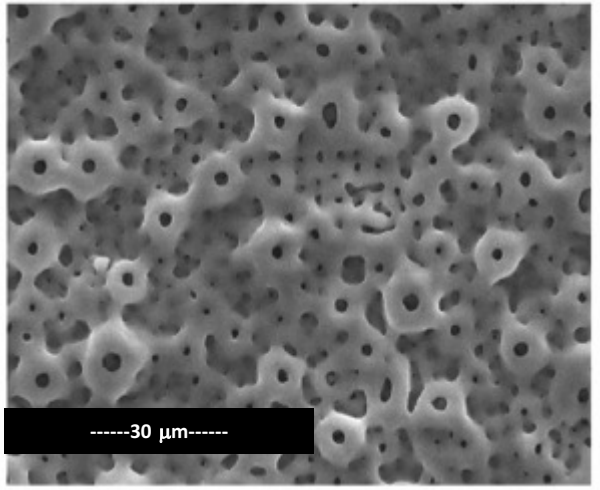
Codifica colore

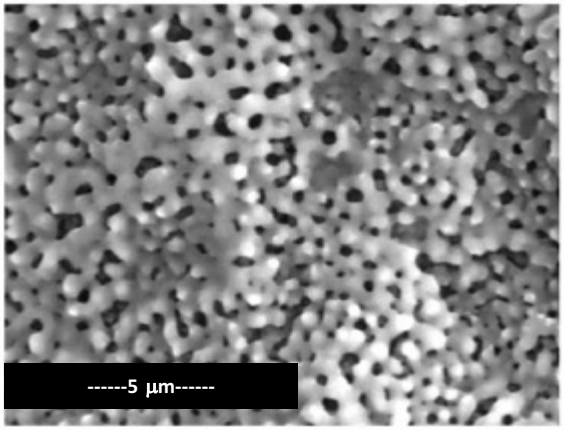


Anodic Spark Deposition

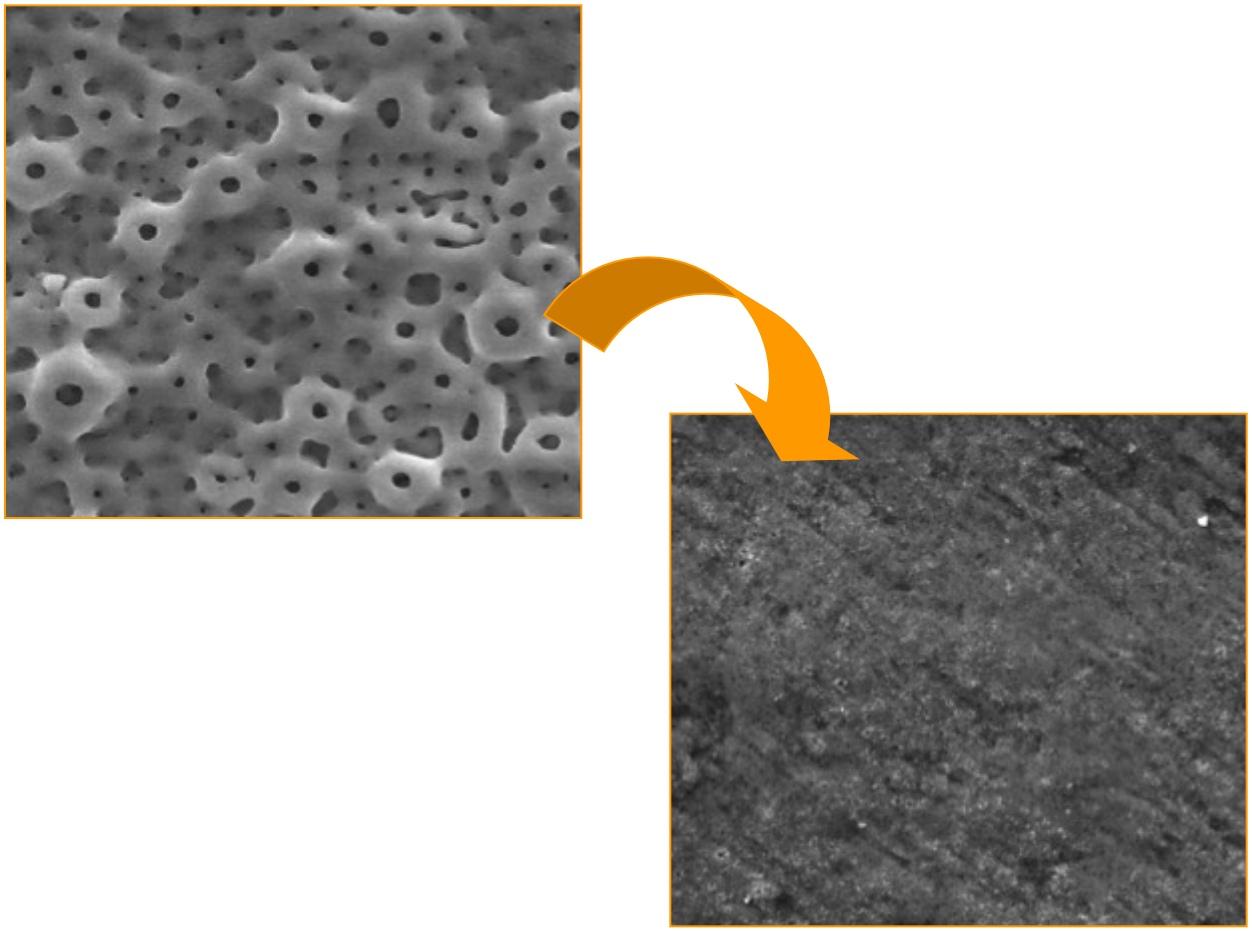
Anodizzazioni ad alto voltaggio

- Dielectric breakdown
- Micro-sparks localizzati alla superficie
- Microfusioni localizzate
- Ossidi porosi e dopati
- Ossidi cristallini: anatasio e rutilo
- Ottima adesione substrato/film

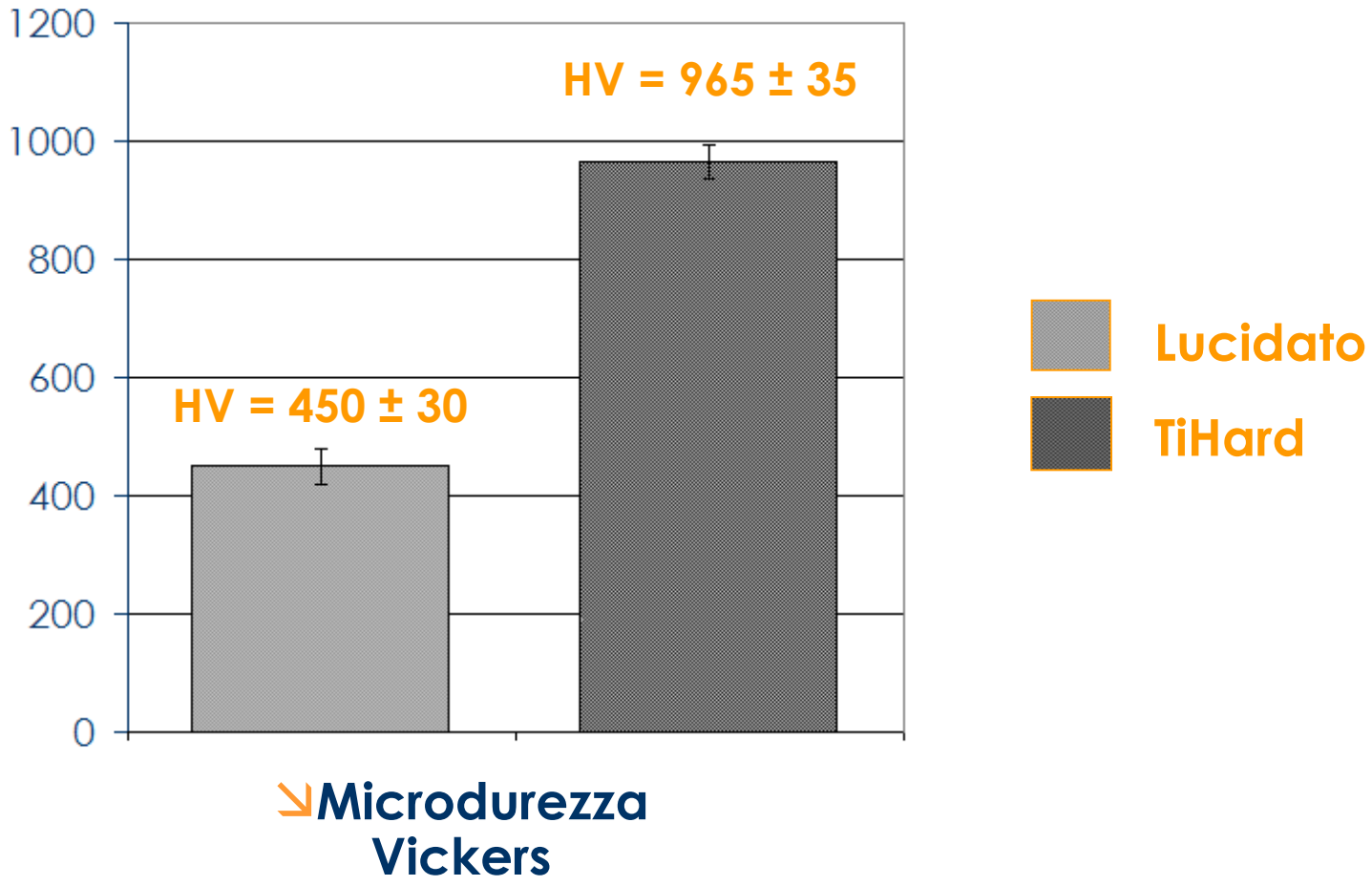




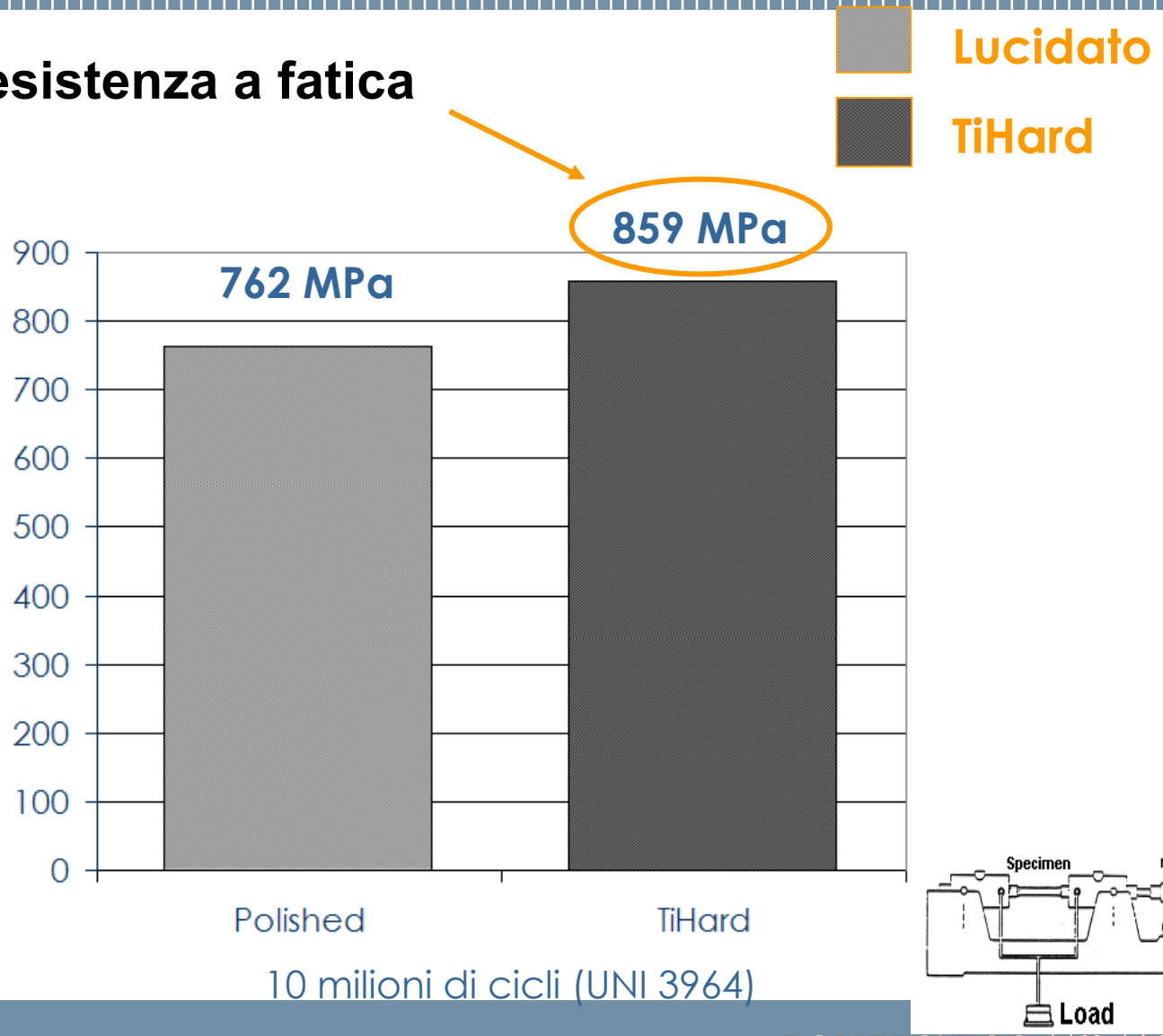
Step 2 – Finitura meccanica



Maggiore durezza superficiale



Superiore resistenza a fatica



Applicazioni

courtesy of PoggiPolini group per

Ongoing activities @CMIC

Sviluppo di trattamenti chimici per la funzionalizzazione di superficie:

- ↘ Tecnologie sol gel per resistenza abrasione
- ↘ Film funzionali (oleo, idro fobici, ..)
- ↘ CVD e Plasma
- ↘ Materiali per l'energia

Sviluppo trattamenti elettrochimici

- ↘ Anodizzazioni ad alto e basso spessore
- ↘ Rivestimenti catodici
- ↘ Rivestimenti micro e nano-strutturati electroless
- ↘ Liquidi ionici

Sviluppo trattamenti e tecnologie fisiche

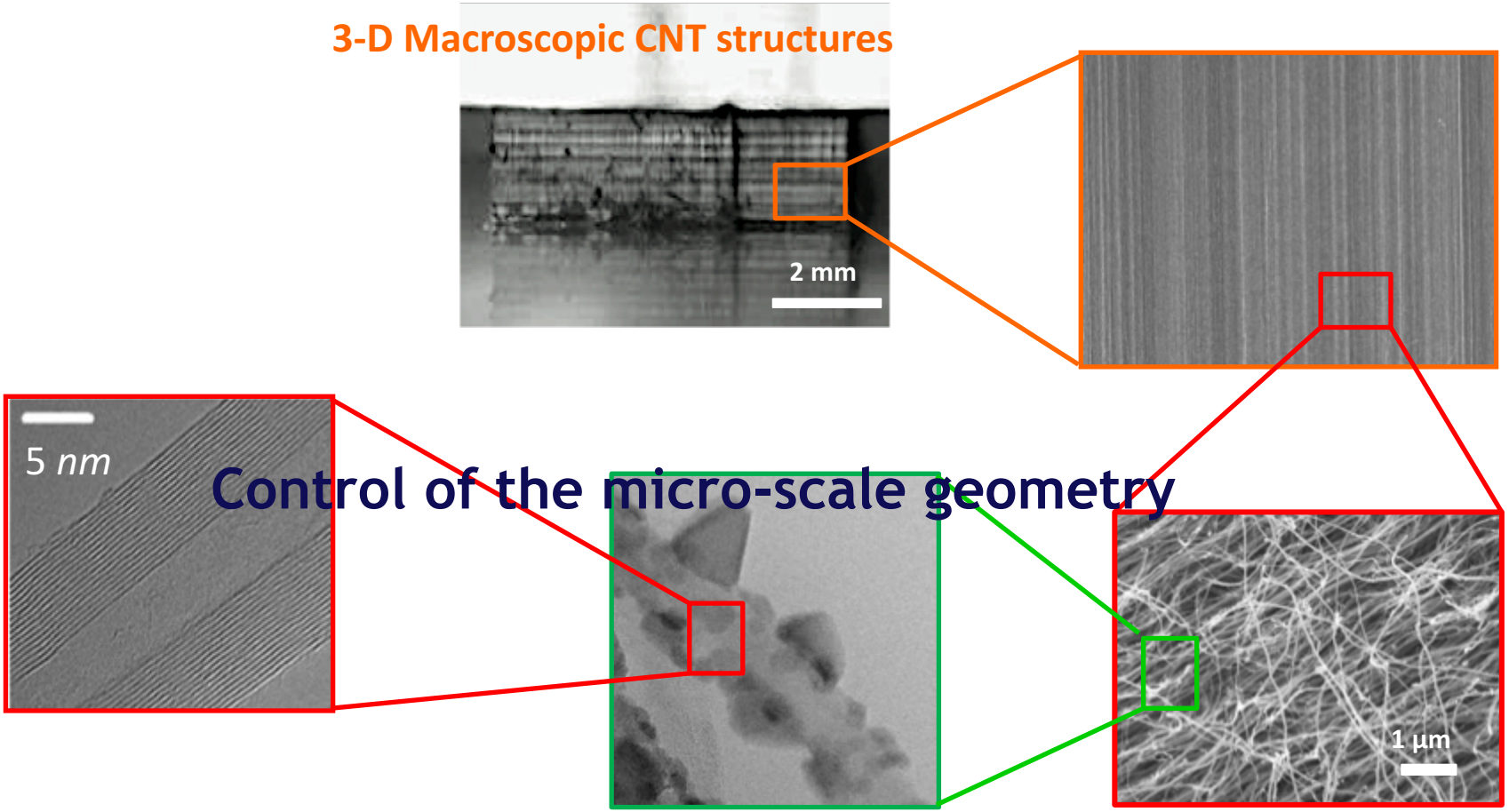
- ↘ PVD
- ↘ Micro e nano-strutturazioni per impartire proprietà funzionali

Sviluppo di materiali carboniosi

Prof. Luigi De Nardo
Prof. Maurizio Masi

Mater. structure - Mech. response

Material Structure → **Material Properties**



Hierarchical Materials
Mechanical behaviour

Dependence of relaxation/creep rate on strain/stress levels

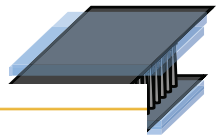
AIP | Journal of Applied Physics

Nonlinear viscoelasticity of freestanding and polymer-anchored vertically aligned carbon nanotube foams

avior

Ludovica Lattanzi, Jordan R. Raney, Luigi De Nardo, Abha Misra, and Chiara Daraio

Citation: J. Appl. Phys. 111, 074314 (2012); doi: 10.1063/1.3699184
View online: http://dx.doi.org/10.1063/1.3699184
View Table of Contents: http://jap.aip.org/resource/1/JAPI
Published by the American Institute of Physics.

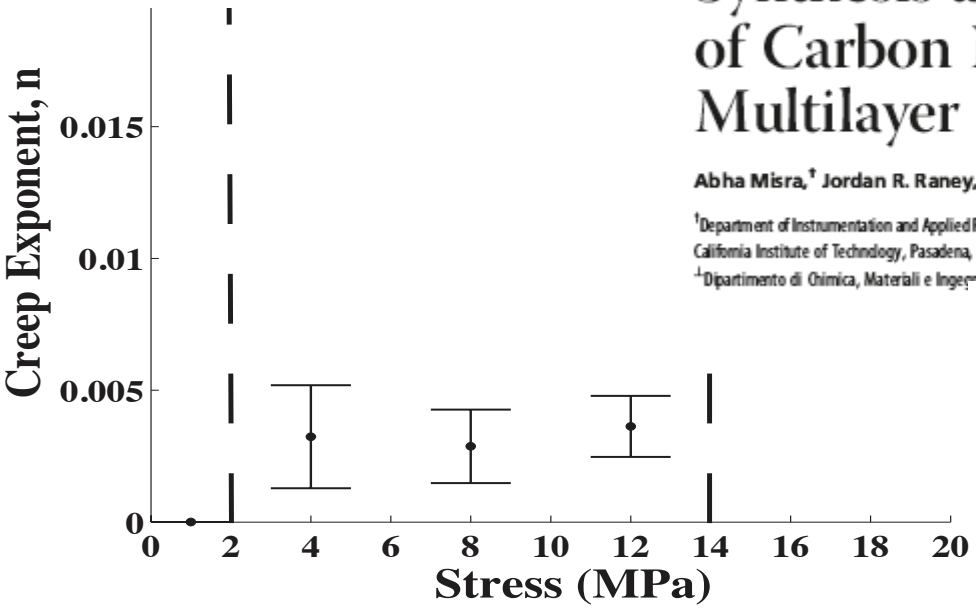


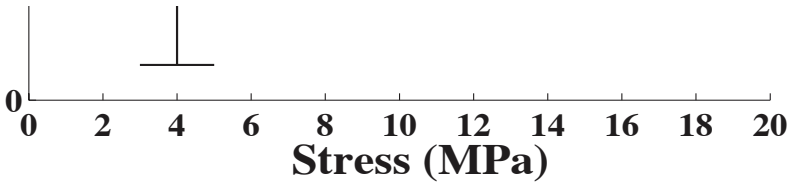
Synthesis and Characterization of Carbon Nanotube–Polymer Multilayer Structures

Abha Misra,† Jordan R. Raney,‡ Luigi De Nardo,§,⊥ Anna E. Craig,‡ and Chiara Daraio‡,*

†Department of Instrumentation and Applied Physics, Indian Institute of Science, Bangalore, Karnataka, 560012, India, ‡Division of Engineering and Applied Science, California Institute of Technology, Pasadena, California 91125, United States, §Istituto Nazionale di Scienza e Tecnologia dei Materiali, Milano, Italia, and ⊥Dipartimento di Chimica, Materiali e Ingegneria Chimica "G. Natta", Politecnico di Milano, Milano, Italy

VOL. 5 ▪ NO. 10 ▪ 7713–7721 ▪ 2011 ACSNANO www.acsnano.org



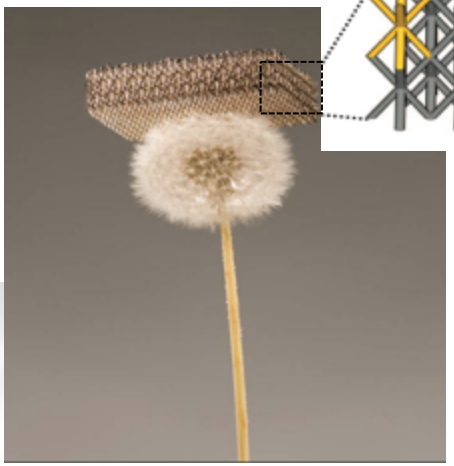


Lattanzi *et al.*,J Appl Phys, 074314, 2012

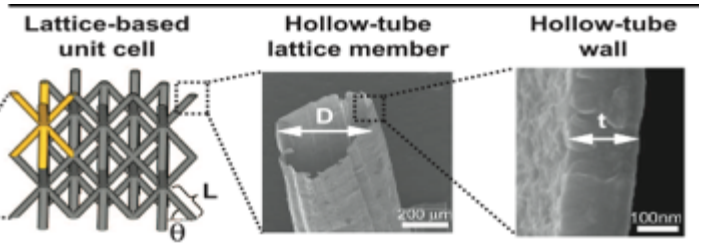
Hierarchical Materials
Mechanical behaviour

In **large-scale structures** it has been shown that introducing **ORDER** and **HIERARCHY** can improve **material utilization** and **resultant properties.**

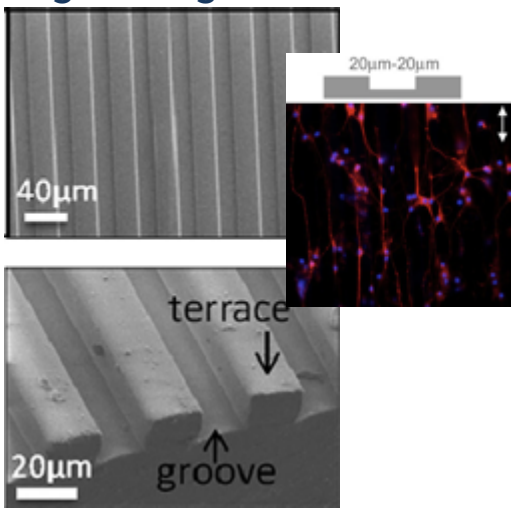
Metamaterial



Schaedler *et al.*, Science, 2011

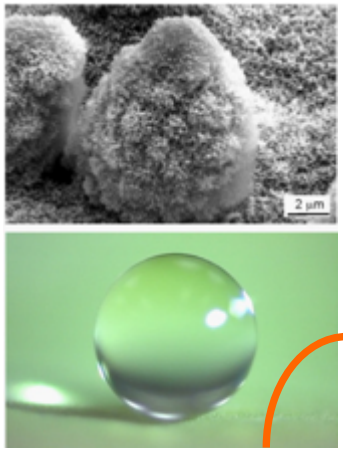


Scaffold for Tissue Engineering

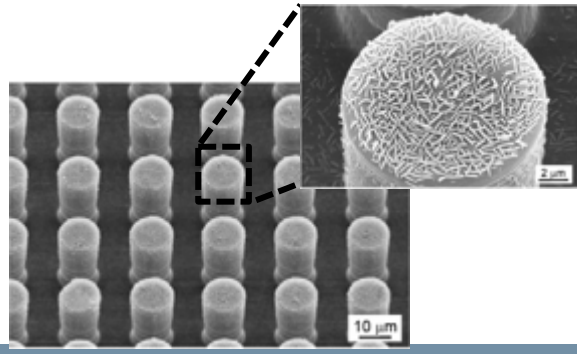


Beduer *et al.*, Biomaterials, 2012

Lotus effect



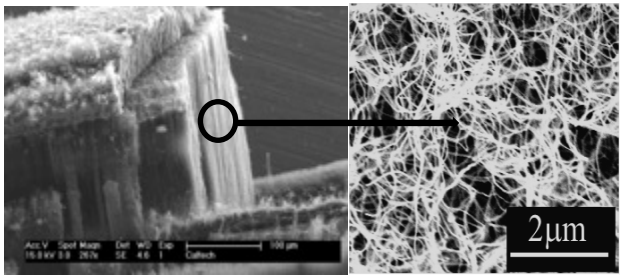
Biomimetic material



Bhushan *et al.*, Prog Mater Sci, 2011

Hierarchical Materials
Mechanical behaviour

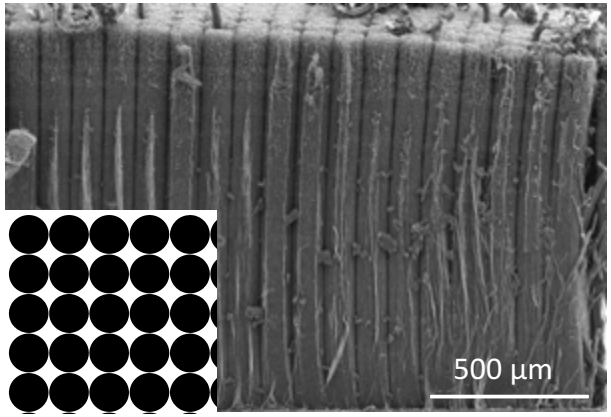
Properties of **low-density** materials are defined by their **structural architecture** and the **properties** of the **solid constituent**



Carbon Nanotube foam

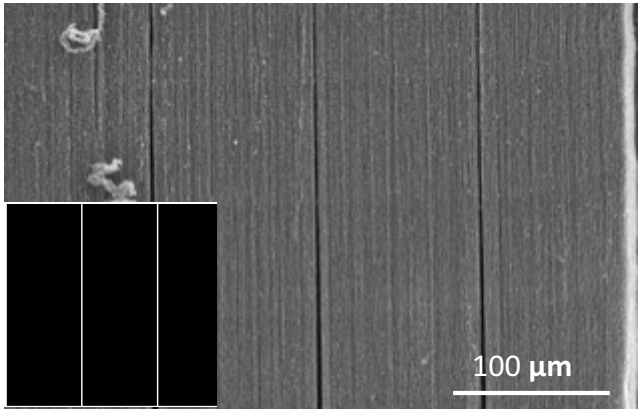
Introduction of **order** and **hierarchy** by **Photolithography**

Pillars



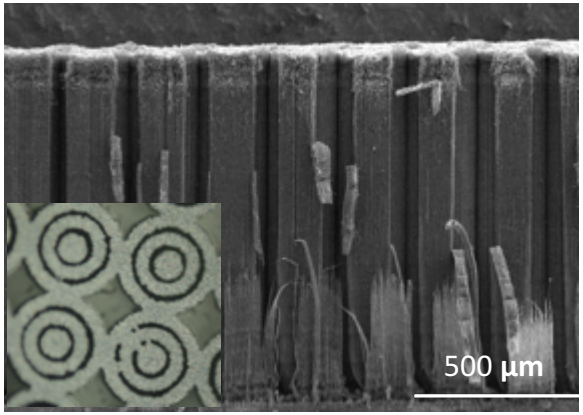
Ø (diameter) = 100 µm
δ (gap) = 0, 2, 10, 20, 50, 100 µm

Lines

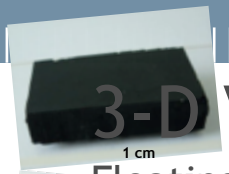


s (thickness) = 100 µm
δ (gap) = 2, 10, 20, 50, 100 µm

Concentric Rings

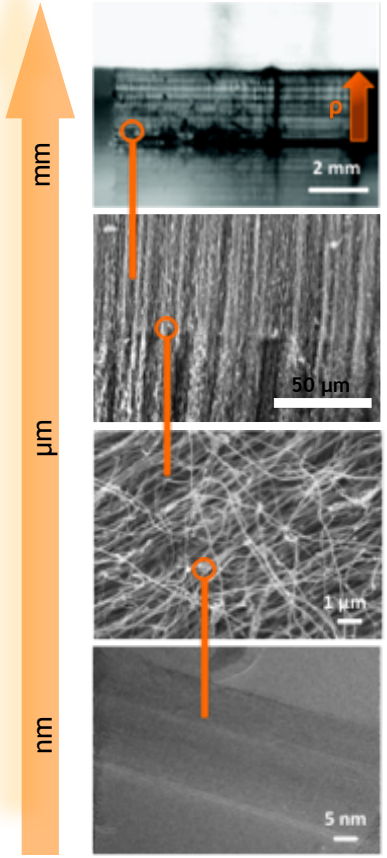


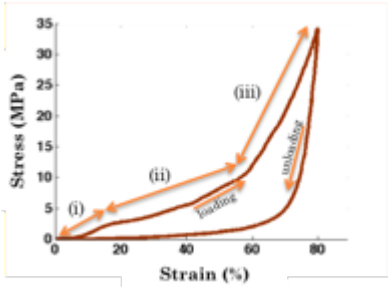
20 µm ring width with 10 µm spacing

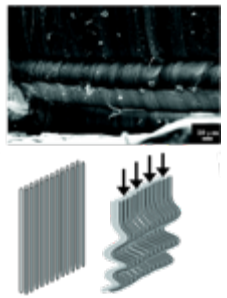


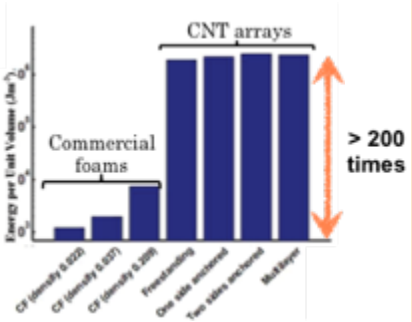
3-D Vertically aligned CNT (VACNT) forest

Floating catalyst CVD system









Directa Plus to lead smart fabrics research project

Supplier of graphene-based products Directa Plus has secured funding from the regional government of Lombardy, Italy.

The €1 million European grant will help it fund research into smart fabrics. It will see the company become the project leader of a research team that includes Italian companies Novaresin and Soliani, and Politecnico di Milano, one of the largest technical universities in Italy.

Directa Plus said the project will focus on the development of its Graphene Plus (G+) membranes, which allow a fabric to act as a filter between the body and external environment. This makes it easier for the wearer to maintain a comfortable temperature as warmth produced by the body is preserved and distributed evenly in cold climates, yet dispersed in warm climates.

Ongoing activities @CMIC

Sviluppo di trattamenti tecnologie per la produzione sostenibile di materiali carboniosi

- ↘ Nanotubi di carbonio
- ↘ Grafene e derivati nanostrutturati

Funzionalizzazione di materiali per impartire proprietà avanzate

Realizzazione e caratterizzazione di materiali compositi con proprietà funzionali

- ↘ Miglioramento conducibilità termica
- ↘ Miglioramento conducibilità elettrica

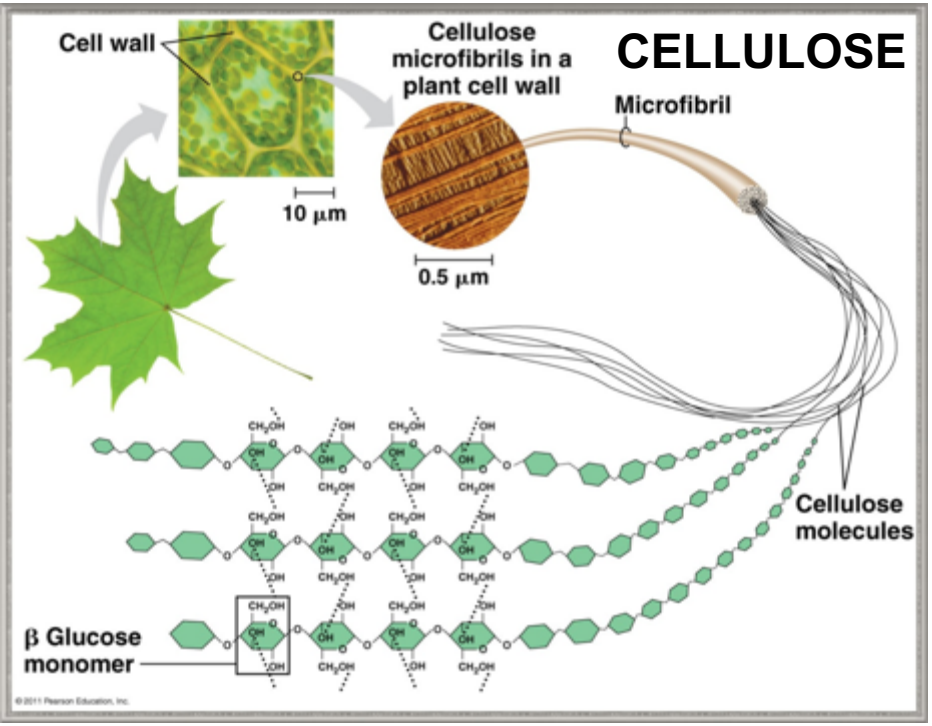
Materiali Nanostrutturati da Fonti Rinnovabili Polisaccaridiche

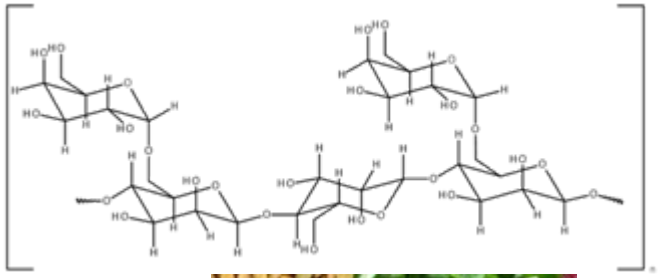
Prof. Carlo Punta

Department of Chemistry, Materials, and Chemical Engineering «G. Natta»
INSTM Local Unit

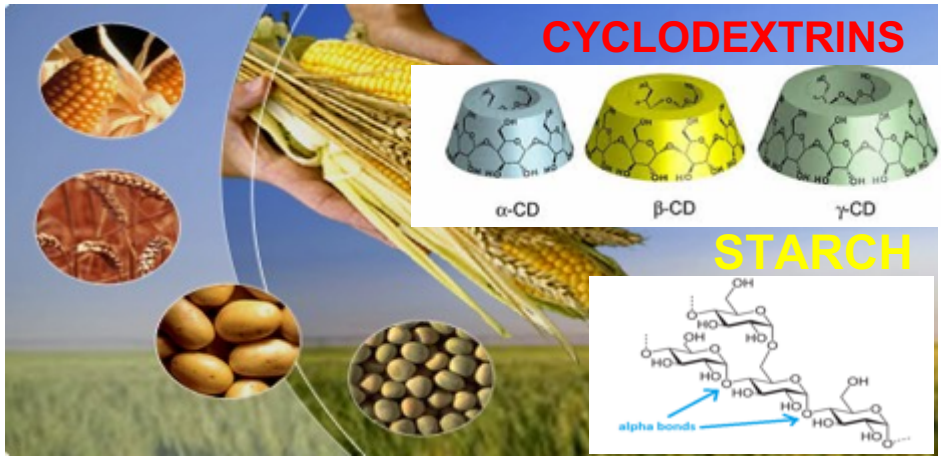
carlo.punta@polimi.it

Materiali a base di Polisaccaridi



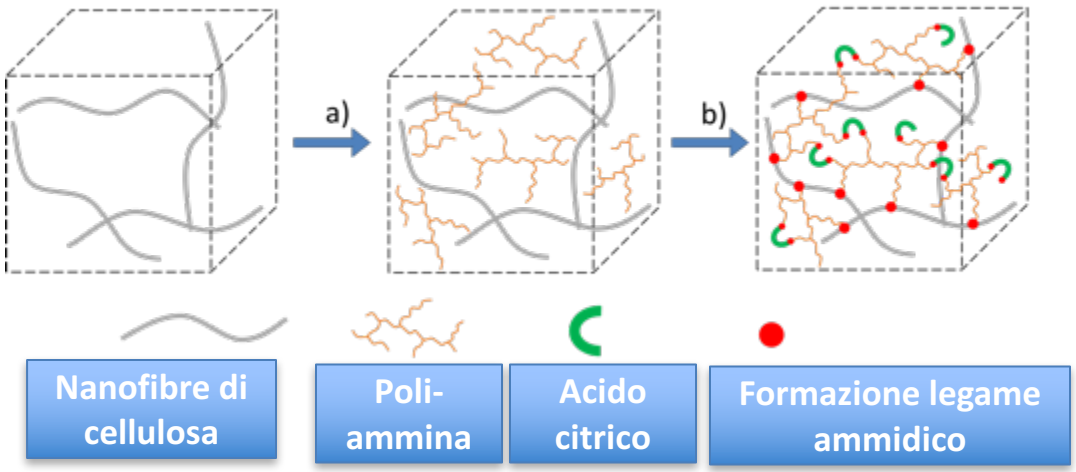


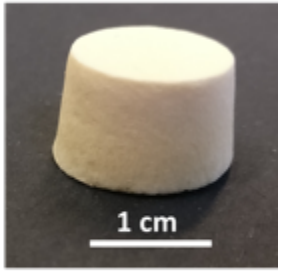
FENUGREEK



La nanostrutturazione di polimeri polisaccaridici porta alla formazione di materiali organici micro- e nano-porosi con proprietà mutuabili a seconda dei campi di applicazione

Versatilità nella progettazione dei materiali



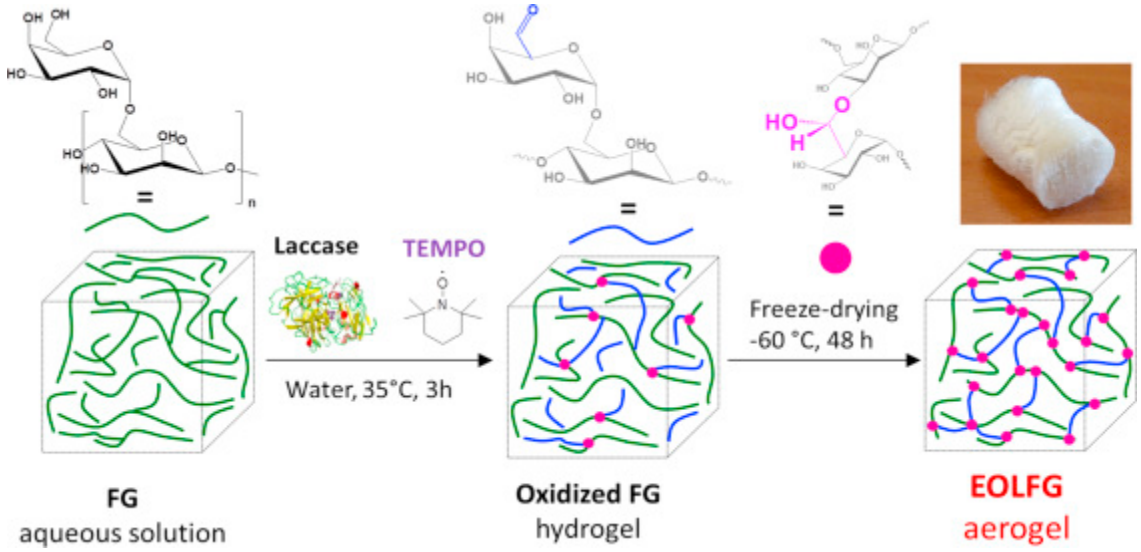


Il processo di nanostrutturazione di nanofibre di cellulosa avviene mediante semplice trattamento termico e i materiali possono essere ottenuti in diverse forme e morfologie

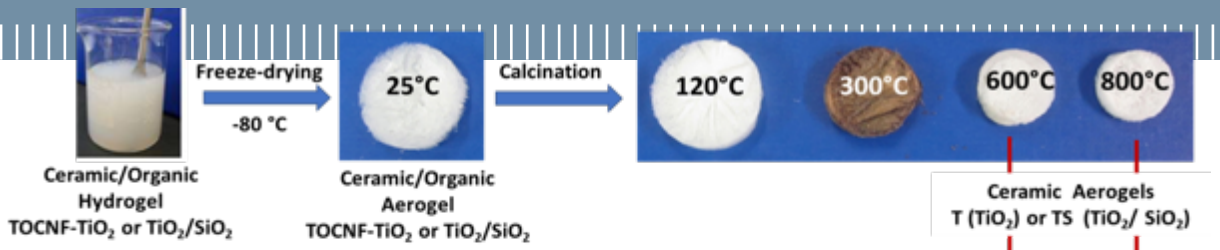
Carbohydrate Polymers **2017**, *165*, 71–85.
ChemPlusChem **2015**, *80*, 1408-1415
ChemPlusChem **2017**, *82*, 848 –858 .

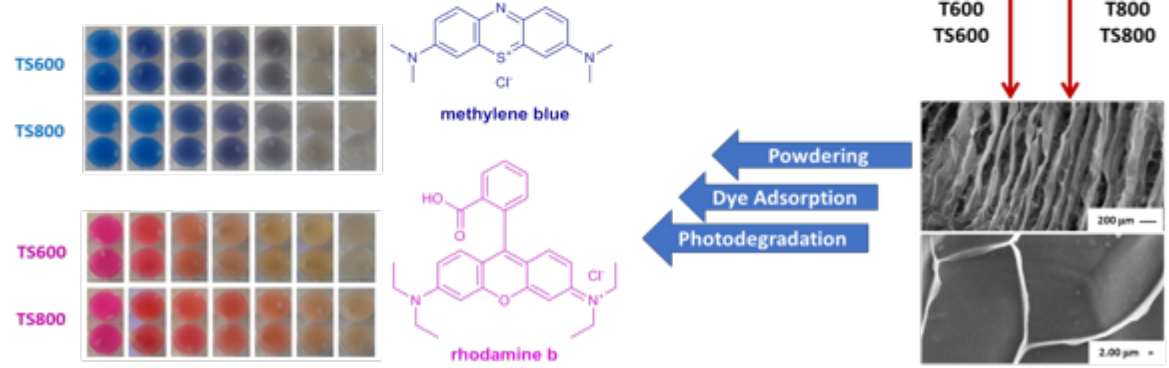
Materiali nanostrutturati con proprietà analoghe o complementari possono essere ottenuti da. Essi evidenziano elevate proprietà adsorbenti di acqua e solventi organici.

Carbohydrate Polymers **2016**, *144*, 353-361.



Facilmente processabili con rivestimenti ceramici e organici.



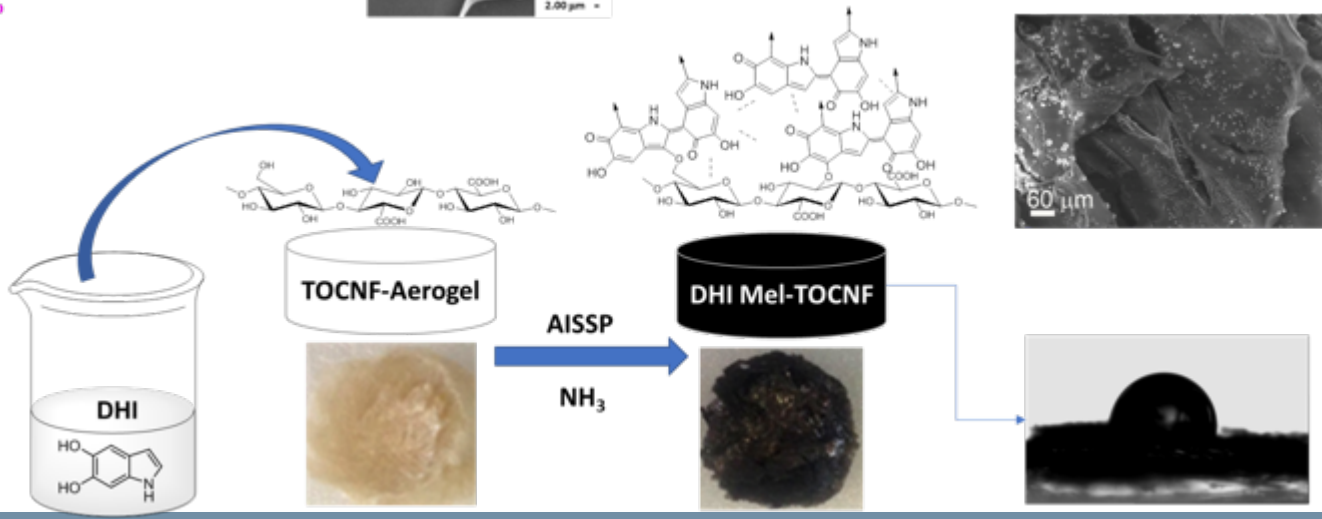


Coating ceramico: Proprietà adsorbenti e fotodegradative

J. Photochem. Photobiol. A. **2013**, *261*, 53– 60

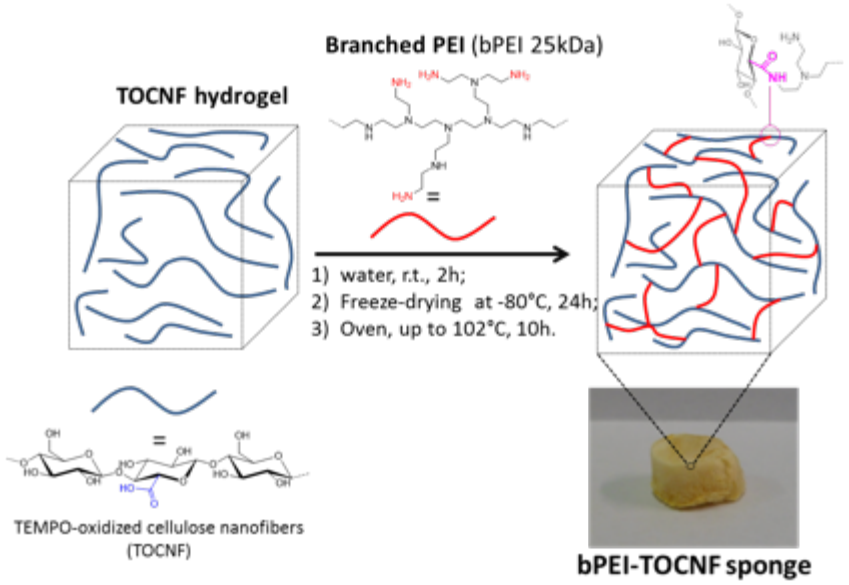
Coating eumelanico: Proprietà idrofobiche e antiossidanti.

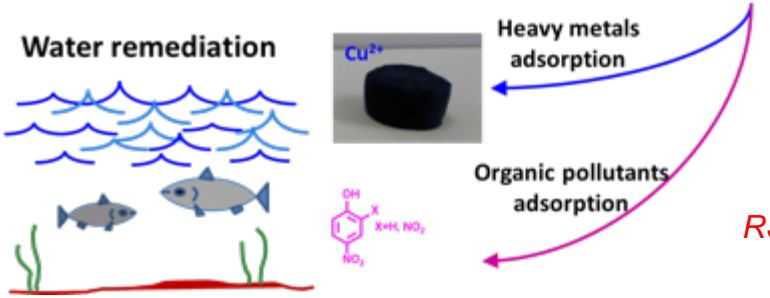
Biomacromolecules **2016**, *17*, 564−571



Versatilità nei campi di applicazione

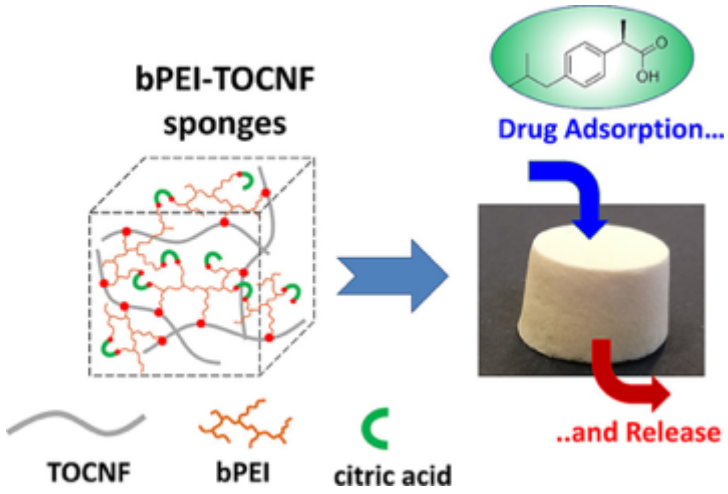
Nanoremediation e Bonifica Ambientale





ChemPlusChem **2015**, 80(9), 1408-1415

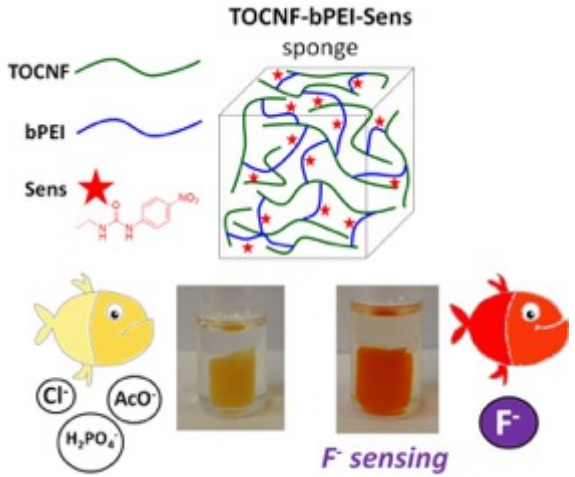
Rilascio controllato di farmaci e fitofarmaci



ChemPlusChem **2017**, *82*, 848 –858 .

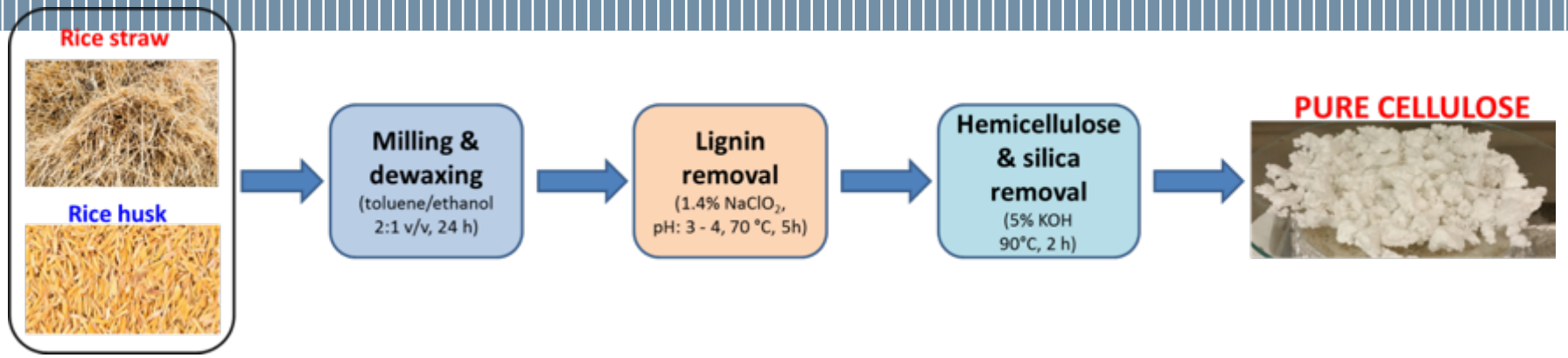
Sensoristica

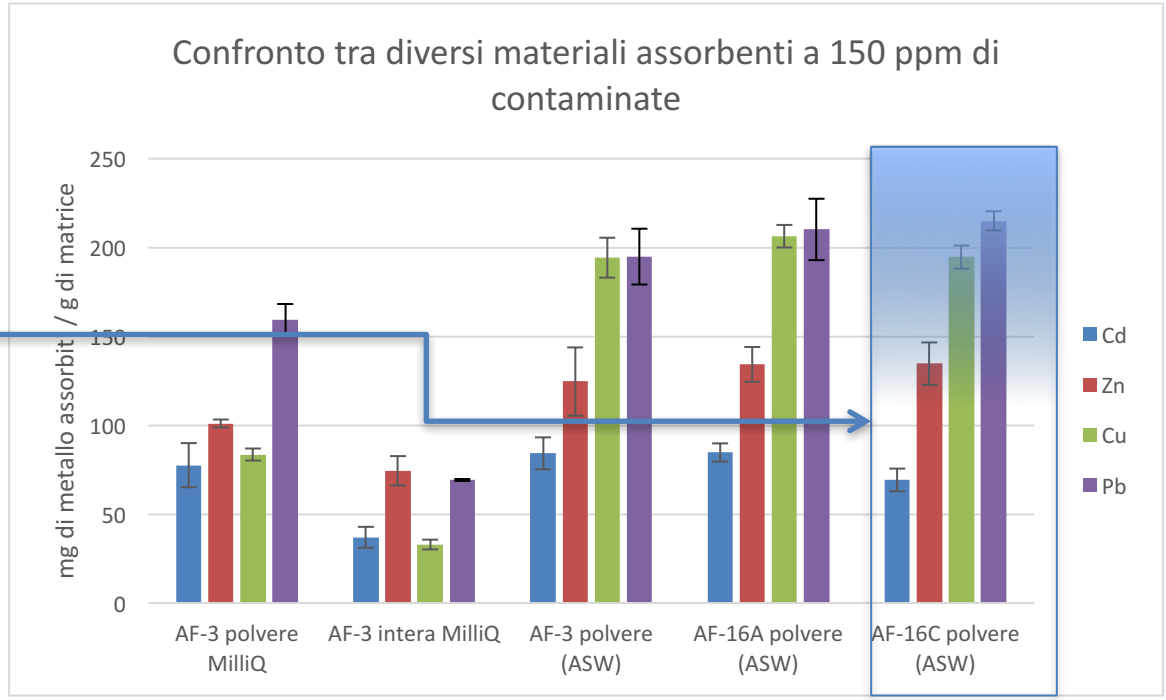
RSC Advances **2015**, 5, 83197-83205



...e molto altro...

Riciclabilità da scarti agricoli e macero selezionato cartario





Finanziamenti

POLITECNICO MILANO 1863

Regione Lombardia

INSTM

Call RSI 2015, POR FSER 2014-2020 Regione Toscana

Baxter

nano bond

SIPCAM

oxon ITALIA

Ministero dell'Istruzione, dell'Università e della Ricerca

2014 2020 POR CreO PROGRAMMA OPERATIVO REGIONALE CRESCITA e OCCUPAZIONE

Unione Europea
Fondo Europeo di Sviluppo Regionale

REPUBBLICA ITALIANA

Regione Toscana

Ongoing activities @CMIC

Sviluppo di nuovi materiali da scarti derivanti da prodotti industriali

- ↘ Valutazione proprietà funzionali
- ↘ Valutazione impatto sul ciclo di vita
- ↘ Modifica dei processi produttivi e valorizzazione delle produzioni

Nuovi materiali

- ↘ Water remediation
- ↘ Isolamento termico e acustico

Take Home Messages

The study of fundamental properties in materials science offer a powerful support to the development of industrial products:

- ↘ New applications in conventional products
- ↘ Reshape the way we think functions

New Materials can pave the road for such an innovation

… there is always a problem waiting for a material, and a property that can find a solution!!!

Contacts

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