Metallic Materials Group
Chemistry Department

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http://momo.ch.unito.it

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

Additive manufacturing

Nanoporous metals

Thermophysical properties of advanced metallic materials

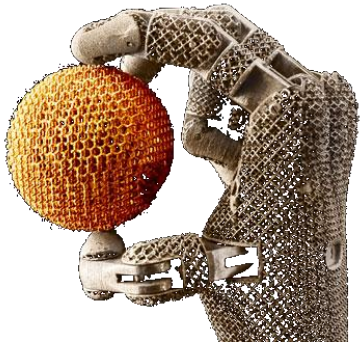
Energy storage and energy harvesting

Energy storage from renewable sources

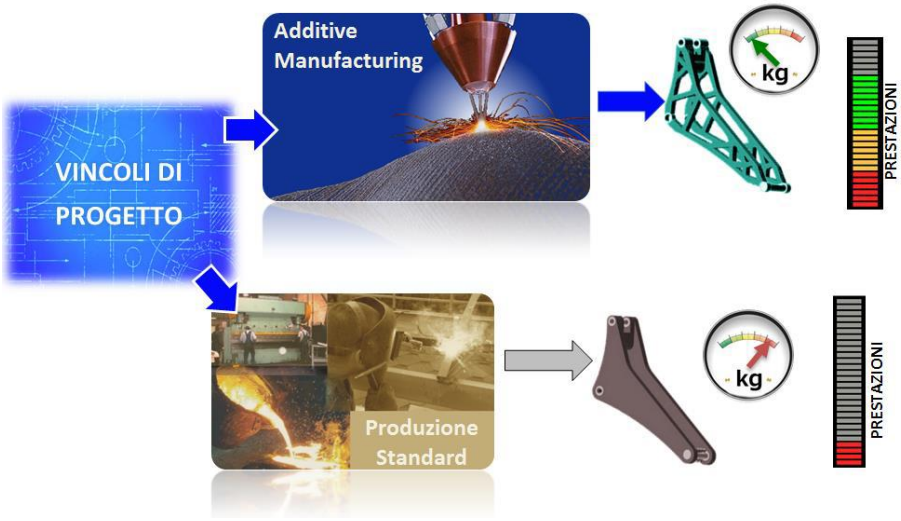
Thermal energy harvesting: thermoelectric materials

Additive manufacturing

Industry 4.0: new production methods

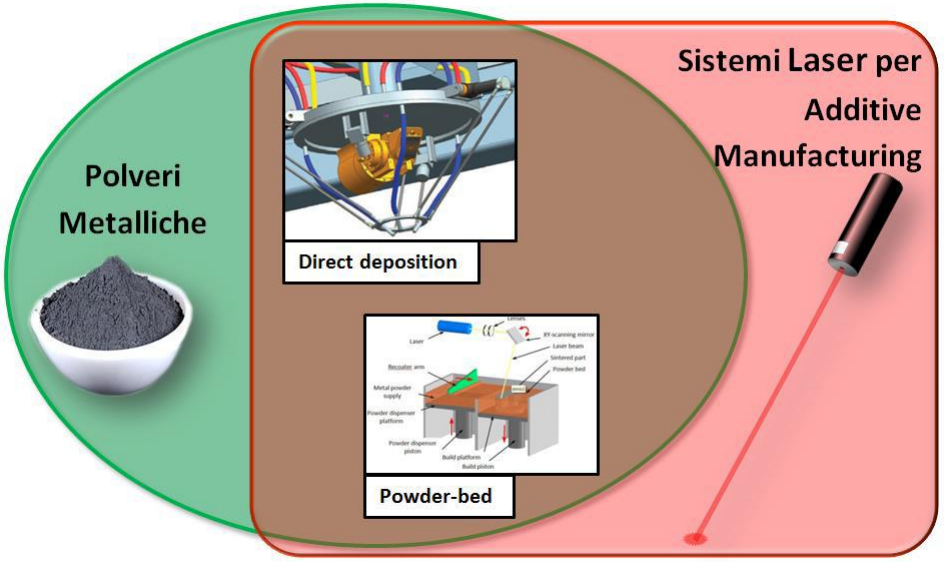


STAMP project financed by *Regione Piemonte*



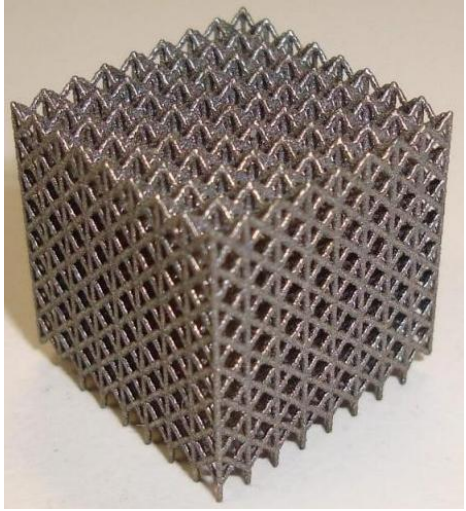
- highly customized production
- minimizing stock
- components weigth reduction

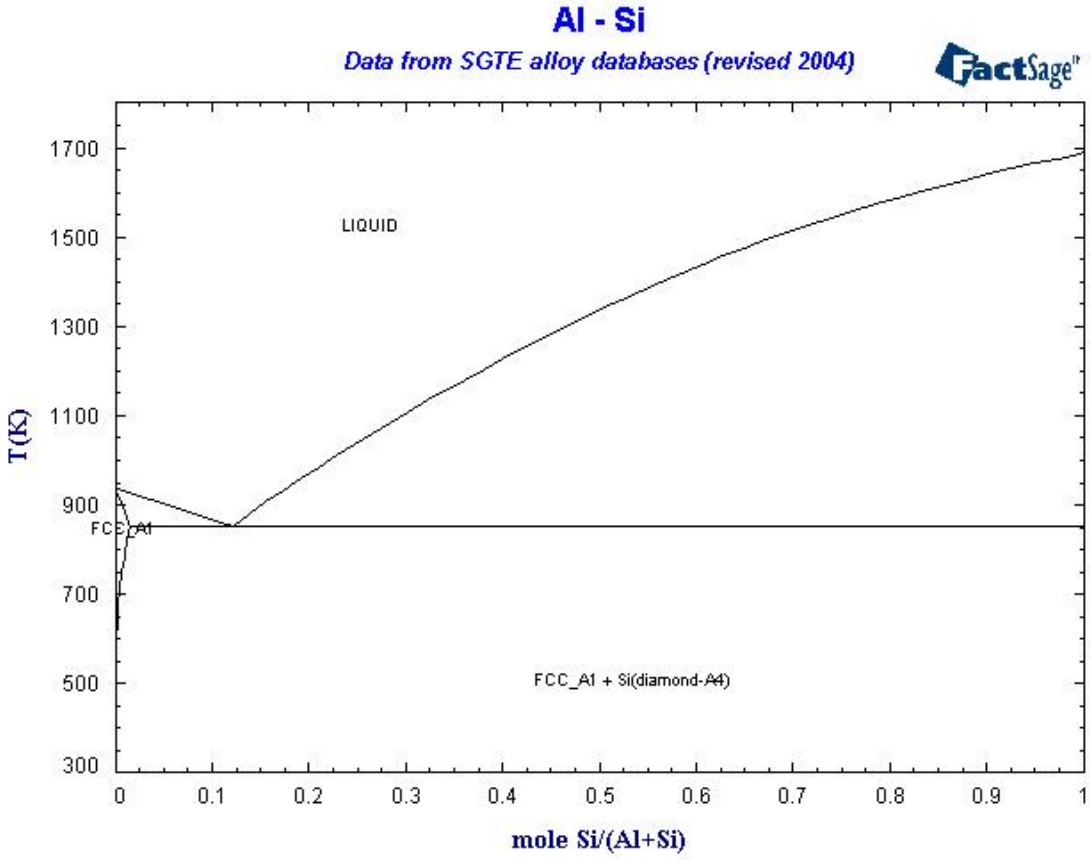
Laser melting of metal powders using a CAD design

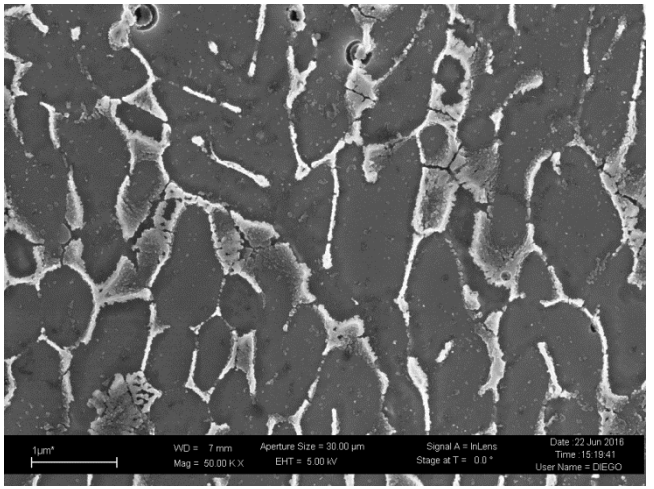


Studies on the influence of process conditions:

- Phase selection (non-equilibrium phase diagram calculations)
- Microstructures
- Mechanical properties







Advanced sensors and catalysts: nanoporous Au

VitriMetTech project , *FP7-PEOPLE-2013-ITN – Marie-Curie Action*
BINGO project *financed by Compagnia di San Paolo*

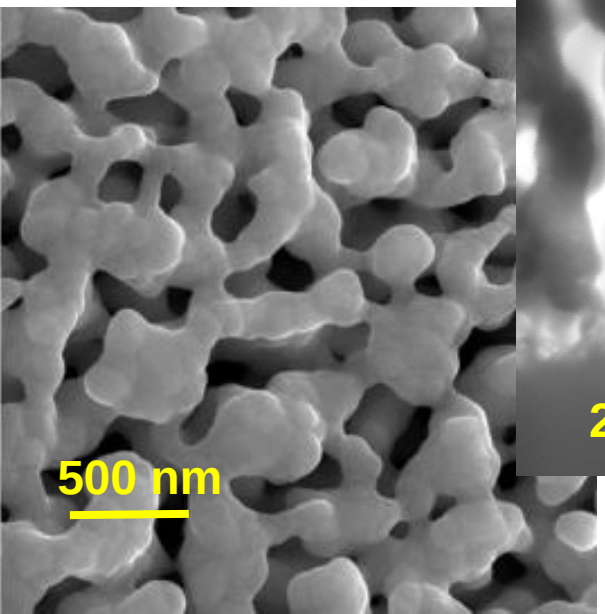
De-alloying of Au based alloys:

a) Crystallines
b) Amorphous

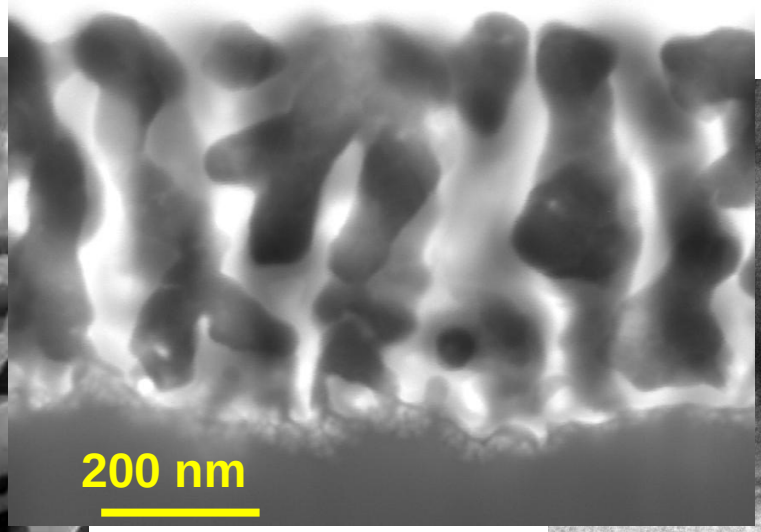
→ nanoporous Au (NPG)

Study of: mechanism and kinetics of de-alloying, ligament morphology

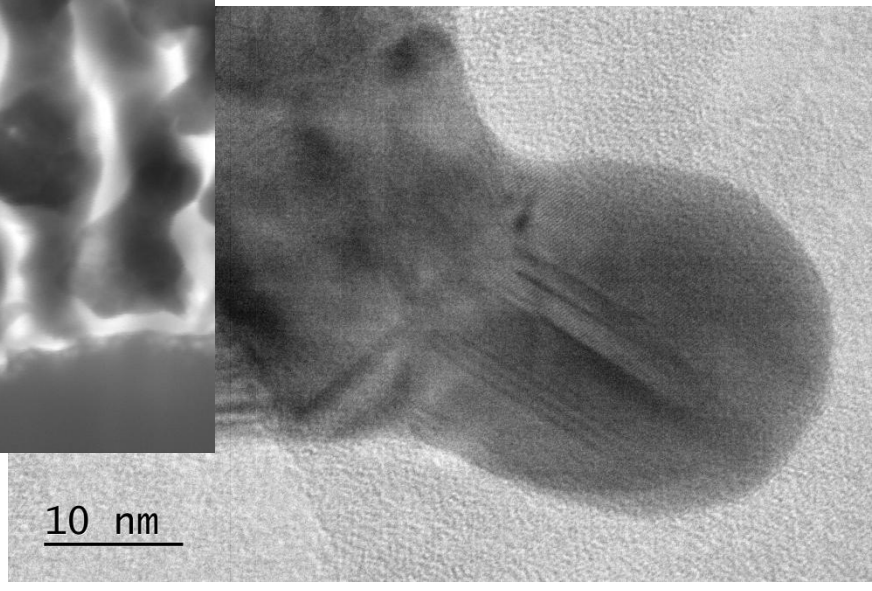
FESEM



STEM

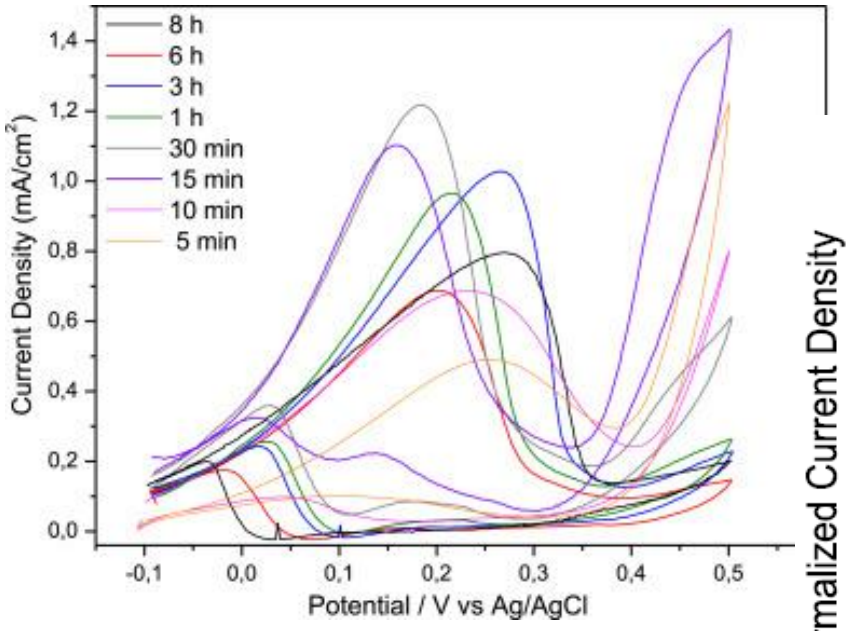


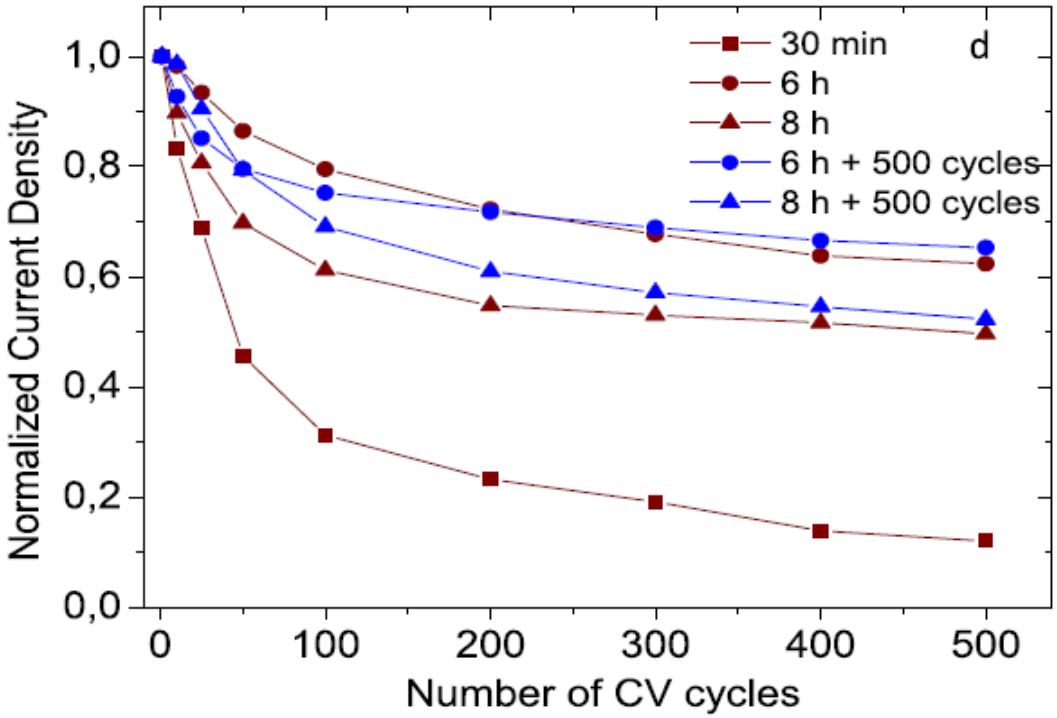
HRTEM



Electrocatalysis: methanol oxidation
Methanol Fuel Cell for energy production

- Effect of de-alloying time on current density
- Effect of number of cycles on current density

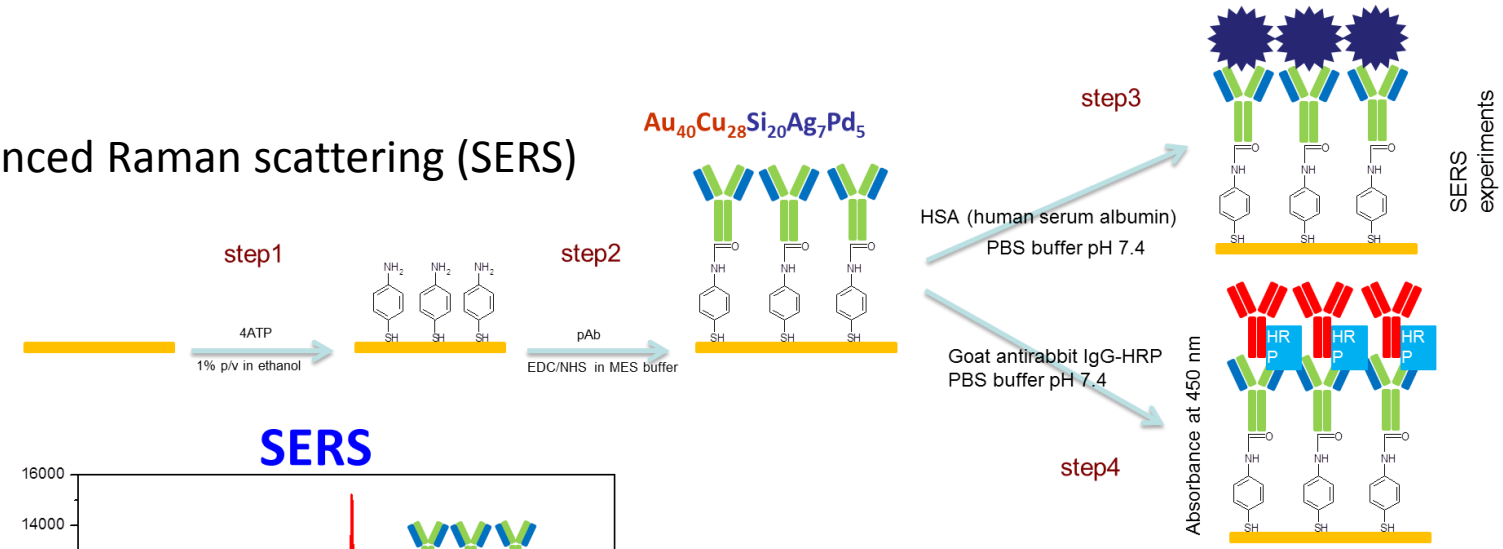


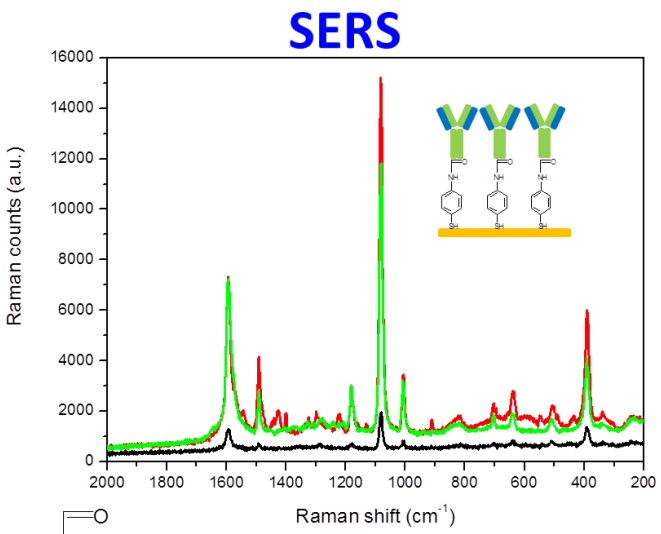


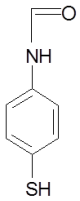
NPG functionalization

Sensors for the detection of proteins/molecules in low concentration for: Point of care, airports (detection of explosives), weareable sensors

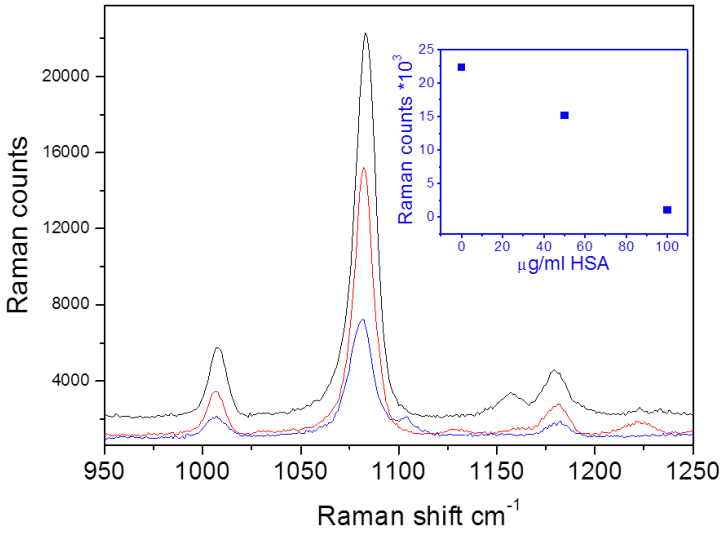
Surface enhanced Raman scattering (SERS)







1082 cm^{-1} = C-S stretching vibrations
With an increase in the HAS concentration the Raman intensity decreases



Thermophysical properties of advanced metallic materials

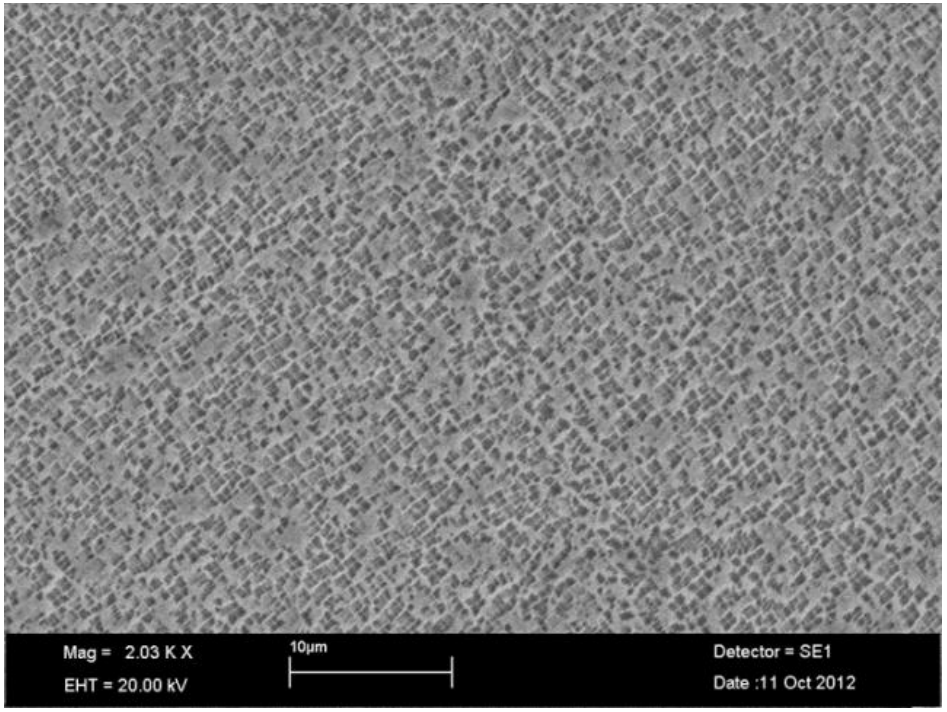
Project financed by *European Space Agency*

Studies of advanced metallic materials

Superalloys

High Entropy Alloys (HEA)

Metallic glasses



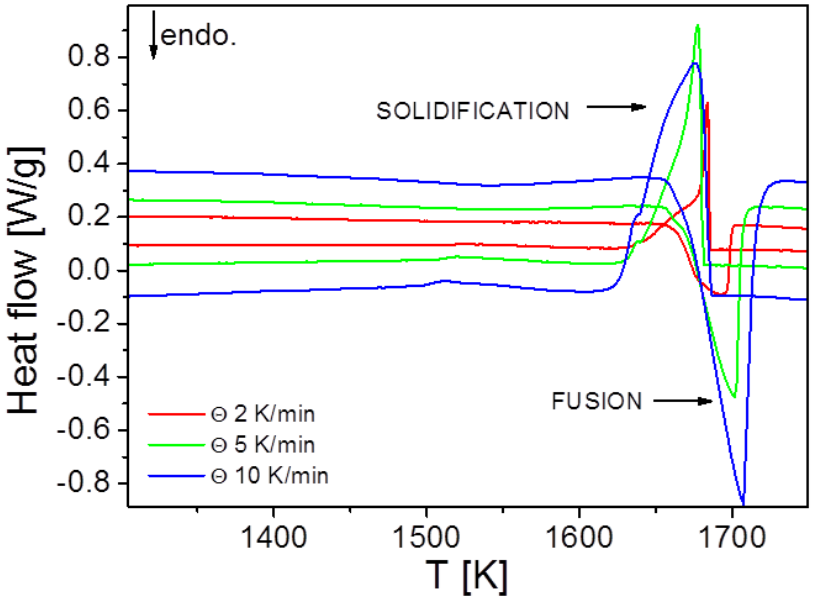
Goals

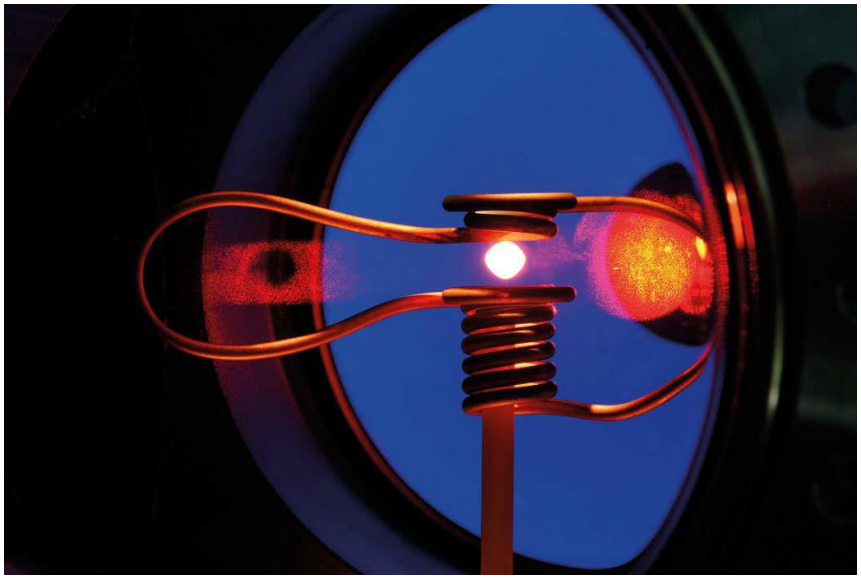
Measurement of:

- Specific heat
- Melting entalpies
- Range of melting and solidification

Study of:

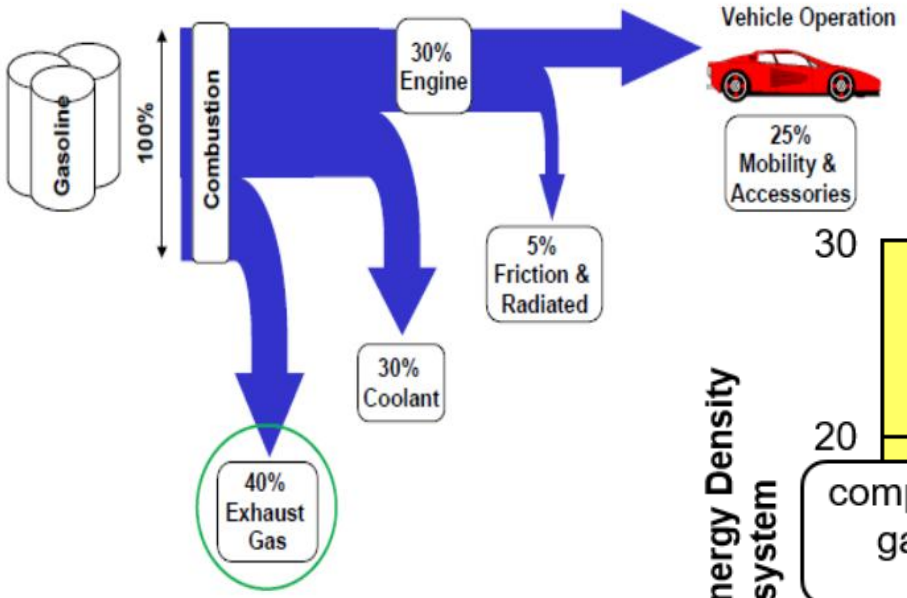
- Containerless solidification
- Liquid undercooling

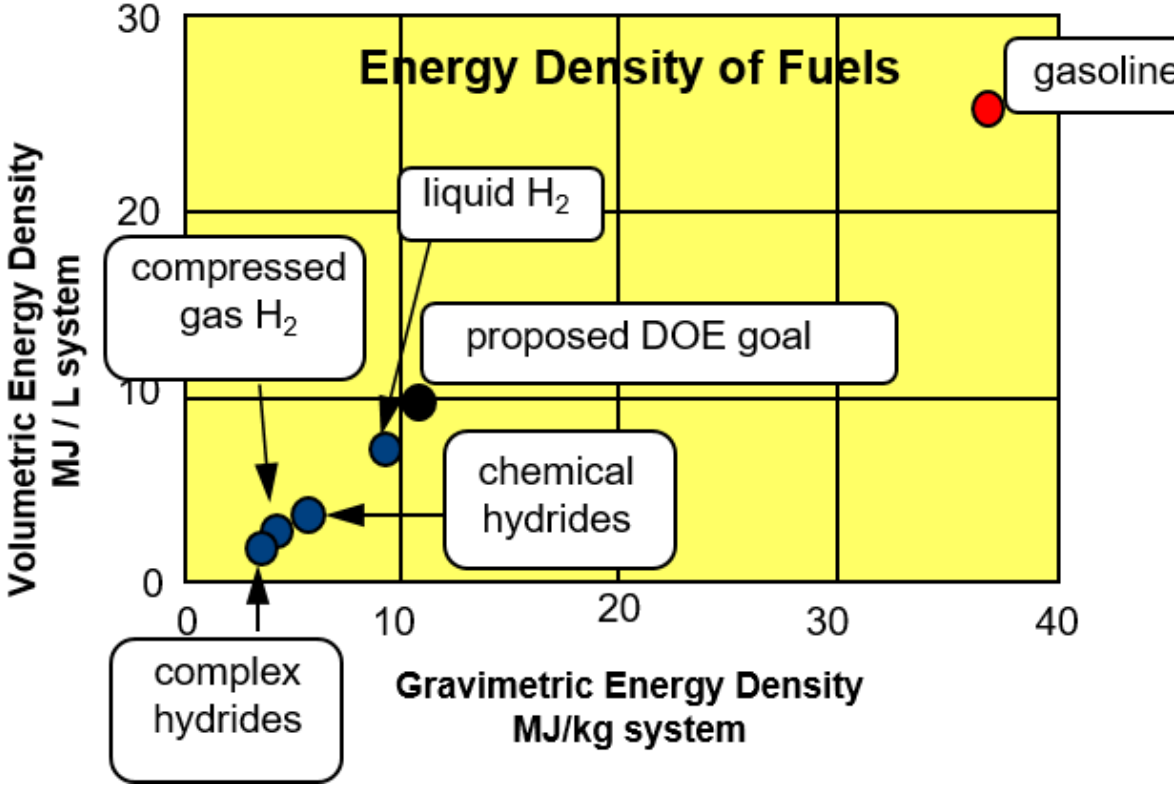




Comparison of data obtained with experiments made on space station

Energy storage and energy harvesting

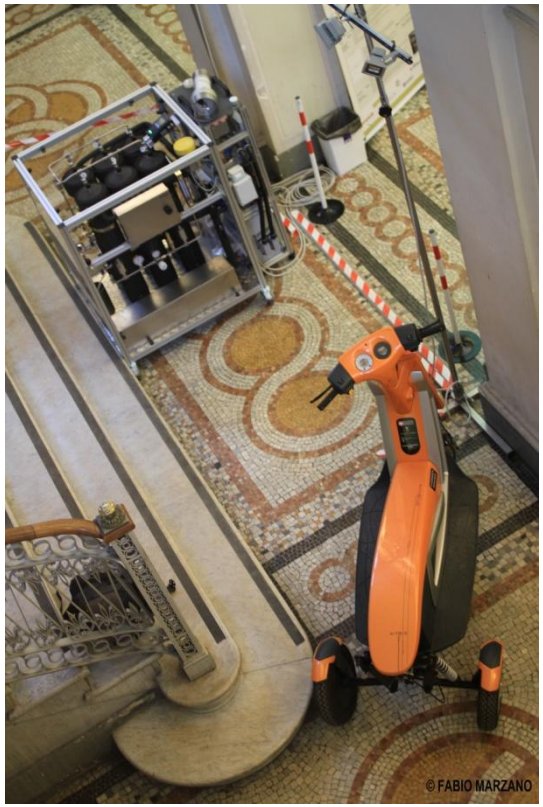




- hydrogen technologies
- thermal energy harvesting
- development of new materials and processes
- energy storage from renewable sources

Energy storage from renewable sources

Need to optimize the storage of hydrogen as an energy carrier for stationary and mobile applications



JRC EUROPEAN COMMISSION · TECNODELTA · KIT Karlsruhe Institute of Technology · FIAT GROUP · CRF CENTRO RICERCHE FIAT · DLR · Sertenergy · nis Nanostructured Interfaces and Surfaces · IFE

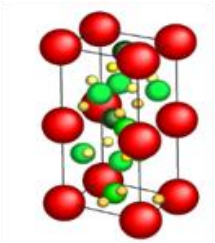
APU installed on IVECO Daily

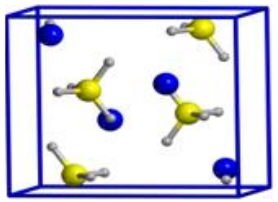
Mobile applications: hydrogen storage

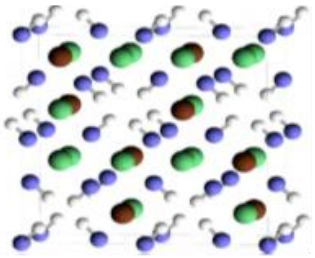
Scientific goals:

Solid state hydrogen storage

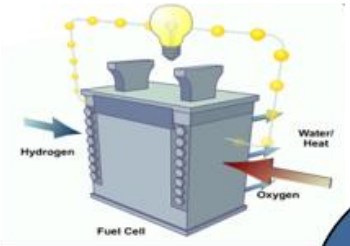
Integration with hydrogen fuel cells







LaNi5H7 LiBH4 Li2Mg(NH)2

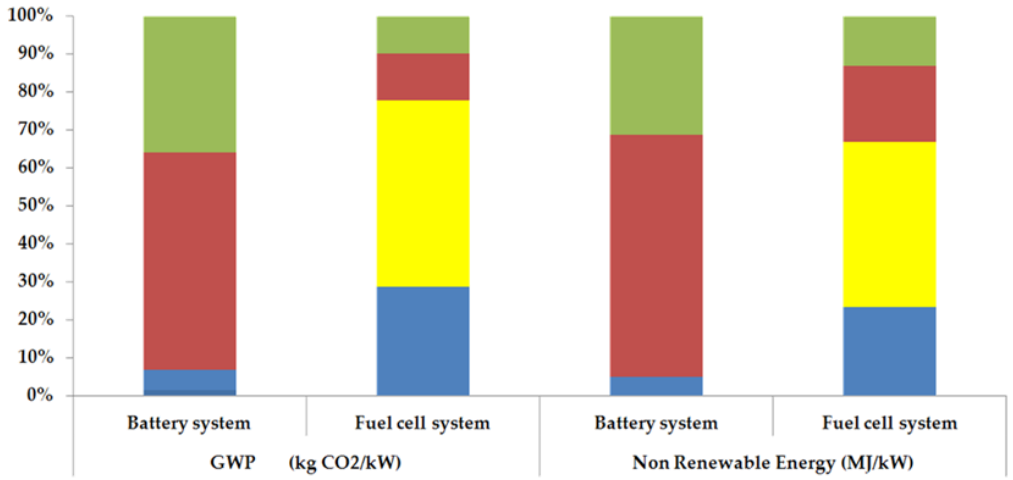


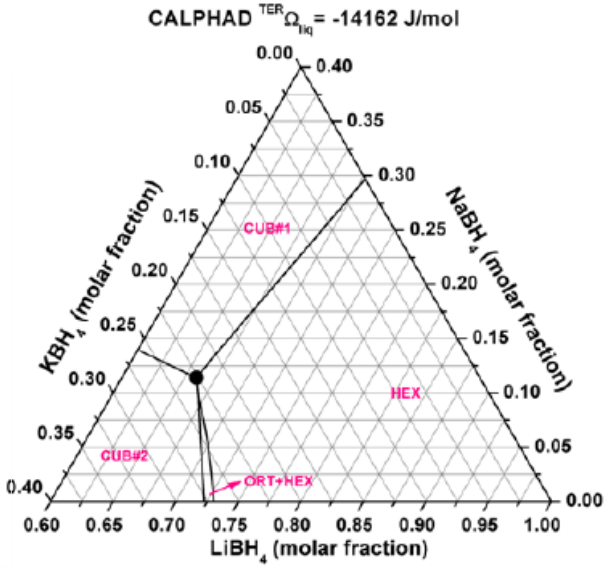
Project financed by :
Fuel Cells and Hydrogen Joint Undertaking; Regione Piemonte

Development of advanced materials

Complex hydrides and intermetallics with high H2 gravimetric density:

- Phase transformation
- non-equilibrium phase diagram calculations
- Life Cycle Analisys (LCA)





Thermal energy harvesting: thermoelectric materials

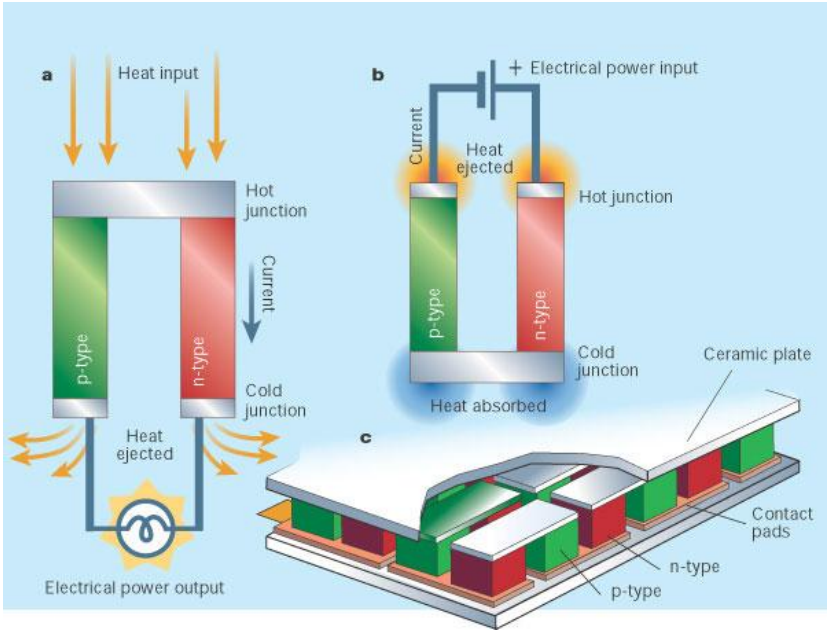
Project financed by *Fondazione Cassa di Risparmio di Torino*

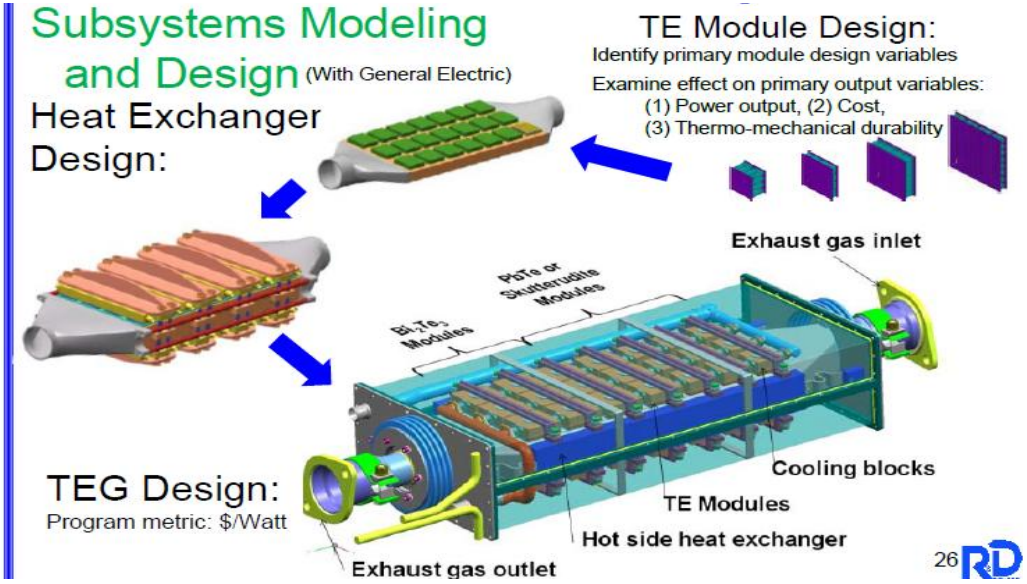
Conversion of thermal energy in electric energy

✓**Seebeck effect (thermic -> electric)**

$$\Delta V = \alpha \Delta T$$

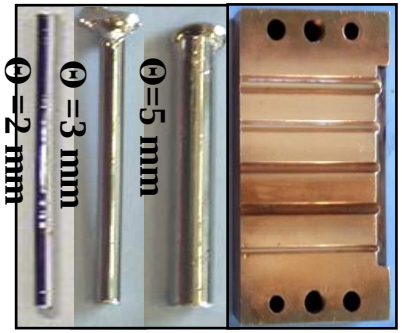
✓**Peltier effect**

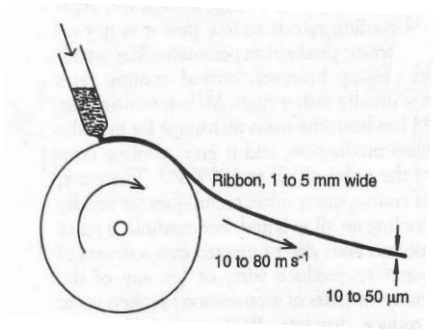




Synthesis of materials

Melting techniques





Soldification rate

Thermod. equilibrium → **Metastable Conditions**

Powder sintering

Electro Sinter Forging (ESF)

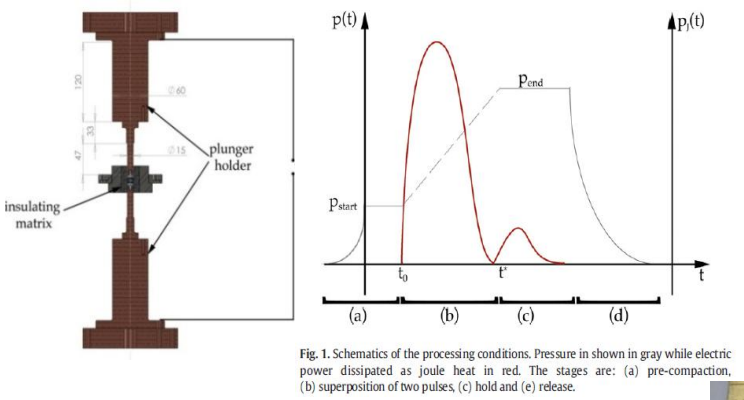
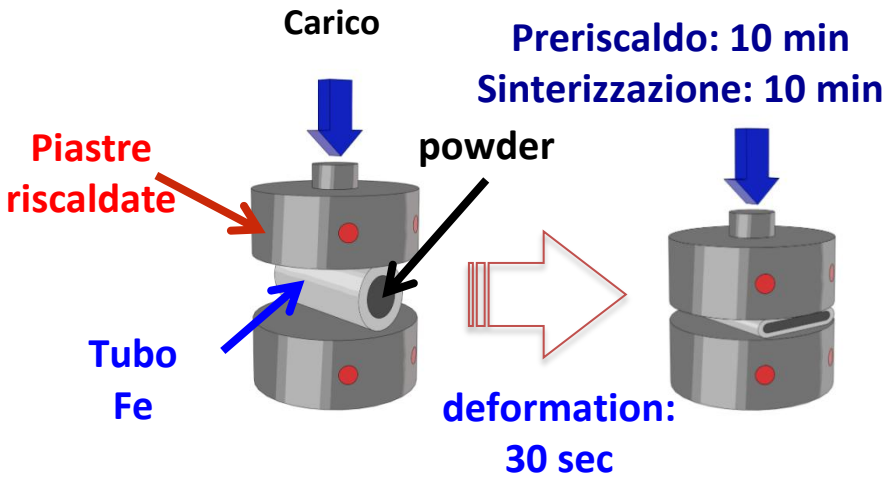


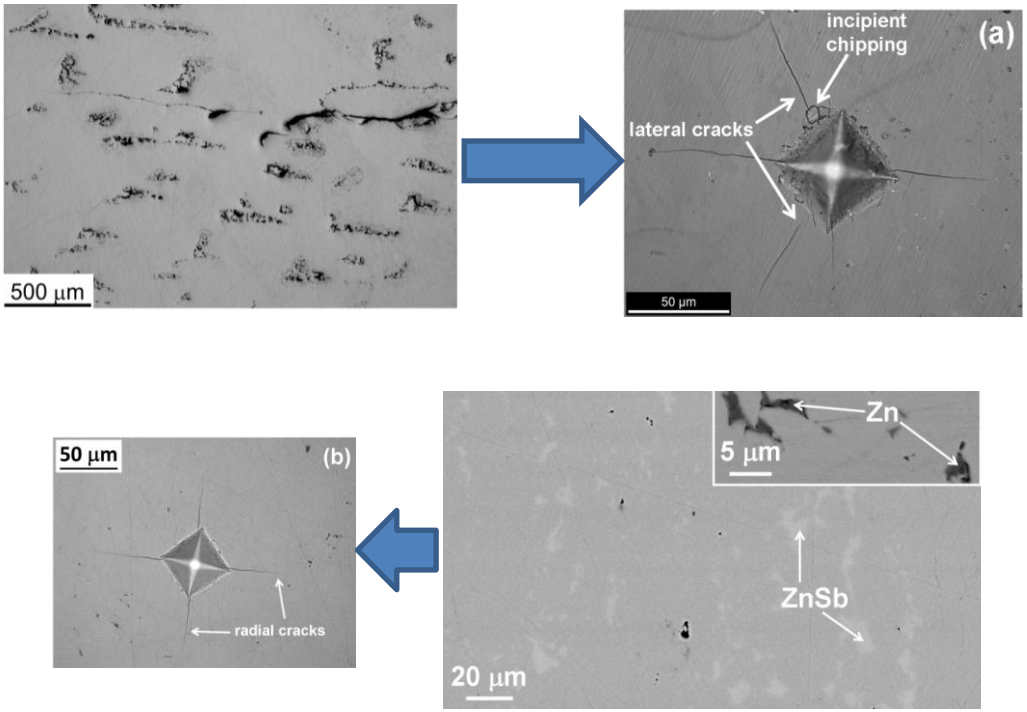
Fig. 1. Schematics of the processing conditions. Pressure in shown in gray while electric power dissipated as joule heat in red. The stages are: (a) pre-compaction, (b) superposition of two pulses, (c) hold and (e) release.

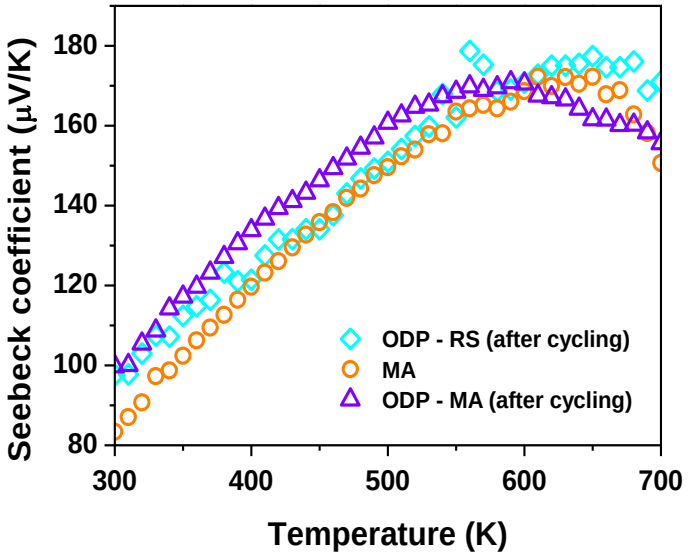
Process time 0.1 s

Open Die Pressing (ODP)

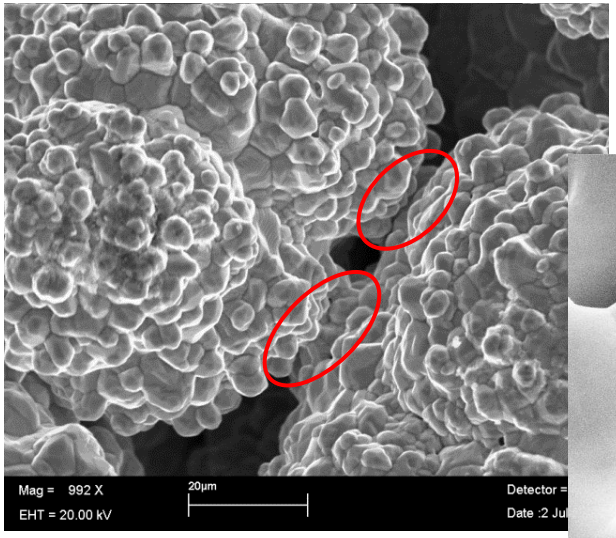


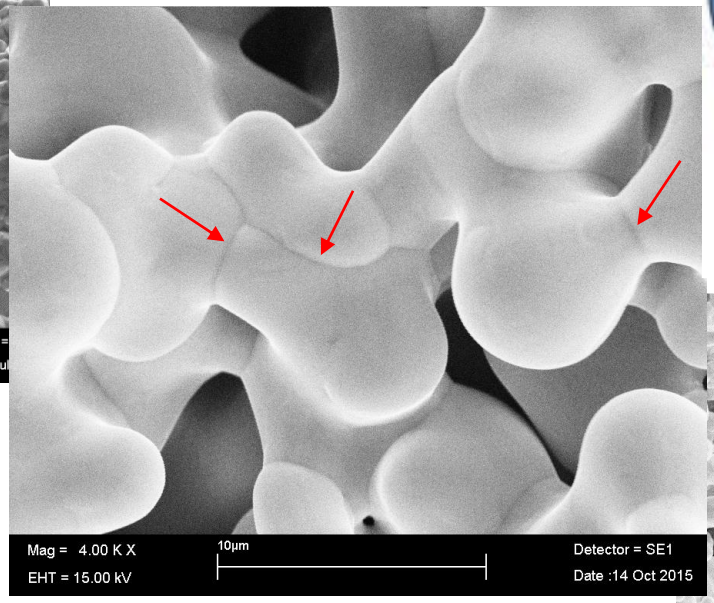
Effect of syntering on mechanical and thermoelectric properties of Zn_4Sb_3

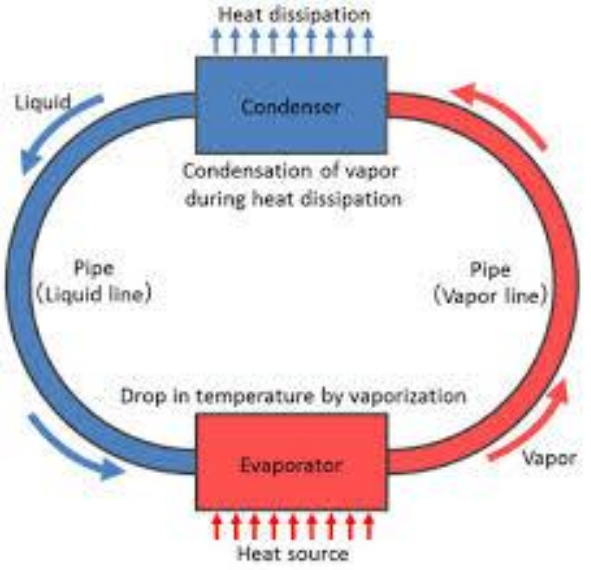


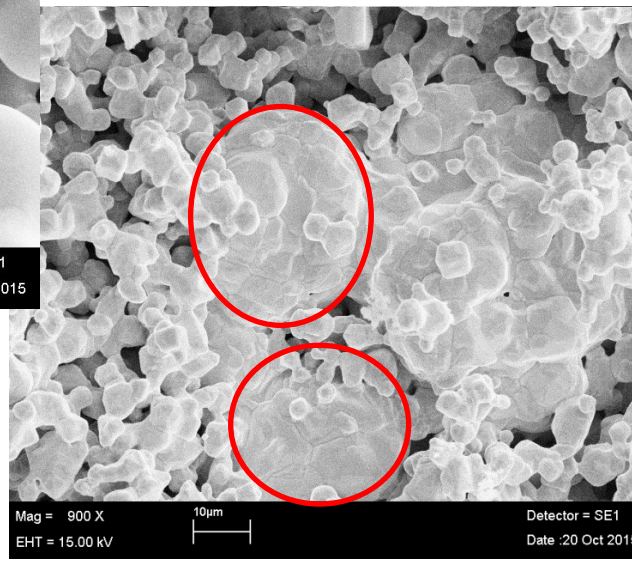


Possible thesis: wick for heat pipe









The wick is one of the pricipal components in an heat excanger (loop heat pipe), that allows the heat transfer from a warm area (evaporator) to a cold area (condenser)

Powder sintering in collaboration with Argotec

Regional project to be financed