



University of Bologna

CIRI –MAM

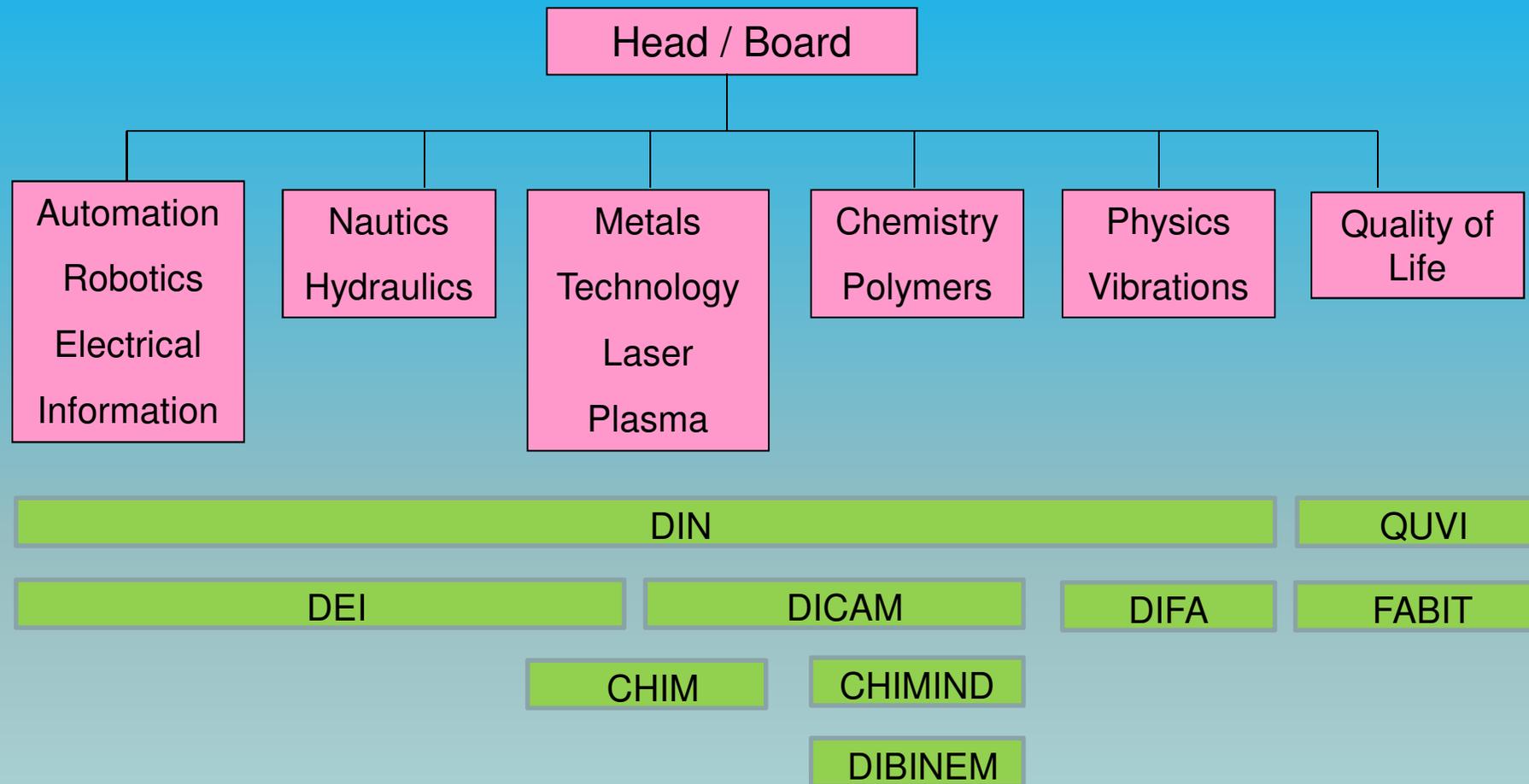
Advanced Applications in Mechanical Engineering and Materials Technology

Director: Prof. Luca Tomesani
Vice: Prof. Claudio Rossi



COSTRUIAMO INSIEME IL FUTURO

SCIENTIFIC STRUCTURE AND DEPARTMENTS



- 60 Full time researchers
- 140 Academics from 12 departments
- 400 Research contracts in 5 years
- 20 M€ net income
- European Projects
- International partnerships
- 2 High-Tech Start-up companies
- 2 Laboratories inside private companies

CIRI MAM IN EMILIA ROMAGNA



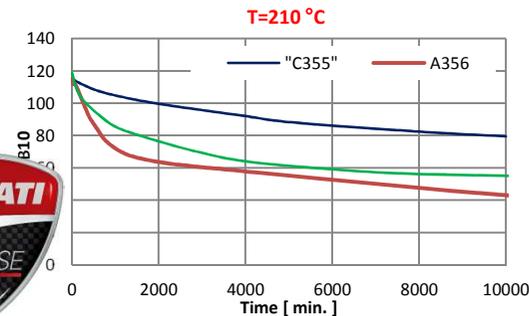
UO1 Automation
UO3 Materials and technologies
UO5 Physics and Vibration

UO2
Nautics

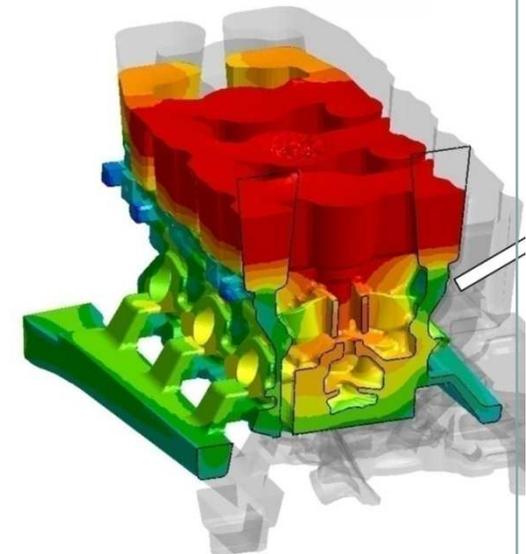
UO4
Polymers

UO6
Quality of Life

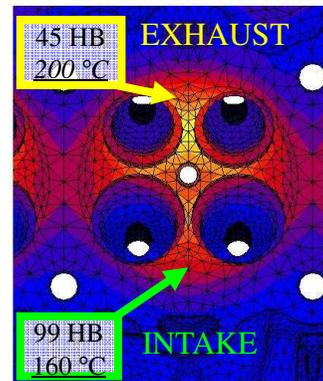
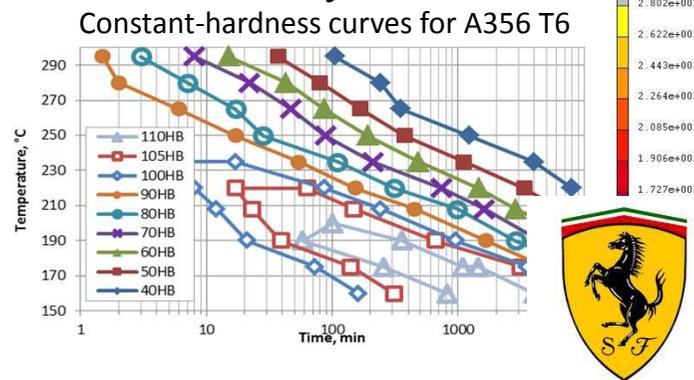
- Aluminium alloys for high temperature applications reinforced with nanodispersoids



- Hybrid
- Graphene – Al alloy castings for high conductivity applications (FP7 NMP Project)

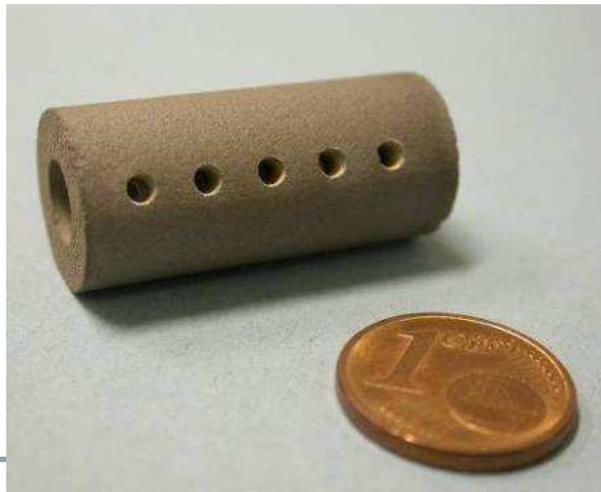


- Foundry and heat treatment optimization of cast aluminium alloys

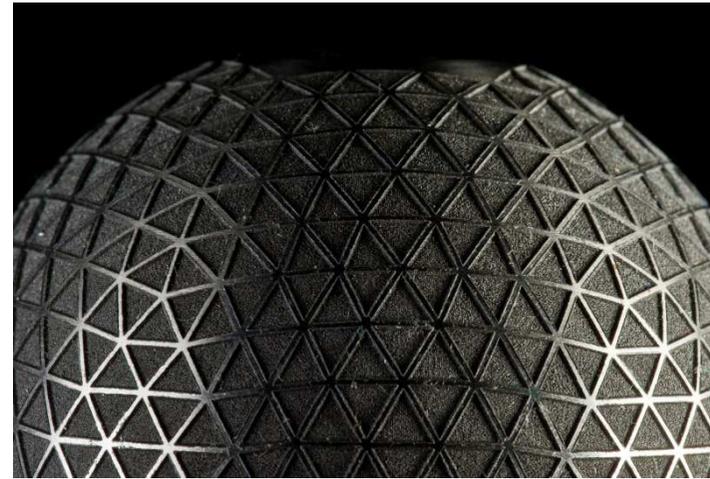


Laser Manufacturing

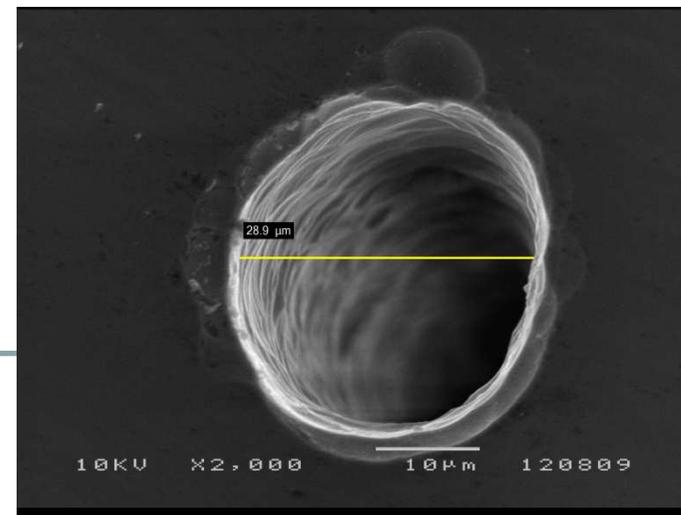
- A wide number of Laser processing technologies are developed in the high power, micro and nano size



Micromachining

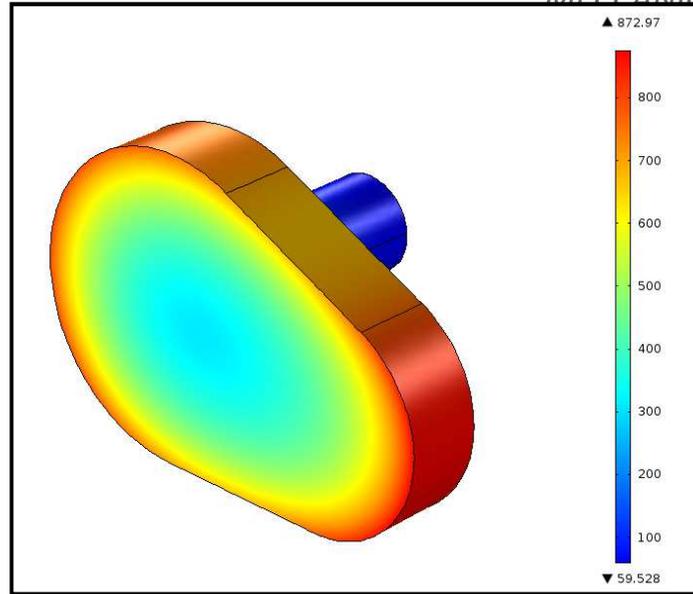


Fine surface Sculpturing

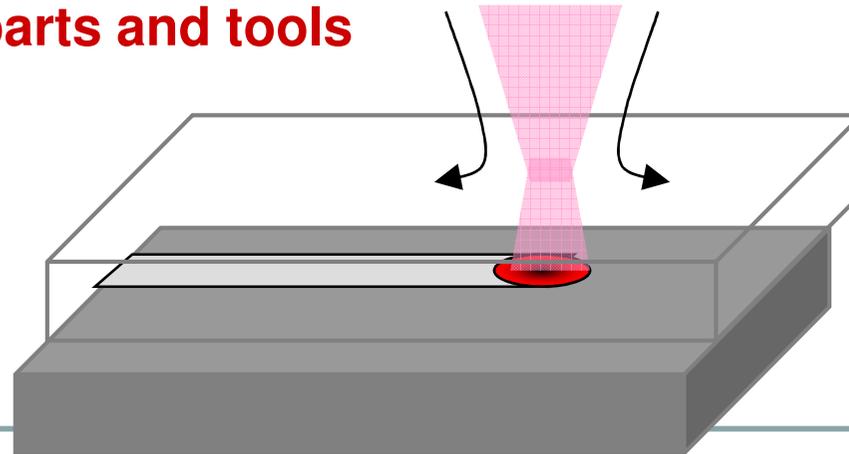


Waveguides on glasses

ADVANCED MANUFACTURING



**Direct Laser Hardening on
finished parts and tools**

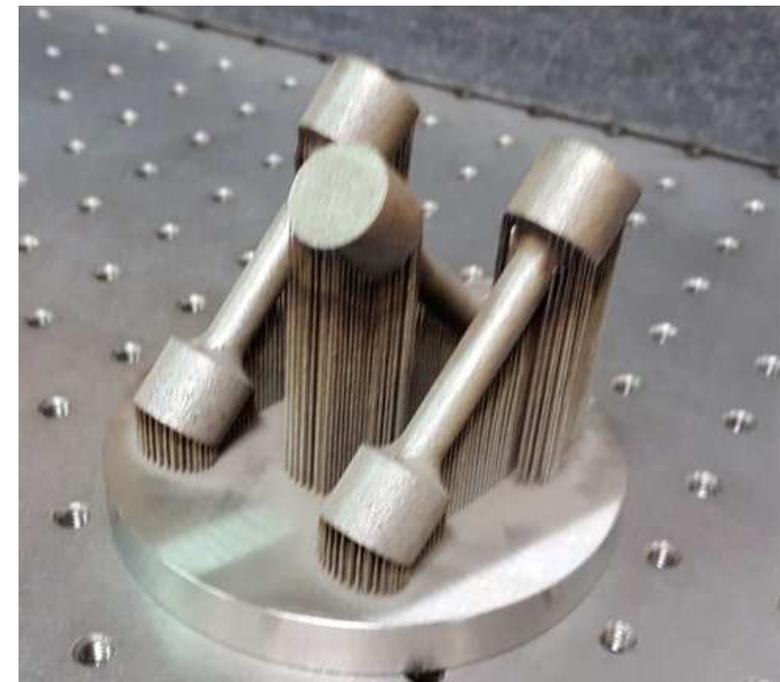


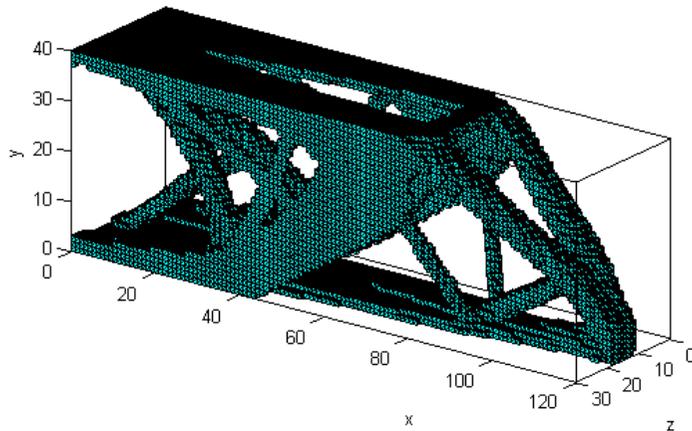
**Metal-Polymer
welding**

(PA, PET, PC, PP) + (AISI304, Al5182, Ti, Steel)

Additive Manufacturing

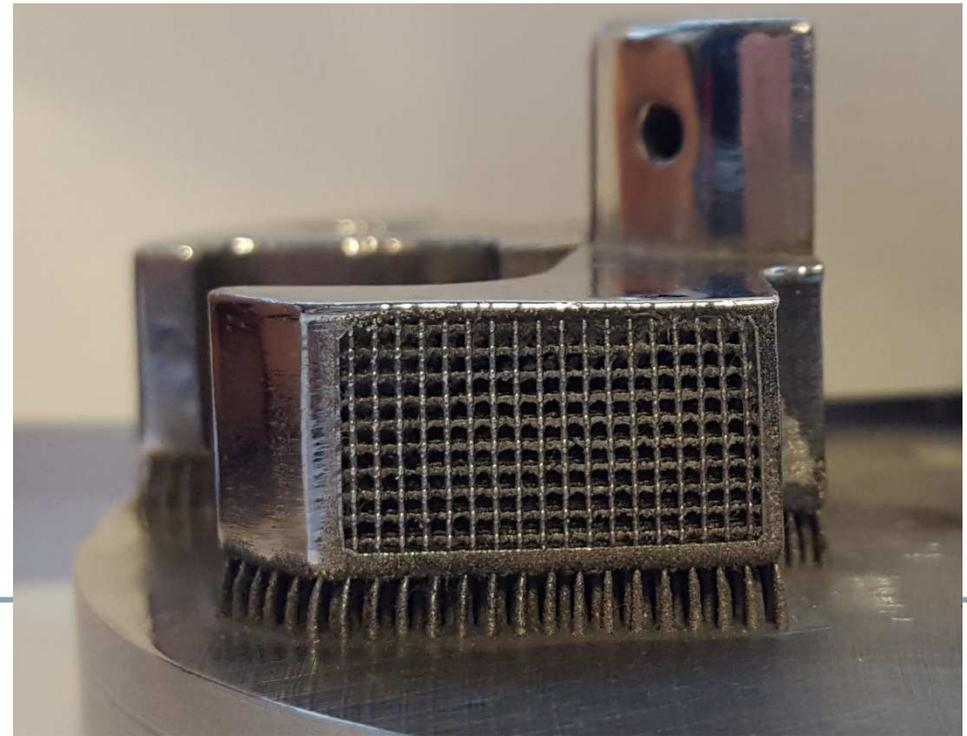
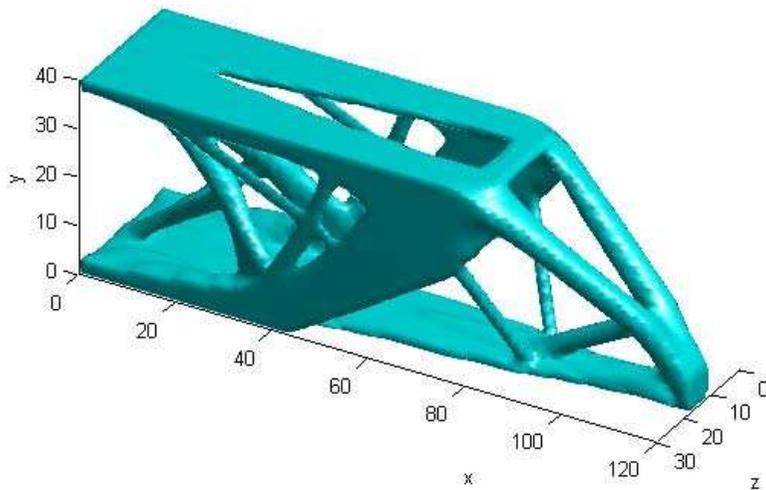
- **MATERIALS:** Metals, Alloys, MMC, Polymers, Composites
- **TECHNOLOGIES:** SLM, Cladding, FDM, SLA, Hybrid
- Development of process parameters for new materials and compositions
- Development of cladding technology for variable chemical composition within a component
- Manufacturing of hybrid components Metal-CFRP (Europe Vanguard Network)





Development of ultra-light components

- by topology optimization
- by cellular structures



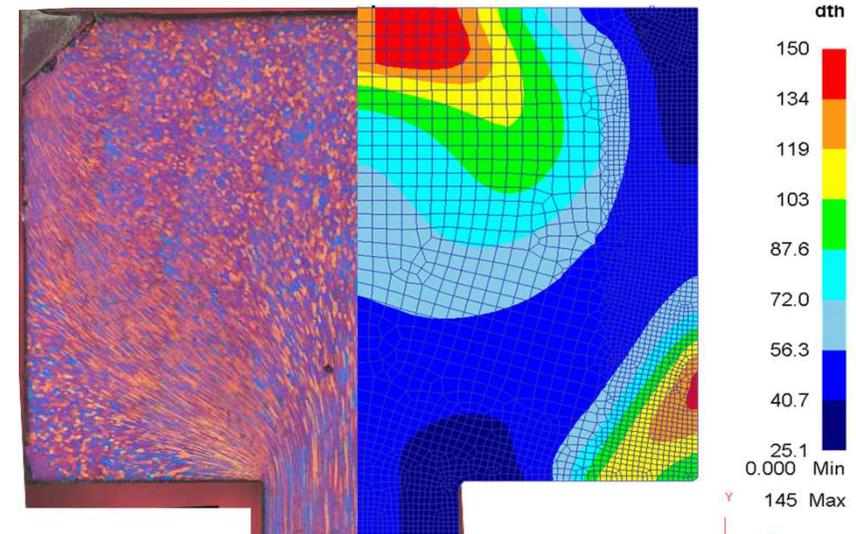
Additive manufacturing application

Complete 3DP
reconstruction of
knee, tibia and
Femur

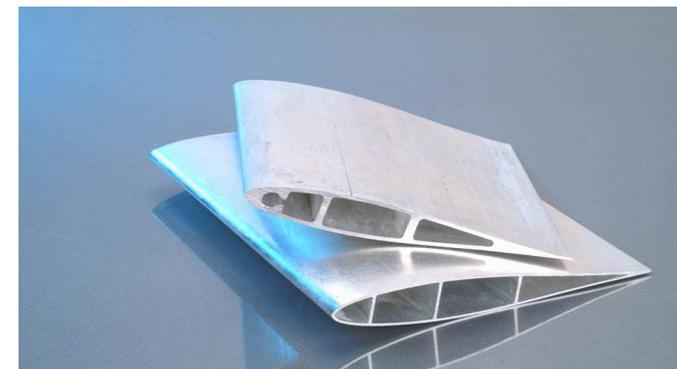


Metal forming

- Material Characterization
- Process Simulation
- Microstructure Evolution
- Solid State Welding
- Dies and Tools: Temperature, Stresses, Strains, Damage



Simulation of microstructure evolution



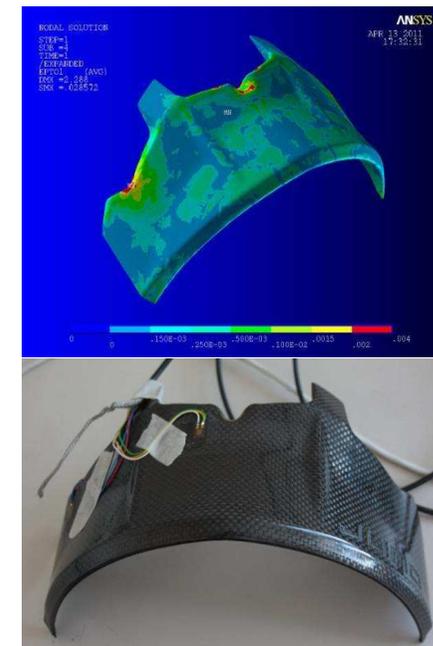
Extruded magnesium blades

Composites

- Lightweight component design and production procedures
- Crashworthiness and Impact Evaluation
- Adhesive joints
- Sandwich Structures: design, optimization, fabrication
- Hybrid Components (Ti-CFRP)
- High damping materials
- Embedding sensors and Bragg fibers for strain and damage evaluation
- Hydroelastic Slamming simulation



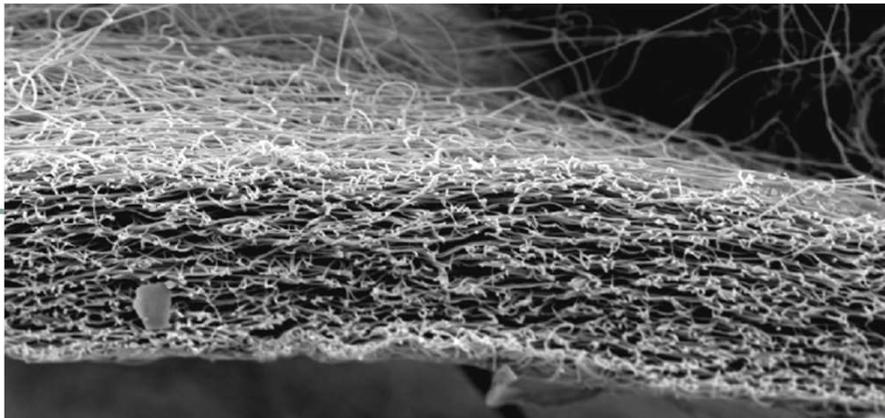
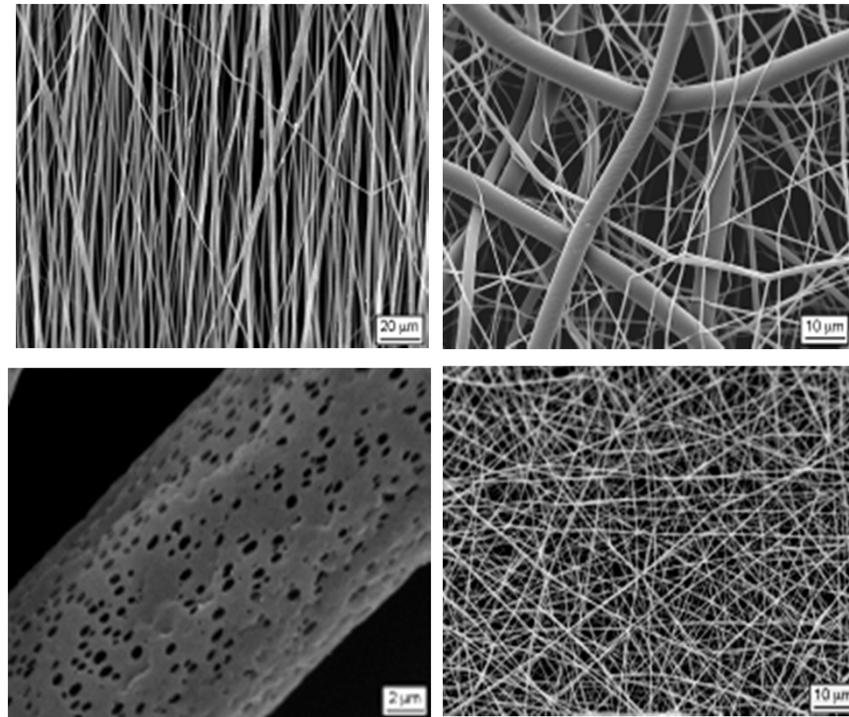
Carbon Fiber Spring
for high cycles fatigue
applications



Hybrid
Component

Electrospinning

- Development of Nano-structured Fibers
- Development of Applications
 - ✓ Scaffolds
 - ✓ High conductive materials
 - ✓ Energy storage
 - ✓ Aromas deposition
 - ✓ Air and water filtration
- Machine Design and Prototype construction
- Vascolarized and self-healing structures

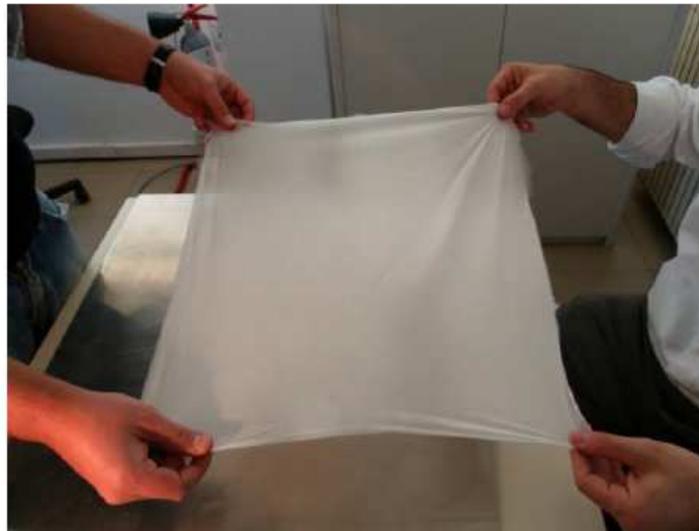


Nanofibers of different shapes and materials are developed for different applications

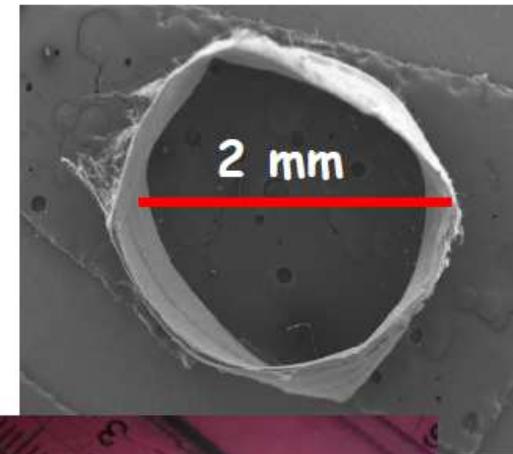
With UNIBO's equipment different types of Nanofibrous Membrane can be produced



Sheets

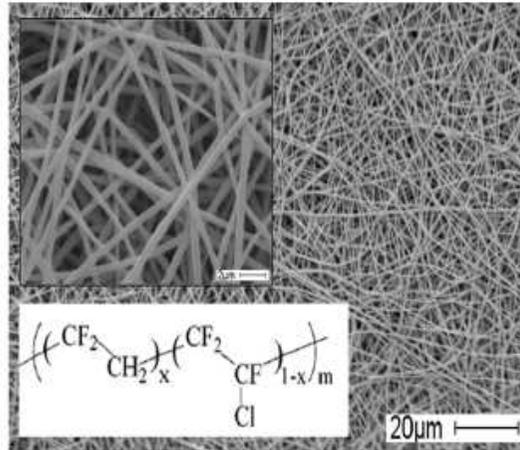
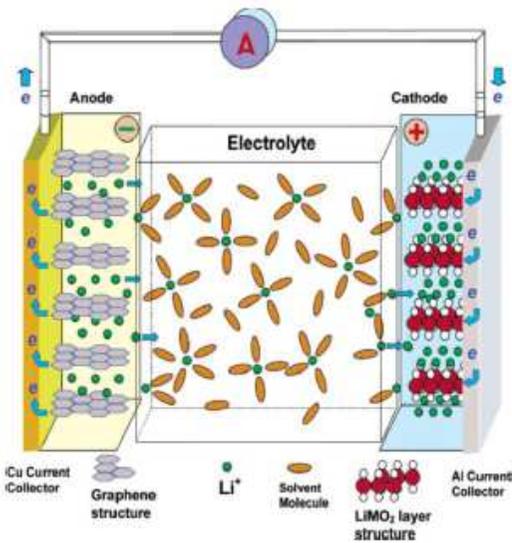


Tubes having tunable diameters



Energy storage

Development of a safe, high-rate and high-energy polymer lithium-ion battery based on gelled membrane prepared by electrospinning



PVdF-based nanofibrous membranes



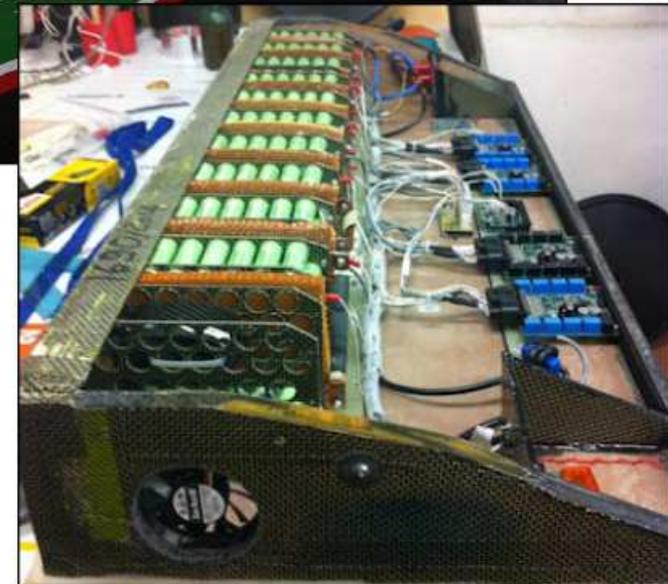
Energy storage

ONDA SOLARE PROJECT

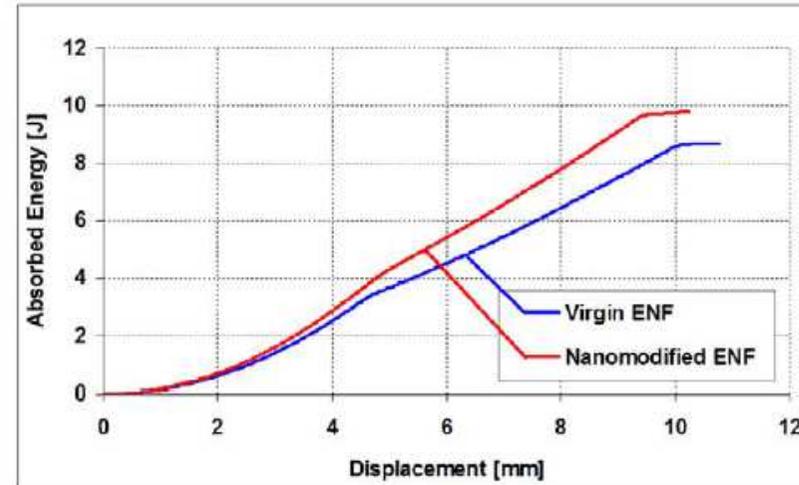
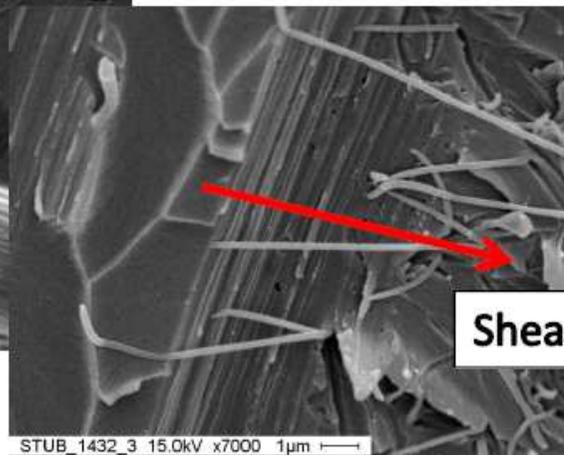
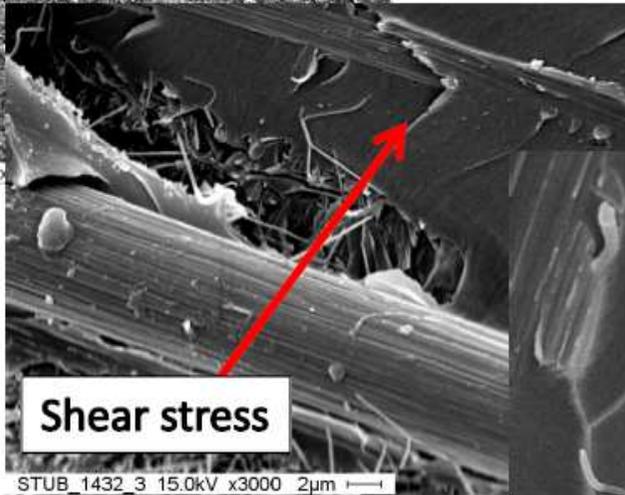
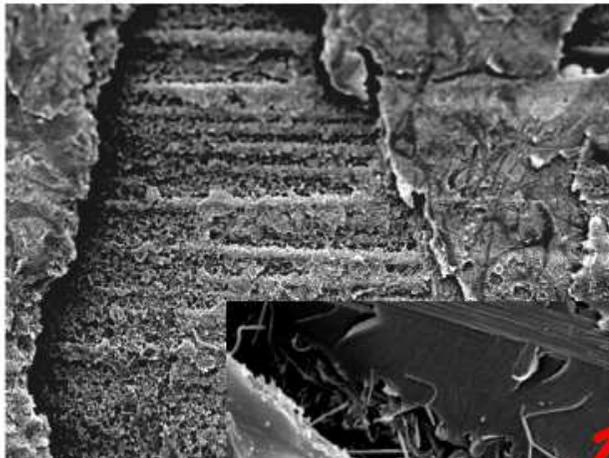
The 100% electrical solar car
made in Italy

Partners:

- University of Bologna
(Mechanical and Electrical
Department)
- GrafiteCompositi S.r.l. (Italy)
- TBE electronic and automation



Nanofibers in composites laminates



The new material exhibit an enhanced energy absorption (10% of increment)

Nanofibers in composites laminates

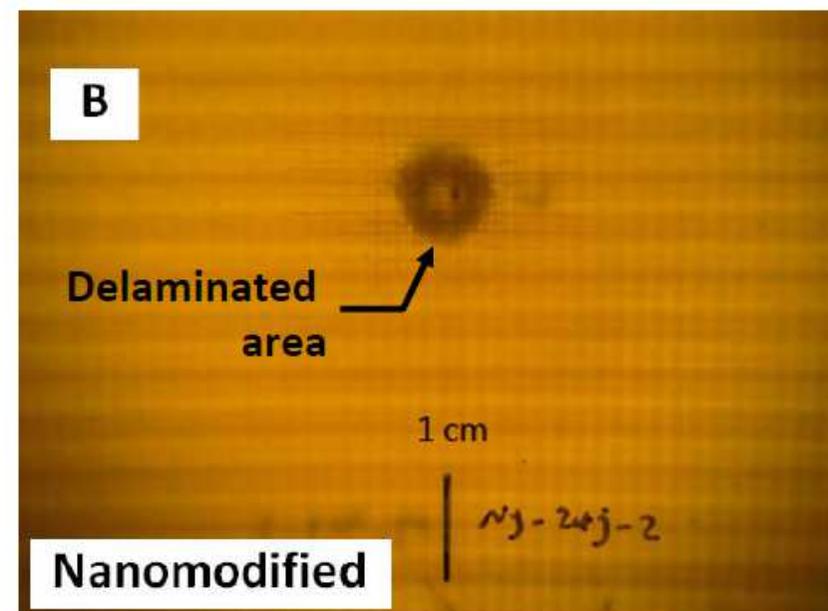
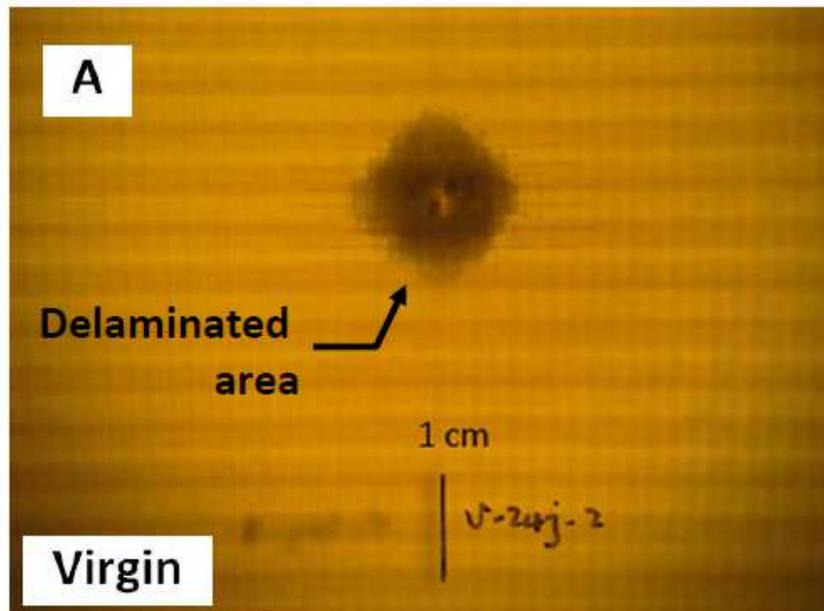
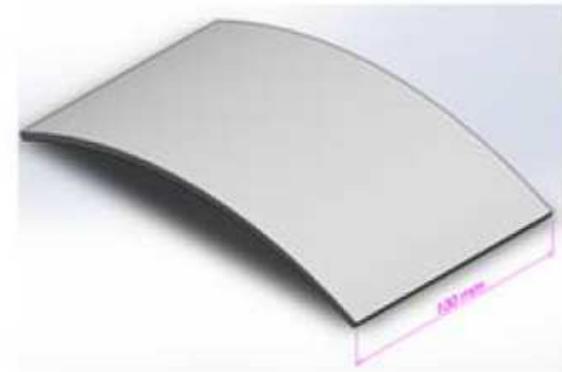
Curved Plates subjected to low velocity impact.

Virgin plates are made of Glass fiber reinforced Epoxy,

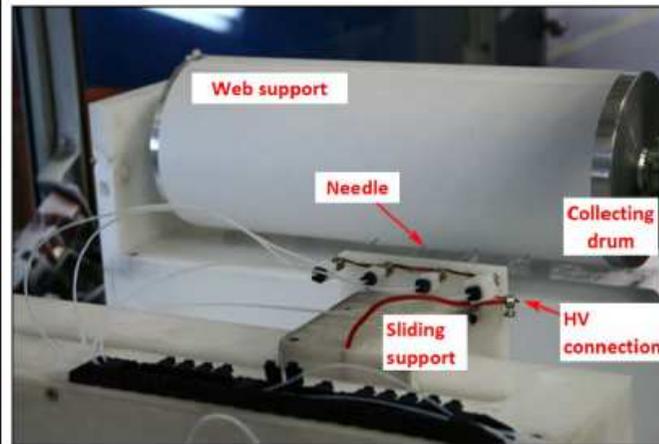
Nanomodified plates are made by interleaving electrospun

nanofibrous mats at the ply-to-ply interfaces of the GFR prepreg.

Low velocity impact test showed a reduction of about 50% of delaminated area in nanomodified plates.

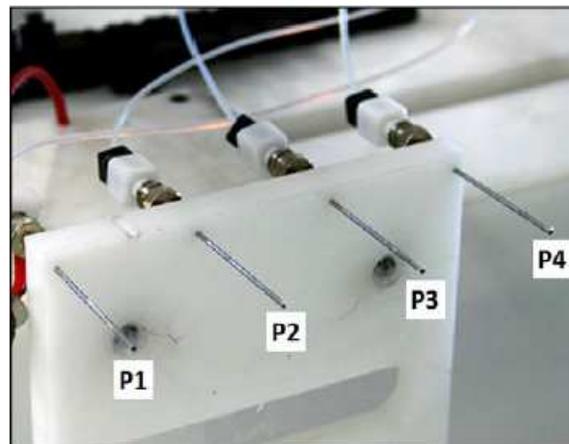


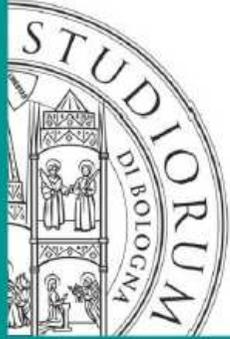
Device and Machines



4 independent needles are mounted on a sliding support to obtain a uniform thickness membrane.

Nanofibrous membrane is collected on a rotating drum which rotation speed can be properly tuned also to obtain aligned nanofibers.





FUNCTIONAL COATINGS

omniphobic surfaces by surface modification with perfluoropolyethers

development of hydrophobic/lipophobic coatings for glass and polymer substrates



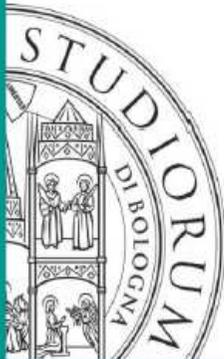
treated glass



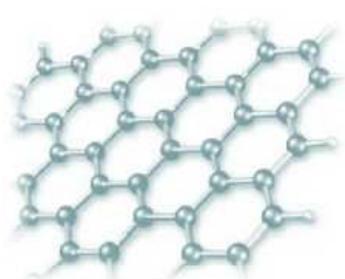
untreated glass

self-cleaning surfaces



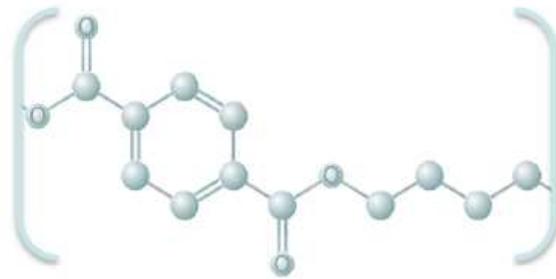


ELECTRICALLY CONDUCTIVE POLYMER COMPOSITES

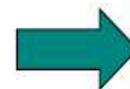


graphene

+



poly(butyleneterephthalate)



POTENTIAL APPLICATIONS:

- ADVANCED COMPOSITES
- AUTOMOTIVE
- ELECTRONICS



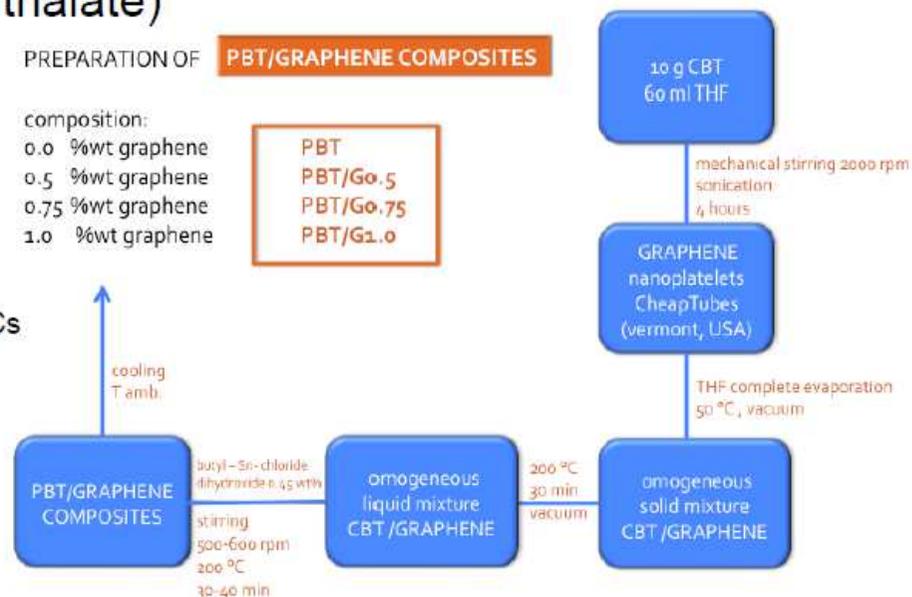
ADVANTAGES OF CBT OLIGOMERS:

- ULTRA-LOW VISCOSITY
- LOW PRESSURE PROCESSABILITY
- HIGH THERMAL STABILITY
- POLYMERIZE TO PBT WITHOUT VOCs
- HIGH POLYMERIZATION RATE
- HIGHER PERFORMANCES OF PBT

PREPARATION OF PBT/GRAPHENE COMPOSITES

composition:
 0.0 %wt graphene
 0.5 %wt graphene
 0.75 %wt graphene
 1.0 %wt graphene

PBT
 PBT/Go.5
 PBT/Go.75
 PBT/G1.0



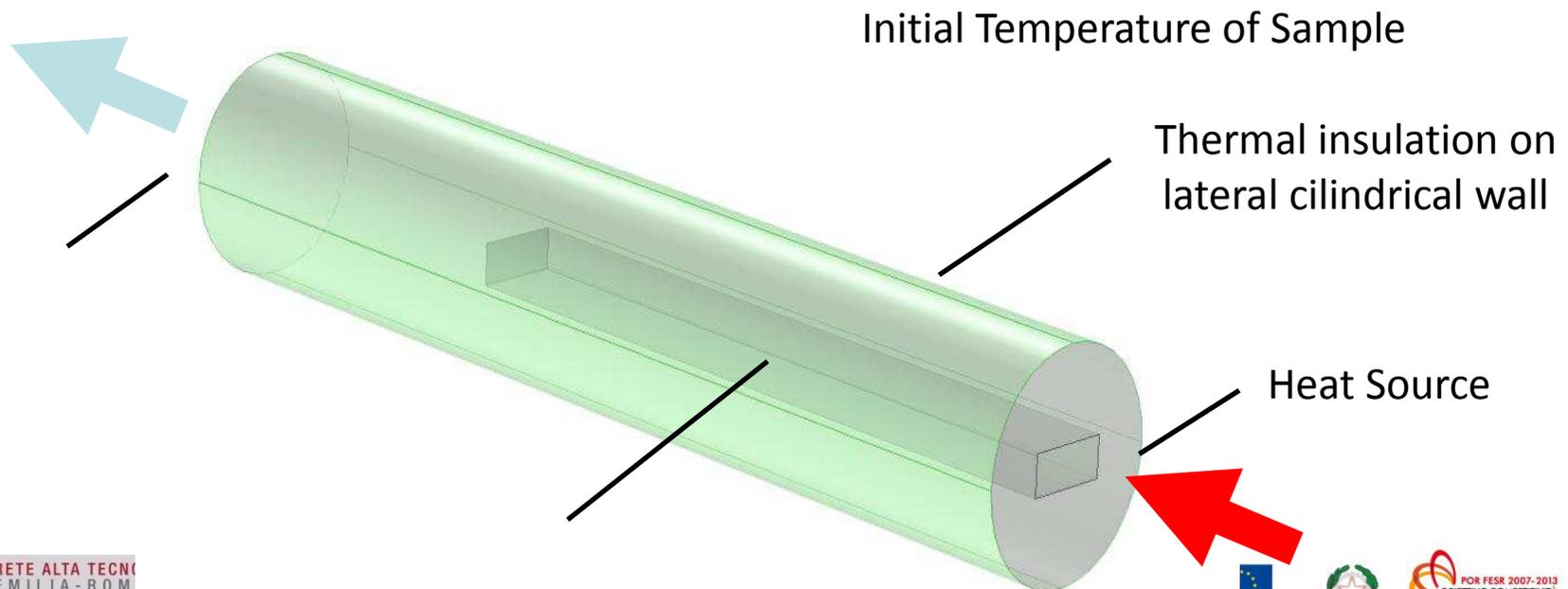
International project with FRAUNHOFER, TECHNION, Lamborghini, for the development of high conductive components Al-Graphene

FEM modeling of IIT experiment: Conditions of experiment and Properties of materials

Materials Properties for :

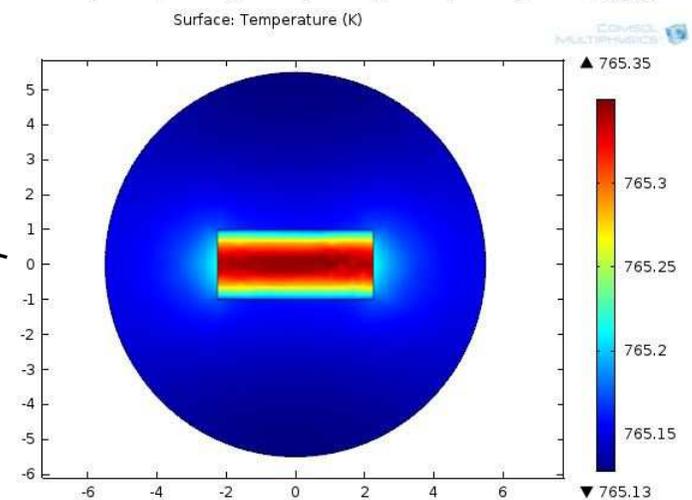
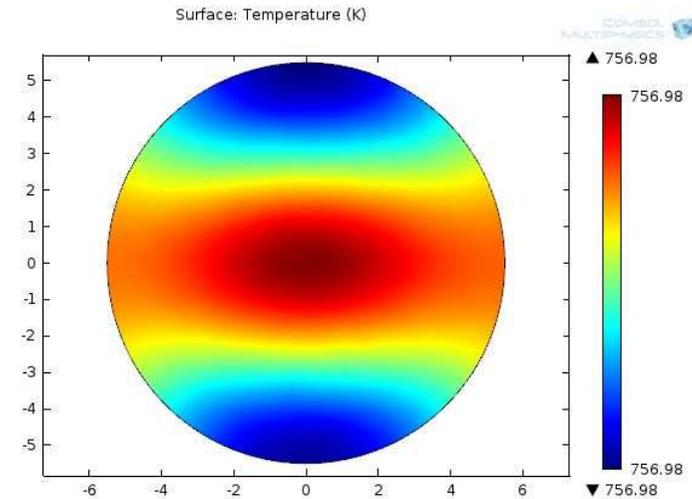
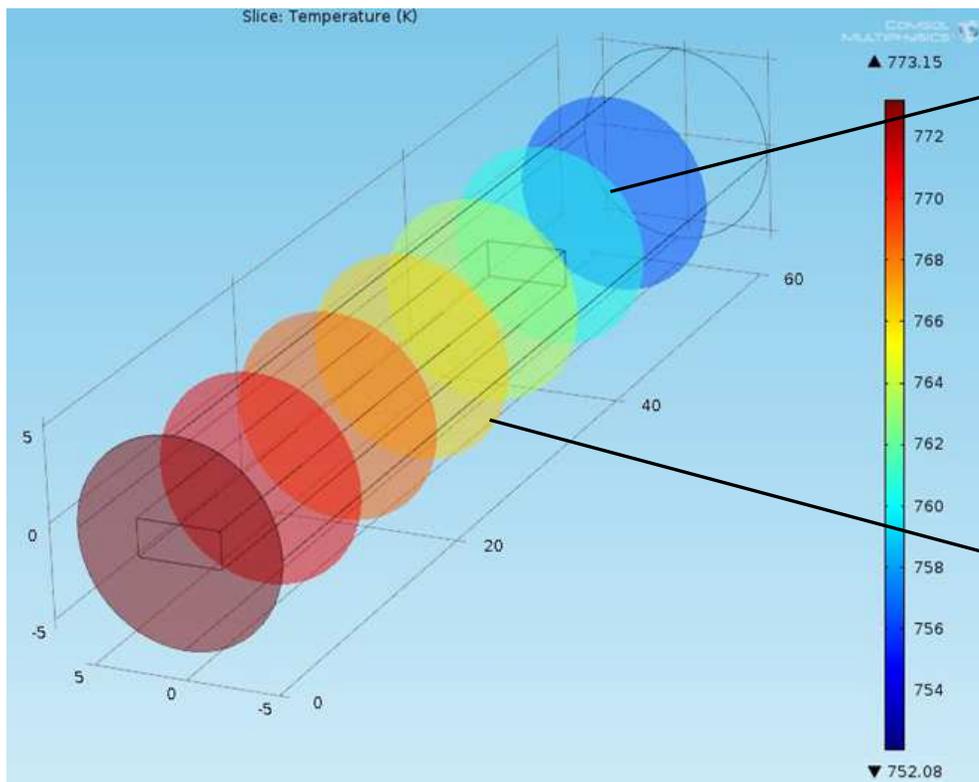
- Graphite (TPG)
- Aluminium A356

Condition of experiment to set as Boundary Conditions



FEM modeling of IIT experiment: Simulation results n. 4a

Temperature distribution in YZ plane
 (with low Thermal Resistance interface)



Packaging Laboratory «Lab4pack»

- Lab4Pack is a laboratory aimed at packaging processes development, established within a private company



- important Instruments(1M€)
- 4 full time researchers

- + Microscopy
- + Rheology and forming processes
- + Permeation – Shelf life
- + Biology assessment