Metallic Materials Group, Chemistry Department

Prof. P. Rizzi*, Prof. Mauro Palumbo,
Prof. M. Baricco, Prof. A. Castellero, Dr. F. Scaglione

*e-mail: paola.rizzi@unito.it

https://www.chimica.unito.it/do/gruppi.pl/Show?_id=cpcf

Topics available

Additive manufacturing

Nanoporous metals

Magnetoelectric materials

Modelling of metallic materials and materials for energy

Energy storage and energy harvesting

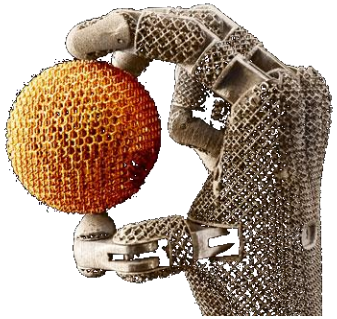
Energy storage from renewable sources

Thermal energy harvesting: thermoelectric materials

+ COMPETENCE
INDUSTRY
MANUFACTURING
4.0

Additive manufacturing

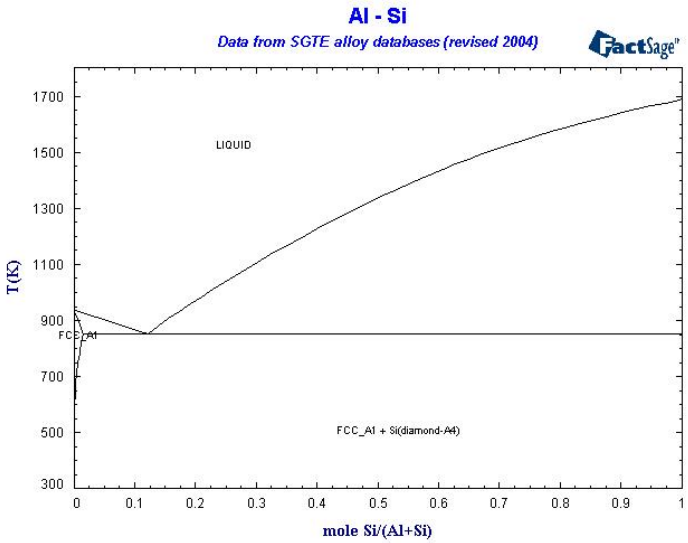
Available: immediately Supervisors: A.Castellero; M.Baricco

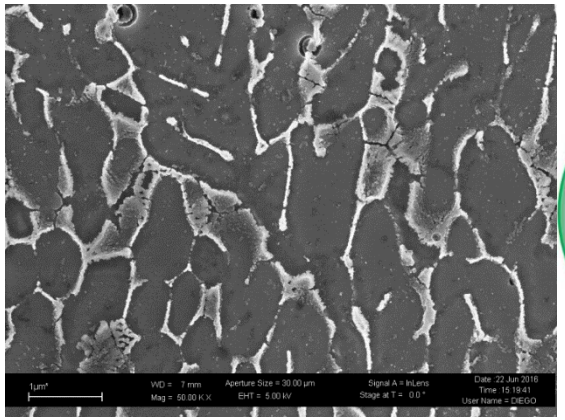


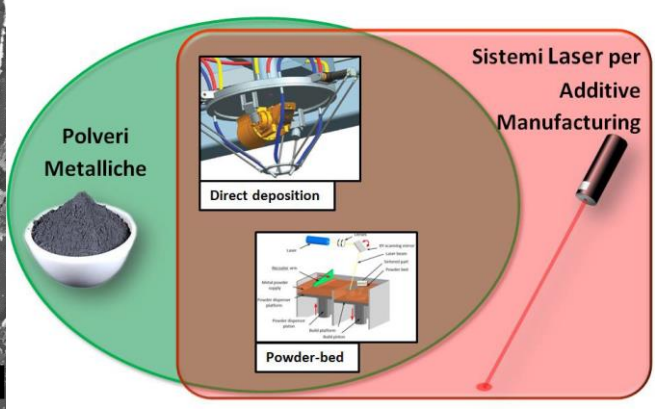
DESCRIPTION: 3D printing is a new production method that allows an highly customized production, minimizing stock and components weight reduction

OBJECTIVES: Studies on the influence of process conditions: **1)** Phase selection (non-equilibrium phase diagram calculations) **2)** Microstructures, **3)** Mechanical properties

APPROACHES: Simulation of additive manufacturing processes by rapid solidification of alloys. Synthesis of alloys, characterisation by XRD, SEM, TEM, EDS, EBSD, DSC, mechanical properties.







Advanced sensors and antibacterial surfaces

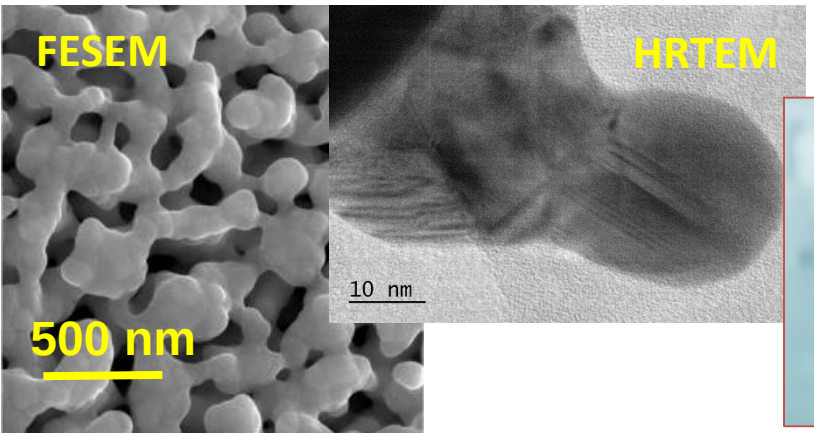
BIOREMIA H2020 Project: https://www.bioremia.eu/
BINGO project *financed by Compagnia di San Paolo*

Available immediately
Supervisors: P.Rizzi, F.Scaglione

DESCRIPTION: **Nanoporous metals** are a new class of materials characterised by an high surface area and advanced optical and catalytic properties. The design of the size and morphology of ligaments and pores, by which the material is constituted, enables to access peculiar properties for biosensors, catalysis, antibacterial applications.

OBJECTIVES: i) design of Au nanoporous metals starting from metastable precursors (Au-Fe, Au amorphous alloys)**; ii)** study of mechanism and kinetics of de-alloying, ligament morphology formation; **iii)** design of Ti/TiO_2 nanoporous metals for antibacterial applications

APPROACHES: Alloy synthesis, dealloying techniques (free corrosion, electrochemical dealloying), structural and microstructural characterisation (SEM, TEM, EDS, XRD, EBSD), calorimetry, electrochemistry, SERS, Raman. Work done in collaboration with PhD students.



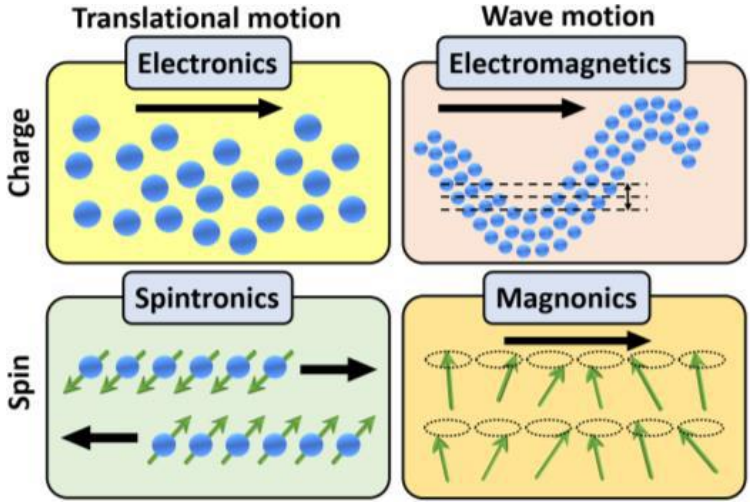
Magnetoelectric materials

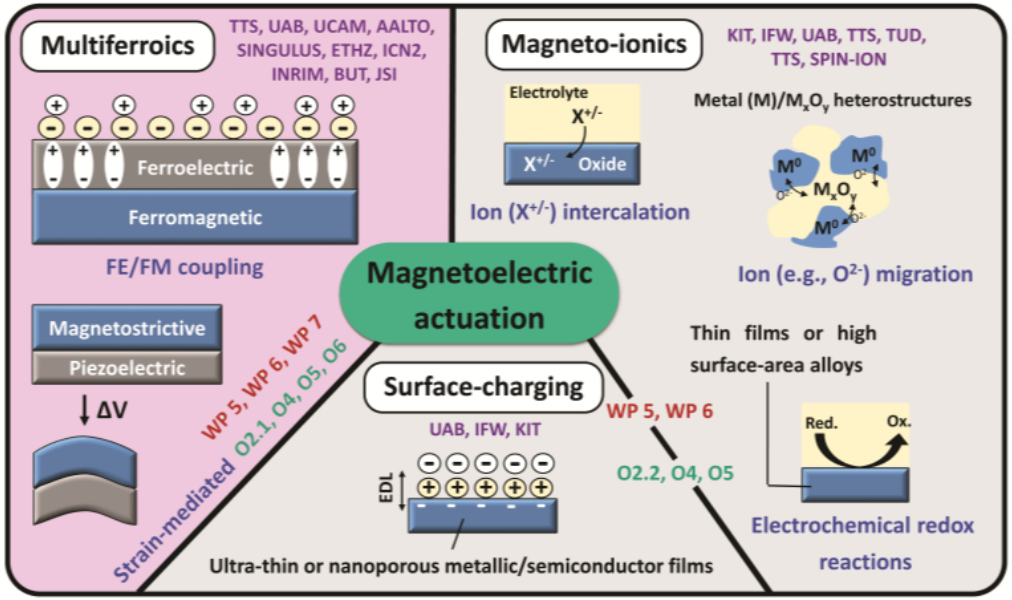
BeMagic H2020 Project: https://bemagic-etn.eu/

Available immediately
Supervisors: P.Rizzi
in collaboration with INRIM

OBJECTIVES: To develop new classes of energy-efficient spintronic devices for data storage systems **1)** Growth of multiferroic structures by sputtering using top-down and bottom-up nanolithography to obtain small disks and other sub-micrometric geometries; **2)** assessment of the magnetization properties

APPROACHES: Alloy synthesis by physical techniques, structural and microstructural characterisation (SEM, TEM, EDS, XRD, EBSD), measurement of magnetic properties. Work done in collaboration with a PhD student.





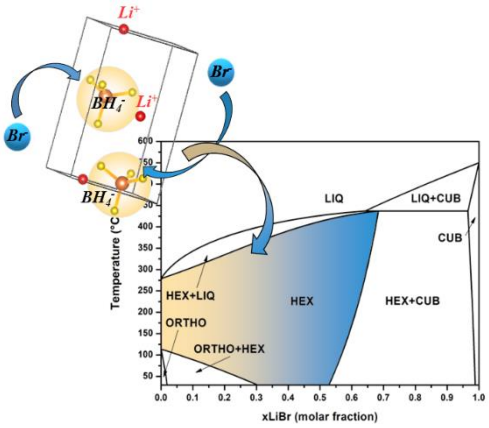
Modelling of metallic materials and materials for energy

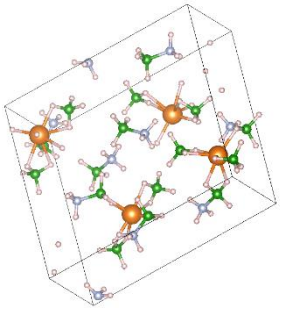
Available: immediately Supervisors: M.Palumbo

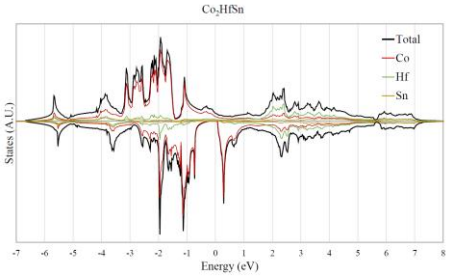
DESCRIPTION: material modelling has become an essential tool for understanding and predicting material characteristics and properties, and for the development of new materials and processes in a shorter time and at a lower cost. From a "multiscal" perspective, modelling can take place starting from fundamental models on atomic scales and then scaling up to macroscopic systems and properties.

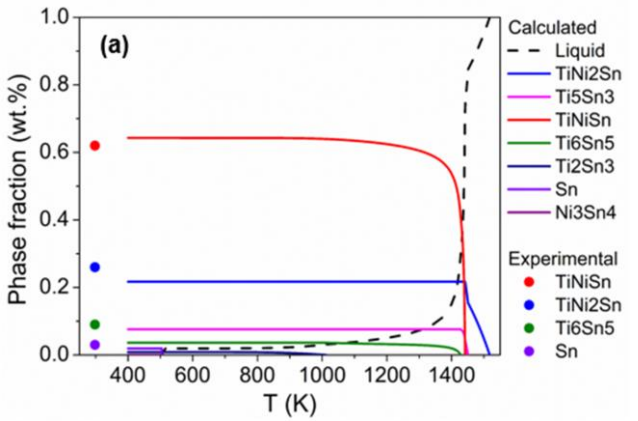
OBJECTIVES: i) quantum mechanics methods based on Density Functional Theory (DFT) for the determination of materials properties **ii) simulation of phase transformation iii)** development of **thermodynamic databases and calculation of phase diagrams** by CALPHAD method **iv)** development and applications of **machine learning** models for materials

APPROACHES: Plane-Wave DFT (VASP, Quantum Espresso), CALPHAD method with ThermoCalc and Pandat software, machine learning with Python, Scikit-Learn and Tensorflow







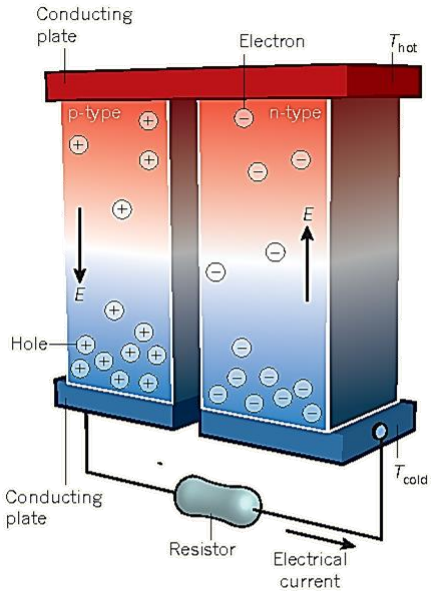


Thermoelectric materials for waste heat harvesting

Project *financed by Compagnia di San Paolo*

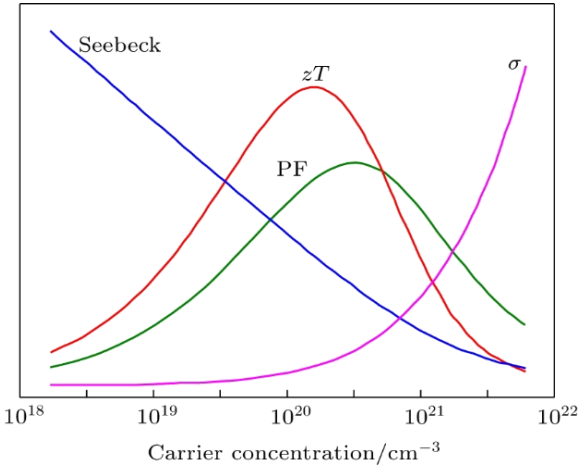
Supervisor: Alberto Castellero

Available: immediately



DESCRIPTION Waste heat from industrial processes, automotive exhaust, domestic appliances can be converted to electricity through Seebeck effect. Thermoelectric generators (TEGs) are based on semiconductors with optimized figure of merit ZT

$$\uparrow ZT = \frac{\alpha^2 \sigma T}{\kappa_{el} + \kappa_{ph}} \uparrow \downarrow$$



OBJECTIVES

- Doping control for adjusting carrier concentration and optimizing power factor ($\alpha^2\sigma$).
- Microstructure refinement to decouple electronic (κ_{el}) and lattice thermal conductivity (κ_{ph})

APPROACHES

- Use of non equilibrium metallurgical processing routes (rapid solidification and mechanical alloying) to favour microstructural refinement.
- Correlation between process, structure, microstructure and properties.

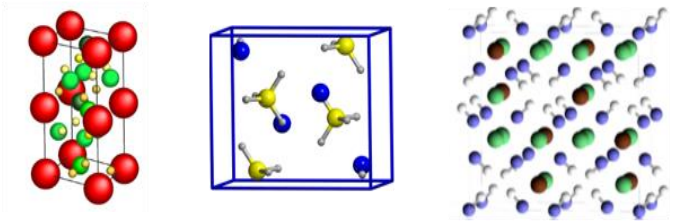
Energy storage from renewable sources

HyCARE H2020 project https://hycare-project.eu/

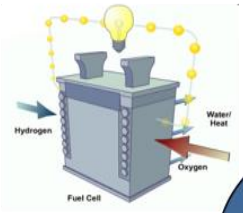
Fuel Cells and Hydrogen Joint Undertaking; Regione Piemonte

Available: immediately
Supervisors: M.Baricco, P.Rizzi

OBJECTIVES: 1) development of new materials and processes to optimize the storage of hydrogen as an energy carrier for stationary and mobile applications; **2)** Solid state hydrogen storage from renewable sources; **3)** Integration with hydrogen fuel cells; **4)** integration with Phase Change Materials (PCM)



Hydrogen storage and compression



APPROACHES: Development of advanced materials: complex hydrides and intermetallics with high H_2 gravimetric density. Study of: phase transformation; non-equilibrium phase diagram calculations; Life Cycle Analisys (LCA). Work done in collaboration with PhD students.