POLITECNICO
MILANO 1863

DIPARTIMENTO DI CHIMICA,
MATERIALI E INGEGNERIA CHIMICA
GIULIO NATTA

ADVANCED MATERIALS FOR SUSTAINABLE FUTURE TECHNOLOGIES

Sezione Chimica

Giancarlo Terraneo

SUPRA BIO NANO

Laboratory of Supramolecular and Bio-Nanomaterials

INFO - TIMELINE

2001

LAUREA IN CHEMISTRY
@ UNIVERSITA' DEGLI
STUDI DI MILANO

2003

FELLOWSHIP @ WAGENINGEN
UNIVERSITY (THE NETHERLAND)

2004

DURING MY PhD ONE YEAR
@ UNIVERSITY OF ZURICH

2006

PhD IN CHEMISTRY
@ UNIVERSITA' DEGLI
STUDI DI MILANO

GOT MARRIED with LAURA

2007

POST- DOC @ DCMIC
POLITECNICO DI MILANO

INFO - TIMELINE

PIETRO

2008

ASSISTANT PROFESSOR @ CMIC

POLITECNICO MILANO 1863
DIPARTIMENTO DI CHIMICA, MATERIALI E INGEGNERIA CHIMICA GIULIO NATTA

2010

DAVIDE

2011

AFFILIATED RESEARCHER @ CNST-IIT

2014

ASSOCIATE PROFESSOR @ CMIC

POLITECNICO MILANO 1863
DIPARTIMENTO DI CHIMICA, MATERIALI E INGEGNERIA CHIMICA GIULIO NATTA

2016

BEATRICE

AFFILIATED RESEARCHER @ CNR

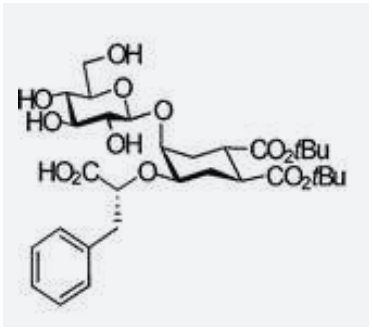
2021

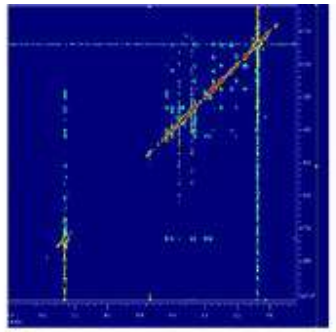
CMIC DAY
Ventesimo anniversario del Dipartimento di Chimica, Materiali e Ingegneria Chimica "Giulio Natta"

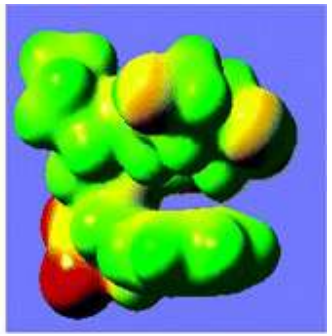
RESEARCH - TIMELINE

During PhD

Prof. Anna Bernardi
Prof. Kim Baldridge



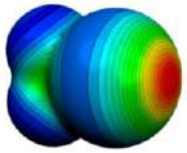


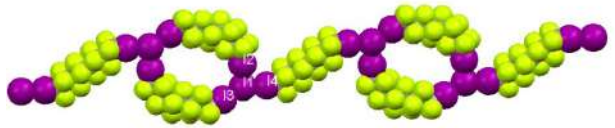


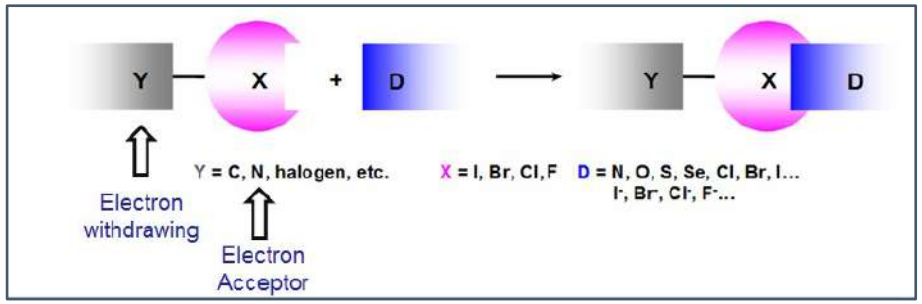
Non Covalent Interactions
Sugars – Aromatics
Synthesis - NMR -
Computational

During Post-Doc

Prof. Giuseppe Resnati
Prof. Pierangelo Metrangolo



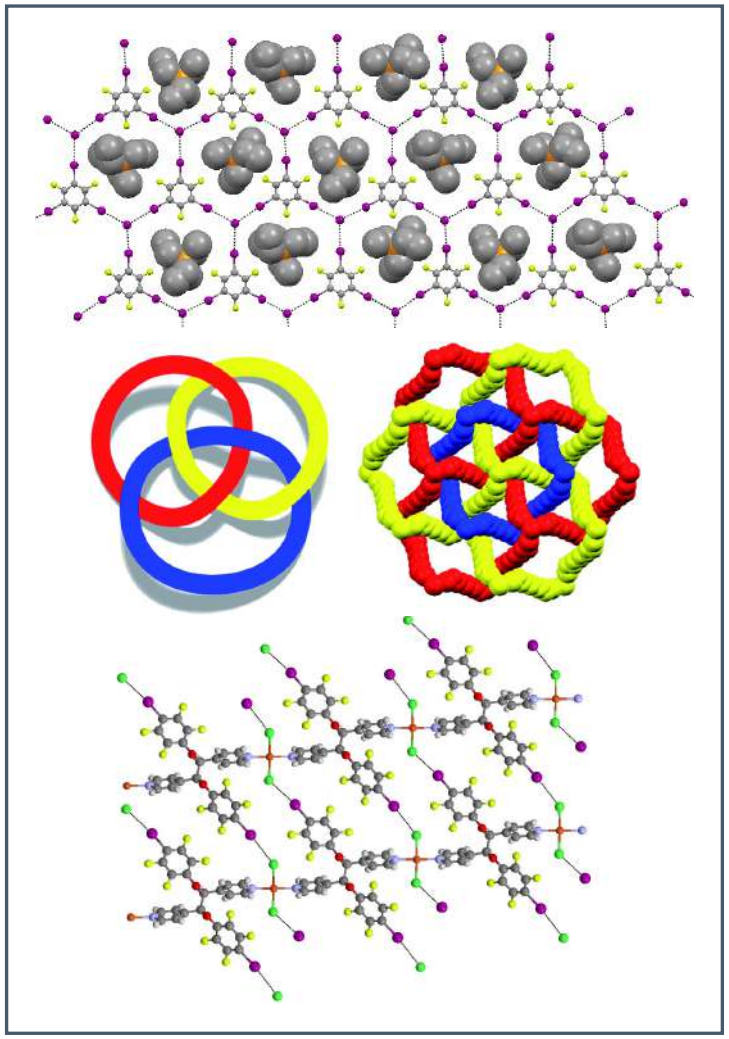




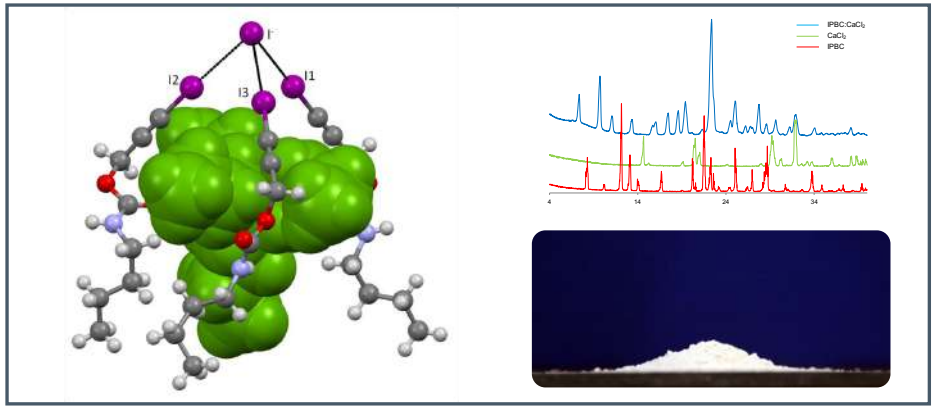
Non Covalent Interactions
Crystal Engineering
Supramolecular Chemistry
Fluorinated Materials
Structural Characterization
The Halogen Bond

CRYSTAL ENGINEERING and SUPRAMOLECULAR MATERIALS TH(AT) WORK !

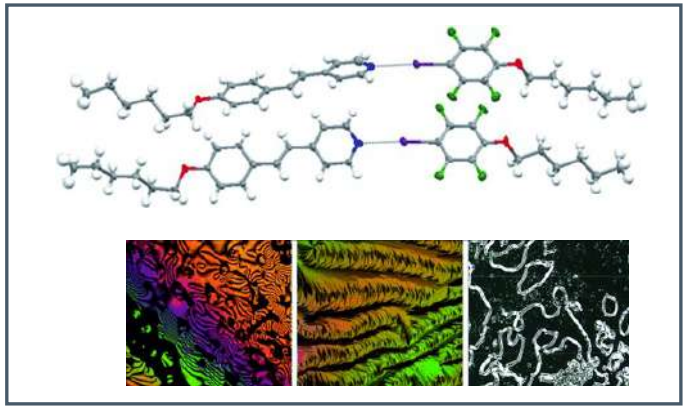
Complex Architectures and Topologies



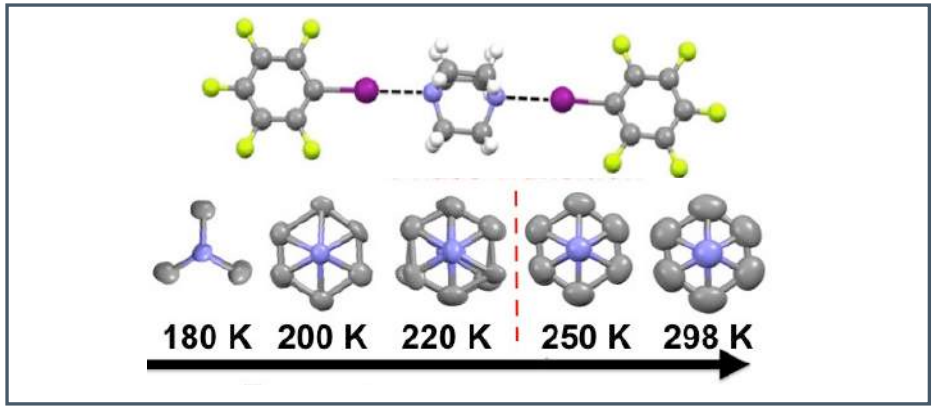
Pharmaceutical Co-crystals



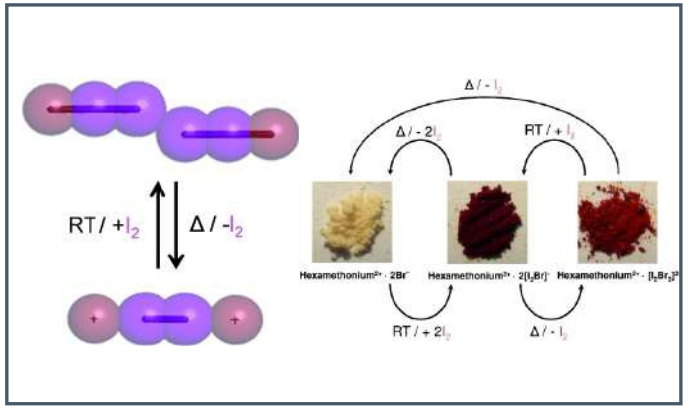
Supramolecular Liquid Crystals



Supramolecular Rotors

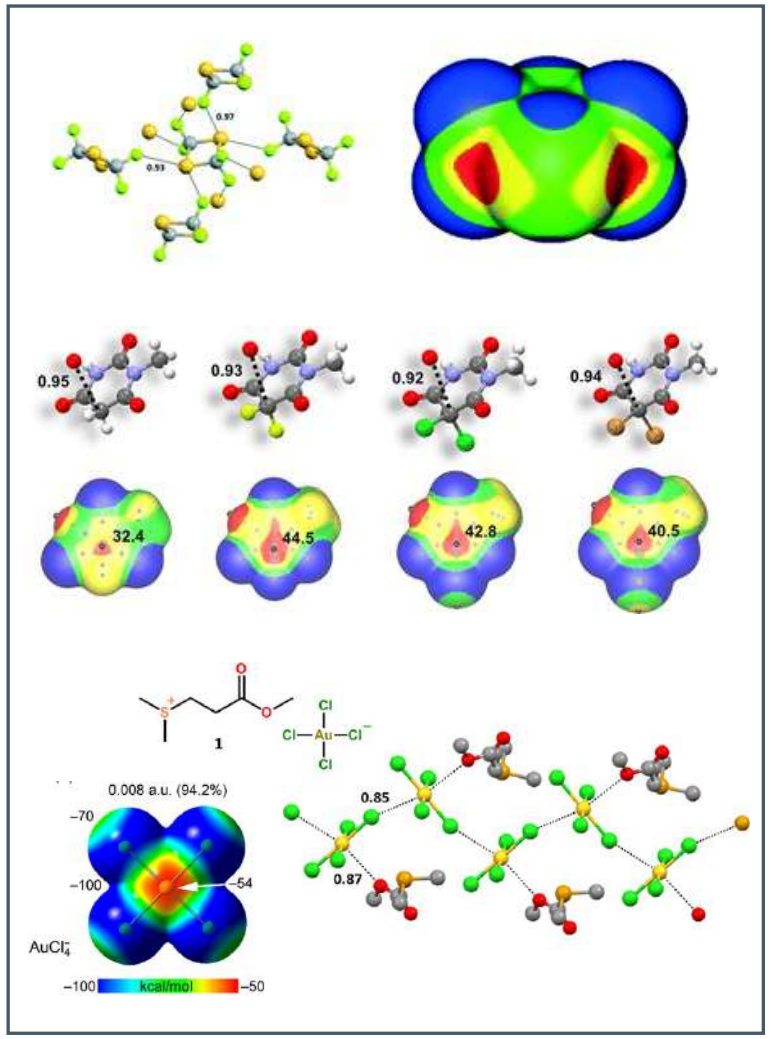


Adaptive Materials

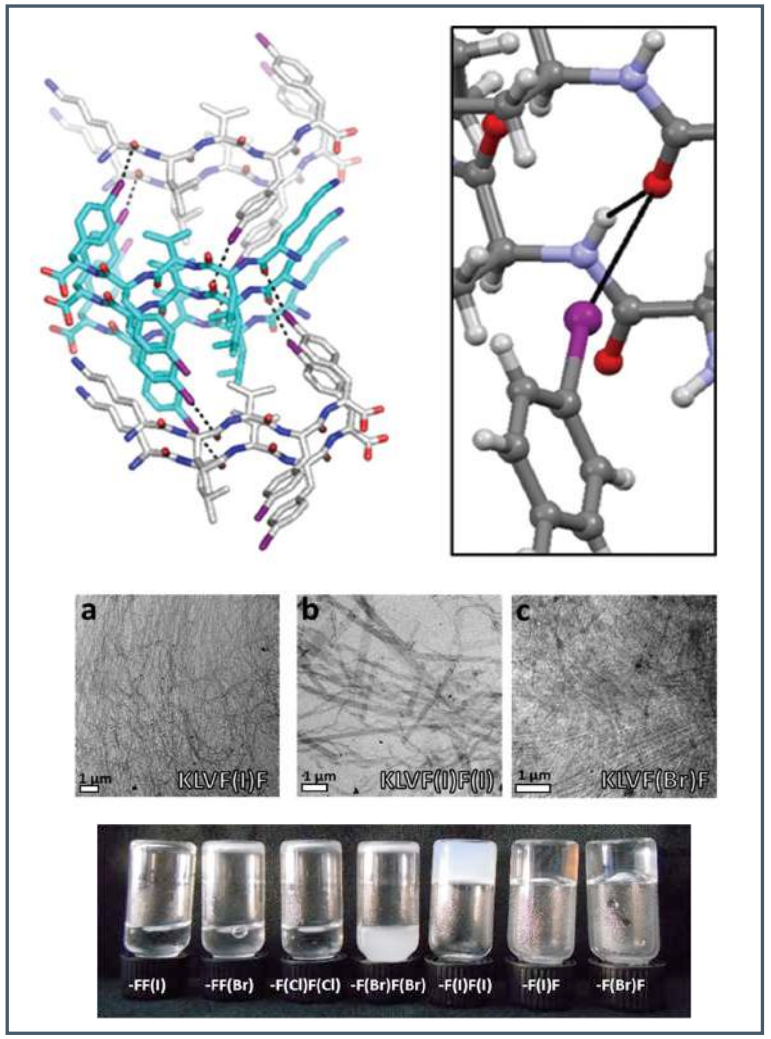


CRYSTAL ENGINEERING and SUPRAMOLECULAR MATERIALS TH(AT) WORK !

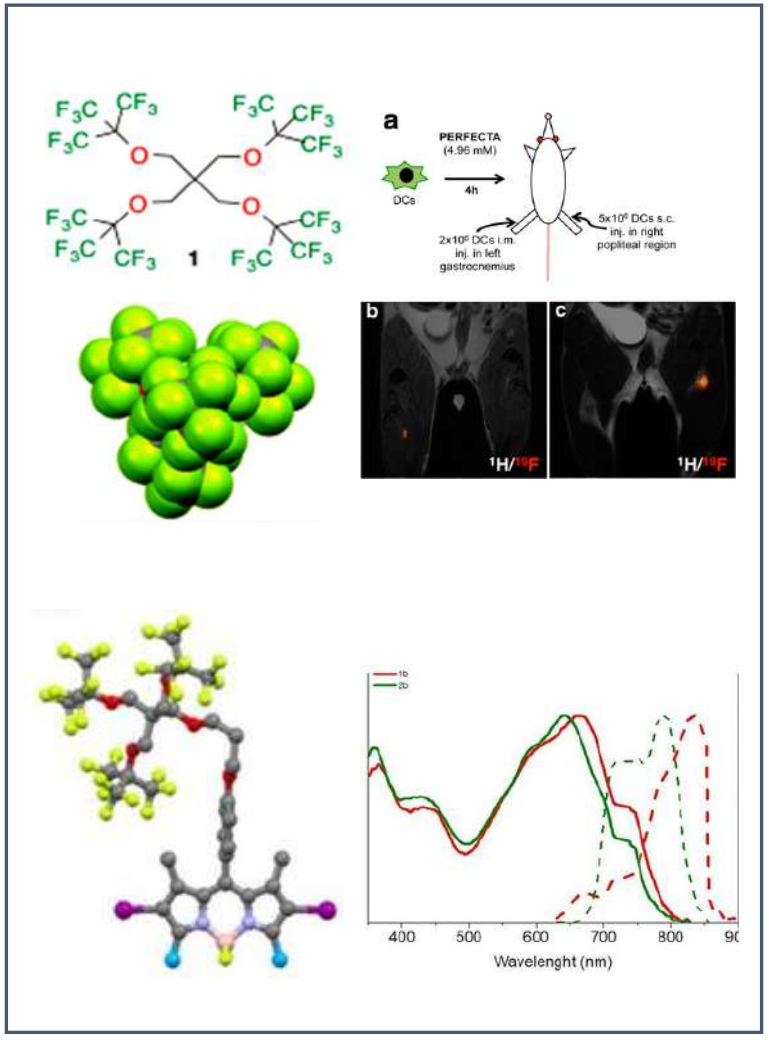
Fundamentals in Non Covalent Interactions



Tunable Bio-materials

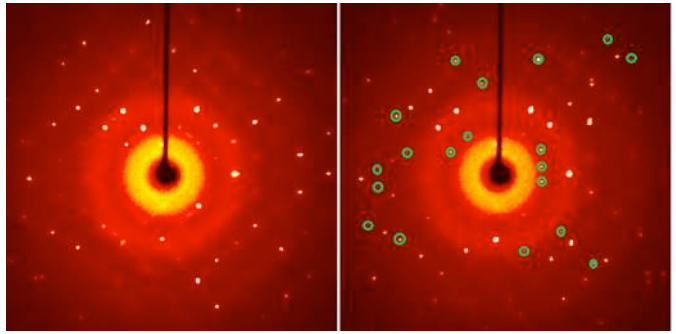


Materials for Personalized Medicine

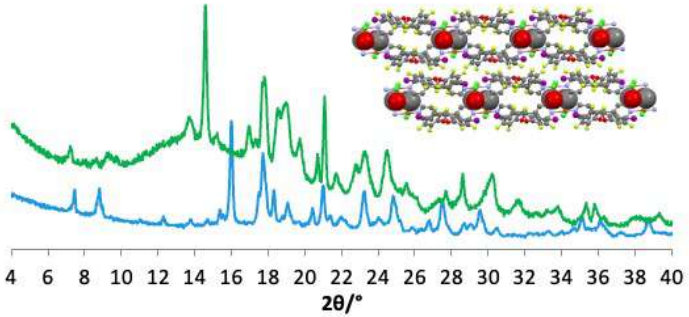


X-RAY STRUCTURAL CHARACTERIZATION

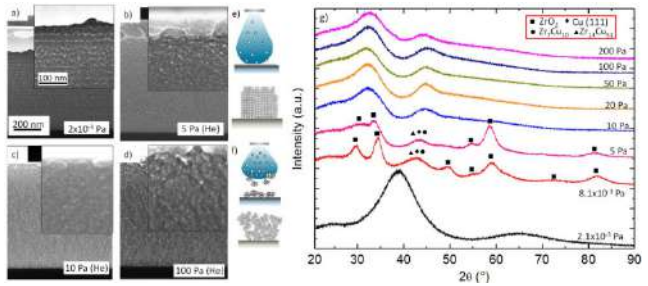
Single Crystal X-ray Diffraction



Powder X-ray Diffraction



Grazing Incidence X-ray Diffraction



Acc. Lincei – Rend. d. Cl. di Sc. fis., mat. e nat. – Vol. XIX.

G. NATTA e P. CORRADINI – *Polimeri cristallini del butadiene e struttura, ecc.* – TAV. I.

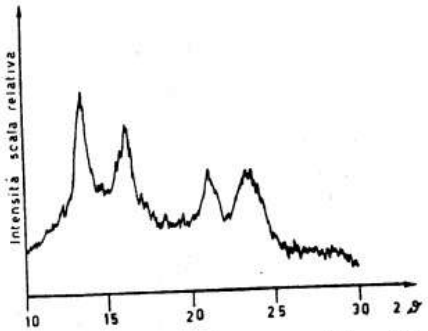


Fig. 1. – Registrazione con contatore Geiger dello spettro ai raggi X del 1–2–polibutadiene (CuKα).

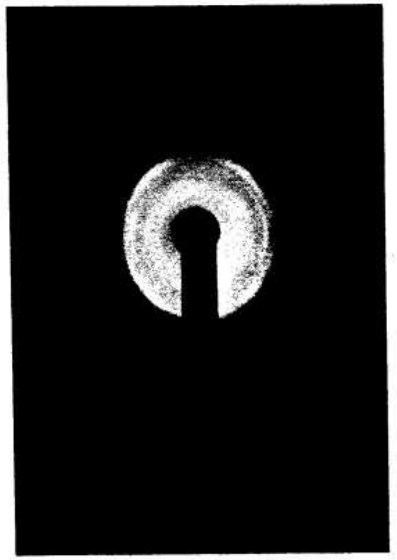


Fig. 2. – Spettro di fibra del 1–2–polibutadiene.

G. NATTA e P. CORRADINI – *Polimeri cristallini del butadiene e struttura, ecc.* – TAV. I.

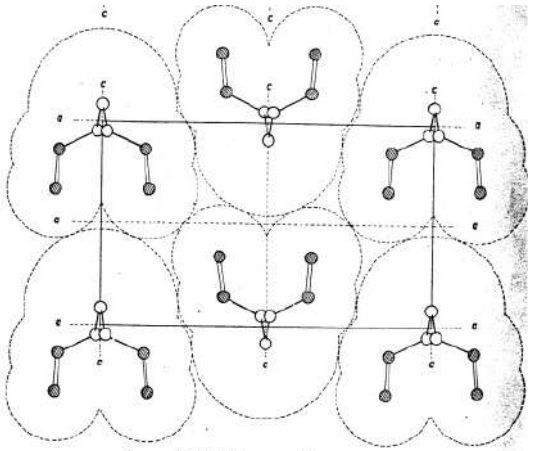


Fig. 4. – Modello della struttura del 1–2–polibutadiene.

STRUCTURE – FUNCTION RELATIONSHIPS

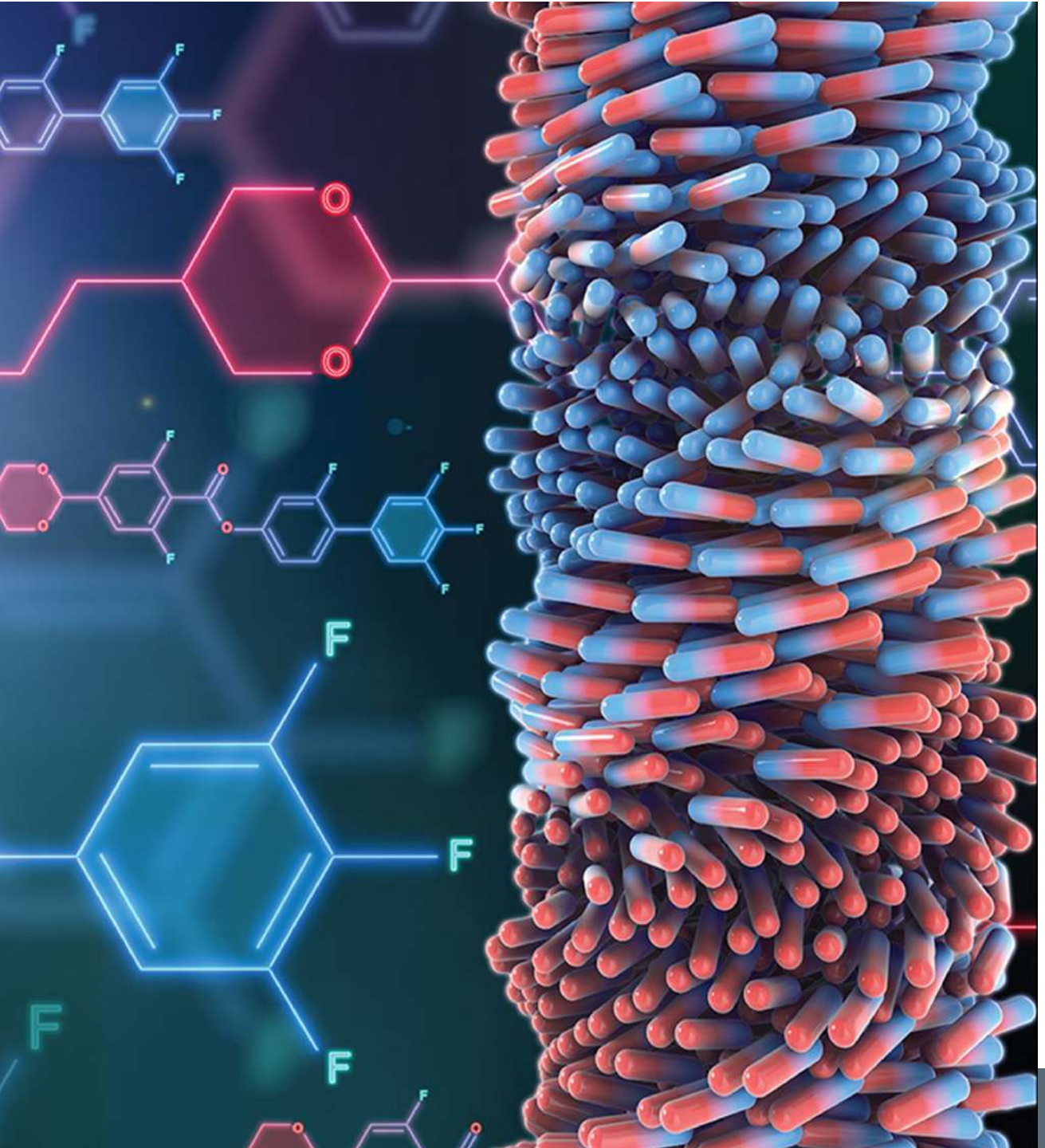
STRUCTURE – PROPERTY RELATIONSHIPS

STRUCTURE – ACTIVITY RELATIONSHIPS

Web of Science Core Collection (2021 – 2017)

- 115 publications with 1378 citations
- 2 granted patents and 6 international patent applications
- More than 13.000 overall citations received in the last 5 years

- Overall budget from competitive projects: 3 Milion Euros



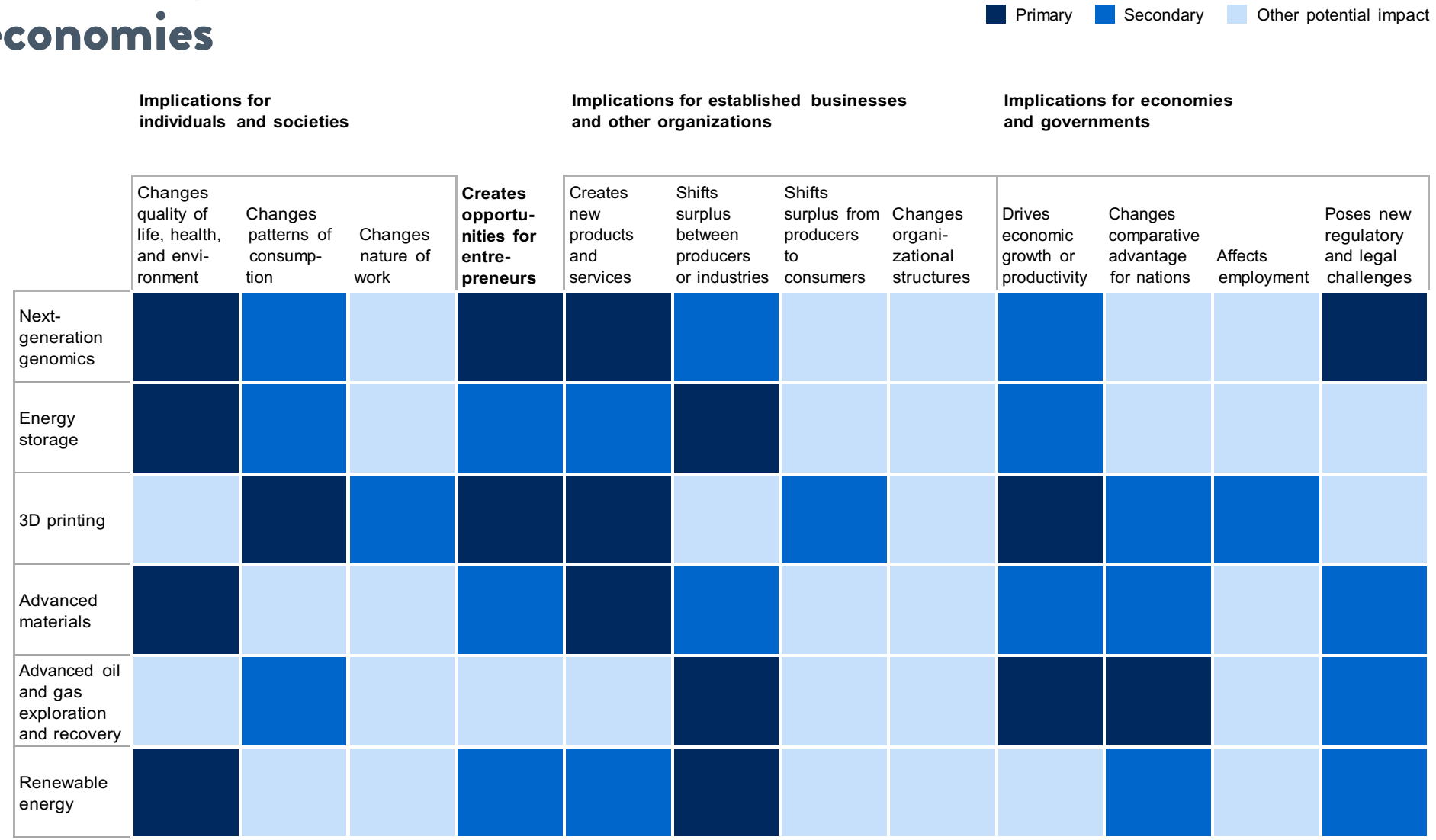
OUTLOOK

- Over the past few decades, scientists have discovered ways to produce **materials with incredible attributes** - smart materials that are **self-healing or self-cleaning**; memory metals that can revert to their original shapes; and crystals that turn pressure into energy; and **nanomaterials**.

- Nanomaterials in particular stand out in terms of their **high rate of improvement, broad potential applicability, and long-term potential to drive massive economic impact**.

- Advanced nanomaterials such as graphene and carbon nanotubes are driving significant impact. For example, **graphene and carbon nanotubes** could help create new types of displays and super-efficient batteries and solar cells. Finally, **pharmaceutical companies** are already progressing in research to use **nanoparticles** for targeted drug treatments for diseases such as cancer.

How disruptive technologies could affect society, businesses and economies



SOURCE: McKinsey Global Institute analysis

ARCHITECTING A BETTER FUTURE

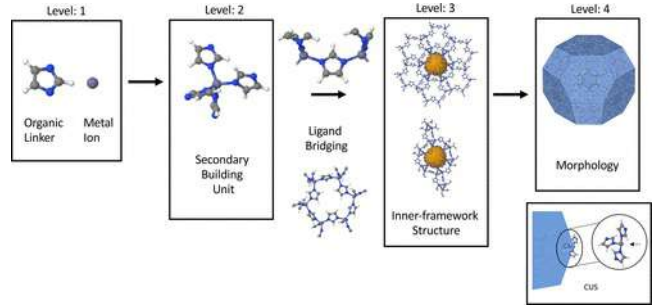
POLITECNICO MILANO 1863

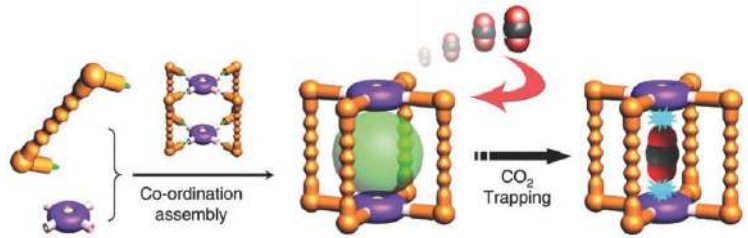
ORGANIC AND METAL-ORGANIC MATERIALS

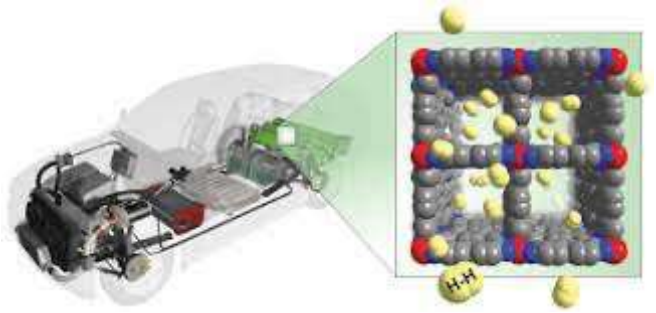
Materials with **permanent or adaptive porosity and structure modularity** will become relevant to several contemporary challenges related to the **environment and energy sustainability**.

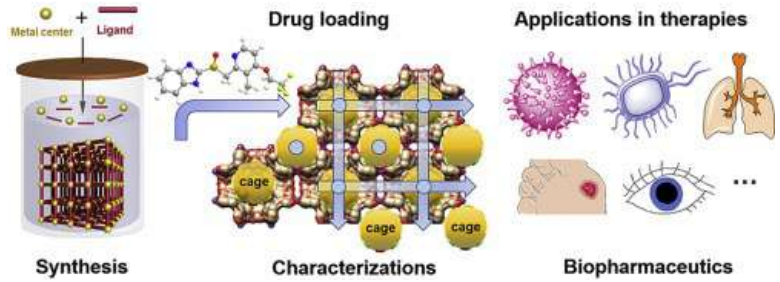
- Improved heterogeneous catalytic processes
- Improved separation methods
- CO_2 capture and pollutant capture
- Methane or hydrogen storage for vehicular transport
- Electrically conductive porous materials
- Photocatalysis, solar energy and environmental sensing
- Drug delivery systems

Molecular modules from renewable resources or waste valorization









Low-Medium TRL

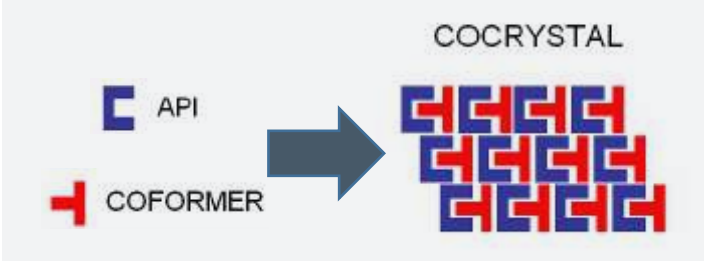
Engineering Active Pharmaceutical Ingredients and Agrochemicals

Exploiting the fundamental principles of crystal engineering and supramolecular chemistry we target **new multi-component pharmaceutical materials** (e.g. API+coformer) or **new multi-component agrochemical materials** with **improved physicochemical properties** and **bioavalaibility**.

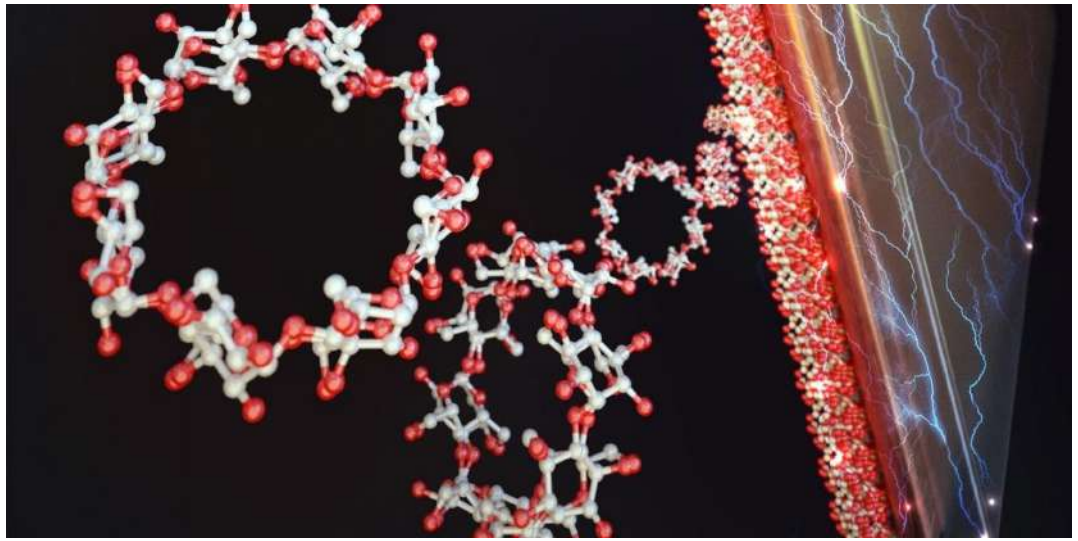
Significant opportunities for **intellectual property** and **improved medicines**

SUSTAINABLE DEVELOPMENT GOALS

A New road to better drugs



High TRL



Engineering Renewable Materials

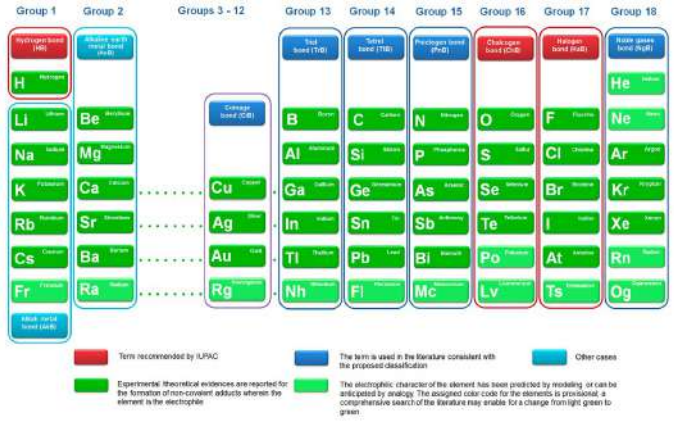
Using the renewable resources provided by Nature we aim to develop functional materials able to perform specific functions such as convert mechanical to electrical energy or harvesting solar energy.

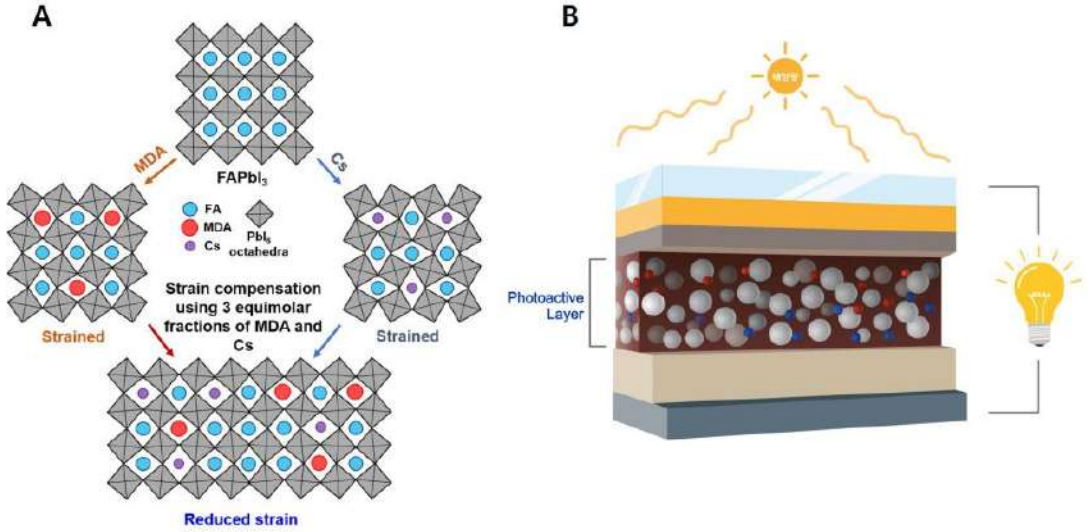
Next-generation energy systems for wearable electronics, biodevices and robots

SUSTAINABLE DEVELOPMENT GOALS High TRL

Investigating the Fundamentals of Non-Covalent Interactions

Non-covalent interactions play a major role in many and different fields of **physics, chemistry, engineering and biology** and their impact span from the **physical properties of matter to the biological functions of living organism**. In general, interactions affect or control recognition, self-organization, and self-assembly phenomena of organic and inorganic systems and are thus an important topic in supramolecular chemistry and nanotechnologies.





X-RAY Structural Characterization

Properties of a material are intrinsically dependent on the internal arrangement of molecules in the solid state. Therefore, knowledge of three-dimensional structure of the matter is a prerequisite for **structure–property correlations and design of functional materials.** The structural information obtained from crystallographic analysis paved the way for rapid development in electronic devices and materials science (e.g. perovskite solar cells.

PROGRAMMA DEGLI INTERVENTI PER LA RIPRESA ECONOMICA:
Sviluppo di nuovi accordi di collaborazione con le università per la ricerca, l'innovazione e il trasferimento tecnologico

POLITECNICO MILANO 1863

Regione Lombardia

Advanced and sustainable materials and manufacturing for the life sciences and energy transition

NEXT-GENERATION ADVANCED MATERIALS (NEXT-GAME)

SINGLE CRYSTAL X-RAY SYSTEM

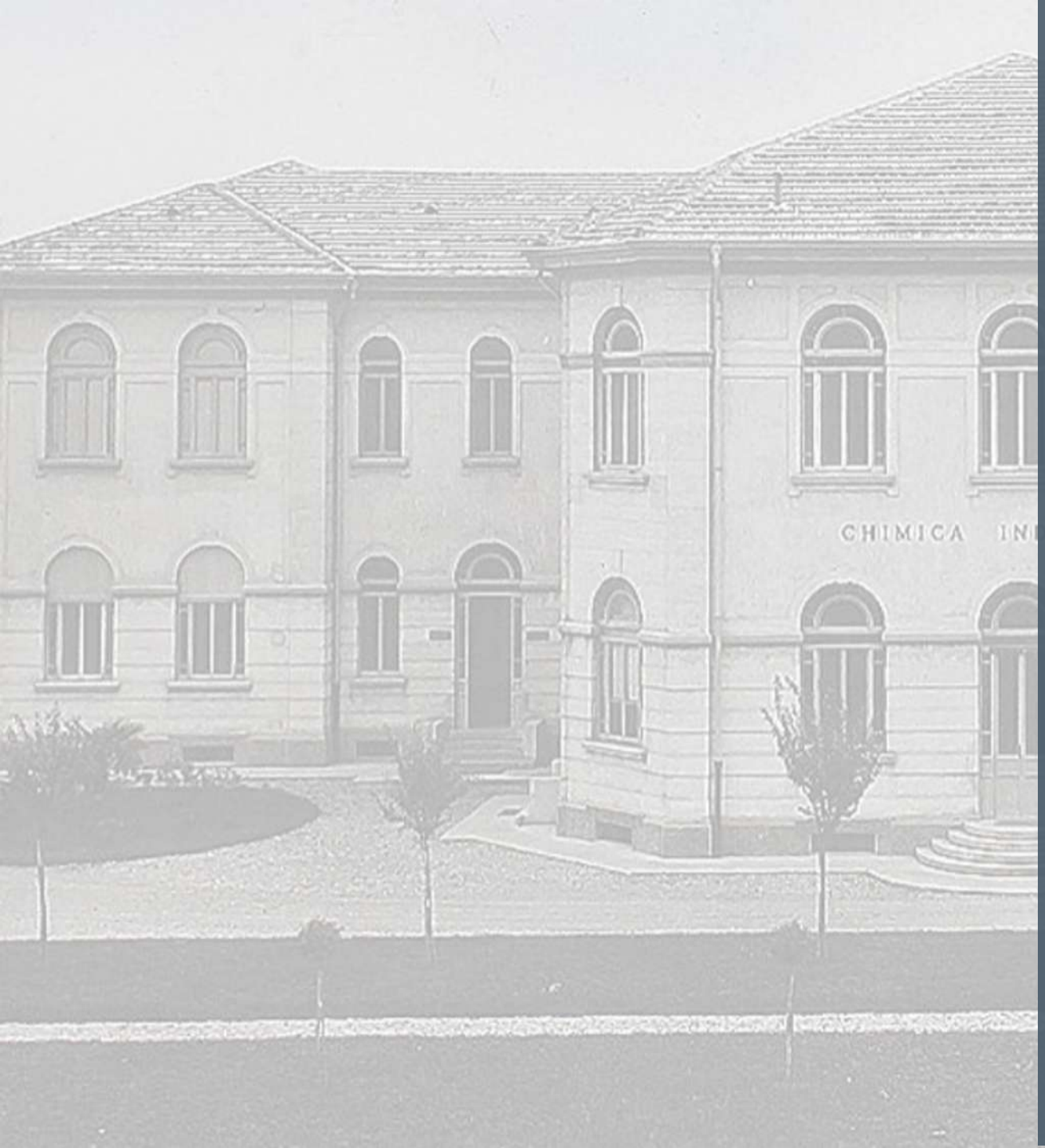
SAXS/WAXS/GISAXS MULTIFUNCTIONAL SYSTEM

LAUE SYSTEM

X-RAY ABSORPTION SPECTROSCOPY (EXAFS)

LEARNING BY DOING

- Modularity and Flexibility towards new emerginng topics
- Increasing laboratory courses both for MS and PhD program
- Meetings and Workshops of new emerging topics



GRAZIE

giancarlo.terraneo@polimi.it