



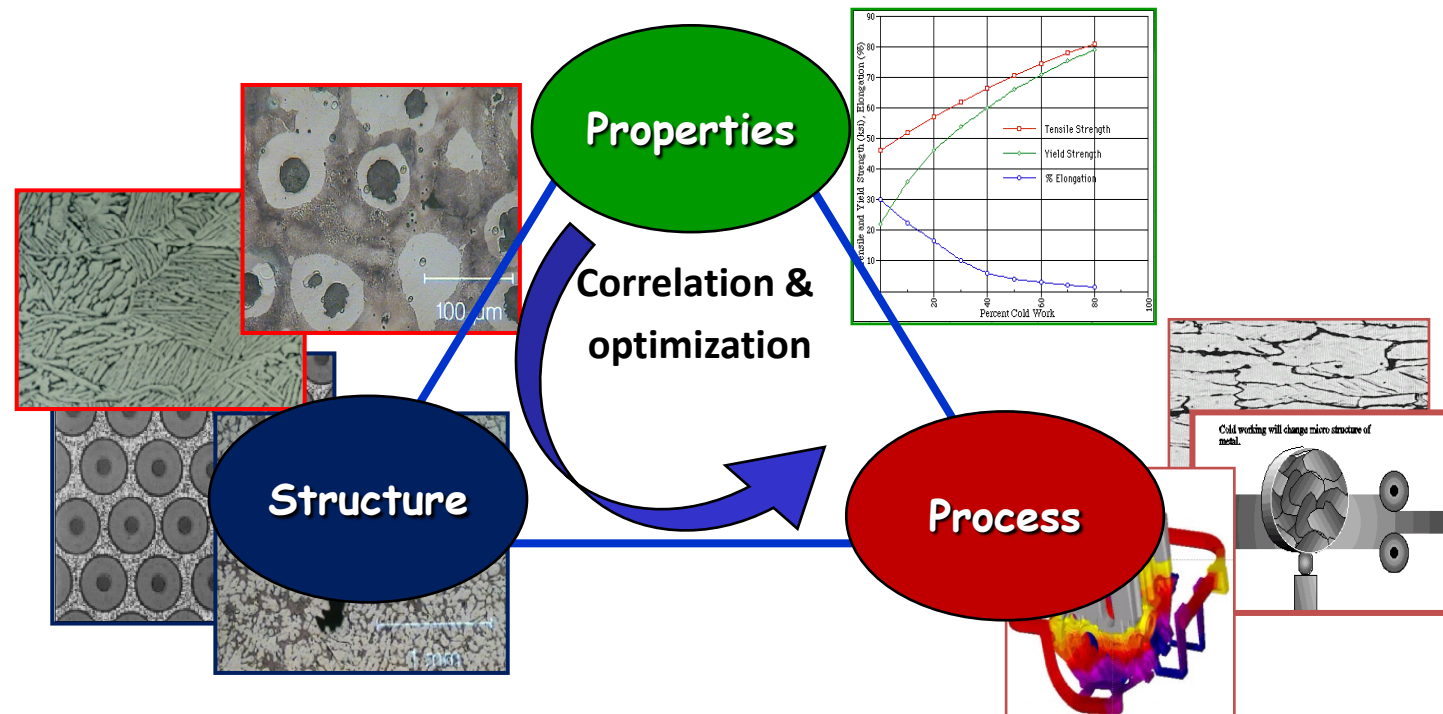
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Area Metallurgia

- **Dipartimento di Chimica Industriale «Toso Montanari»**
- **Dipartimento di Ingegneria Industriale (DIN)**
- **Dipartimento di Ingegneria Civile, Chimica, Ambientale e dei materiali (DICAM)**

METALLURGY GROUP

- **Metals and alloys** (*steels, cast irons, aluminium, titanium, magnesium & copper alloys, precious alloys*)
- **Metal Matrix Composites (MMCs)**
- **Surface engineering** (*overlay coatings, thermo-chemical treatments, conversion processes*)

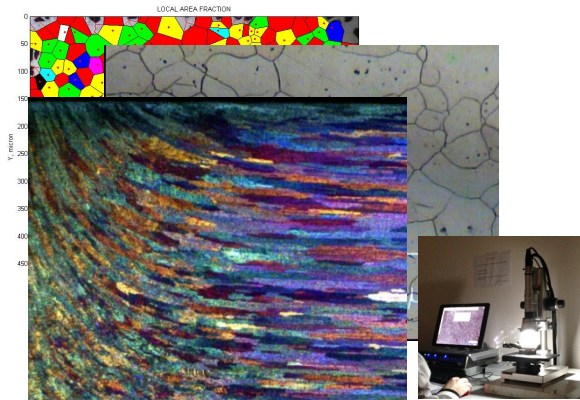


Metallurgy Group: testing equipment

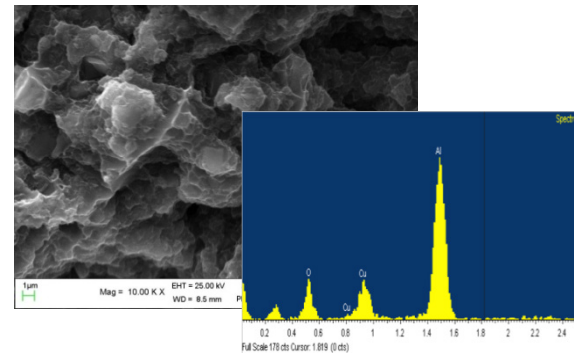
Microstructural, compositional and fractographic analyses

Full characterization with sub-micrometric resolution

- Optical microscopy

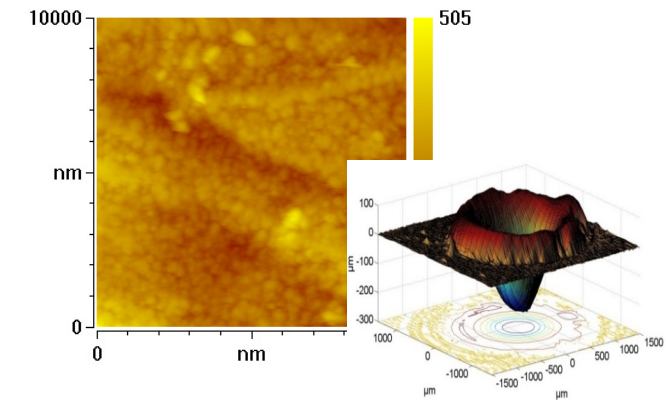


- Scanning Electron Microscopy (SEM) with Energy Dispersive Spectroscopy (EDS)

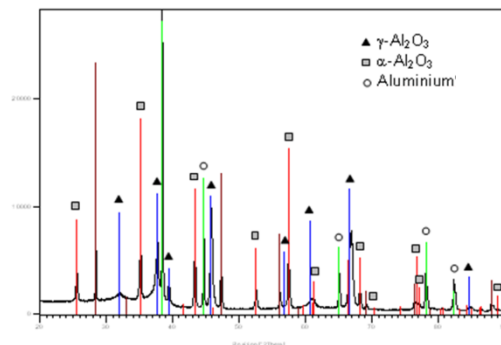


- Topographic characterization

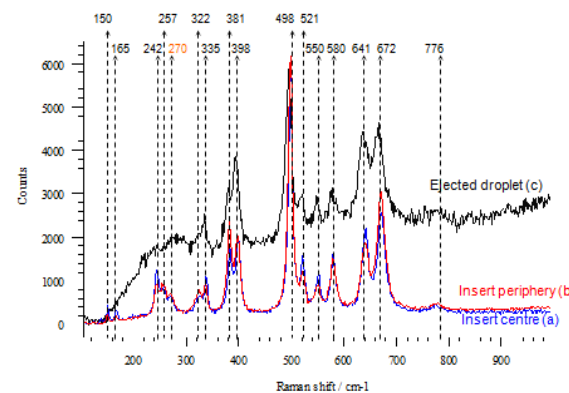
- Contact stylus profilometer
- Atomic force microscopy



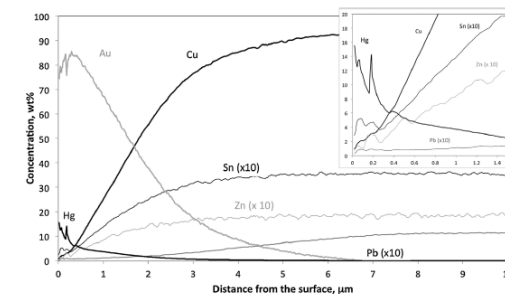
- X-Ray Diffraction (XRD)



- Raman spectroscopy



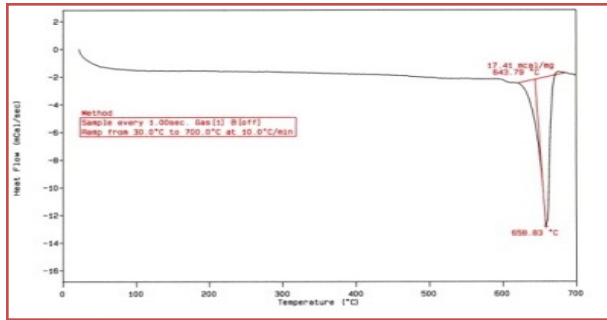
- GD-OES Spectroscopy



Metallurgy Group: testing equipment

Production of new alloys (Al, MMC, ...)

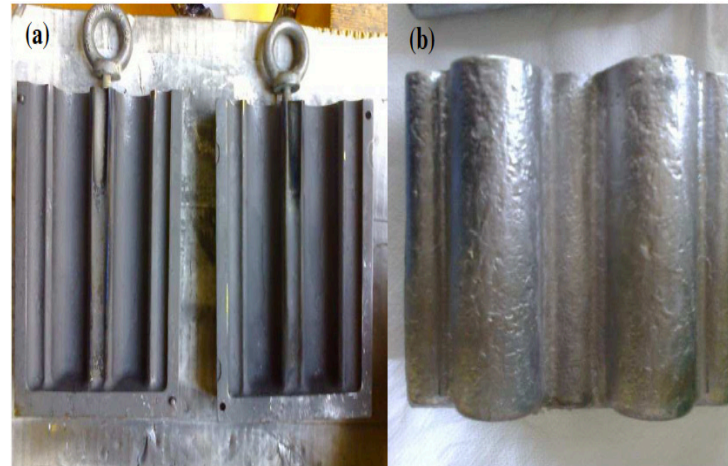
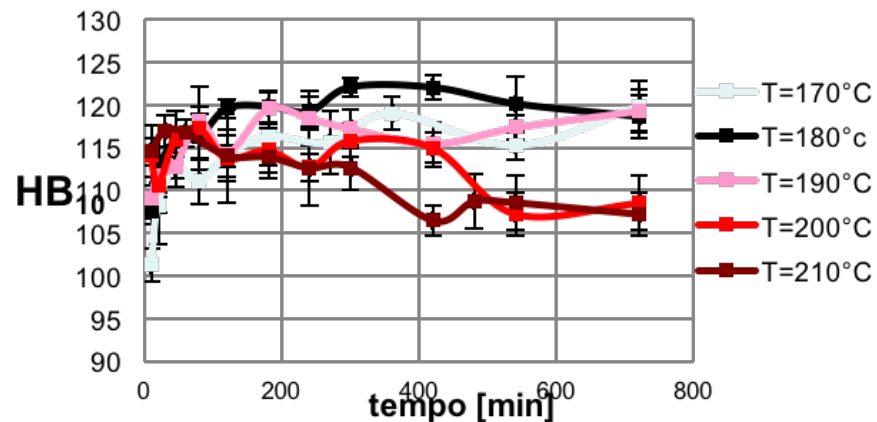
Heat treatment optimization (Ferrous and non-ferrous)



- Differential Thermal Analysis
- Furnaces for heat treatments
- Casting furnace



• Aging curves for Al alloys



Metallurgy Group: testing equipment

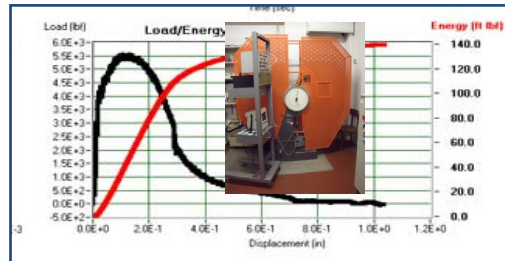
Mechanical properties

Room and high temperature

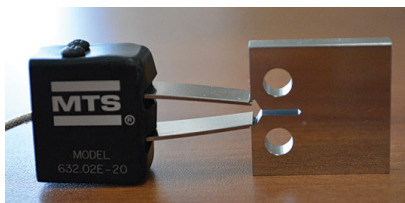
- Hardness and micro-hardness



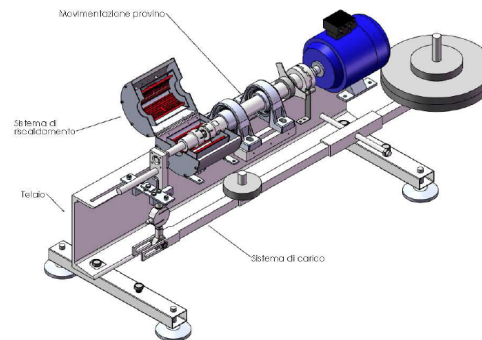
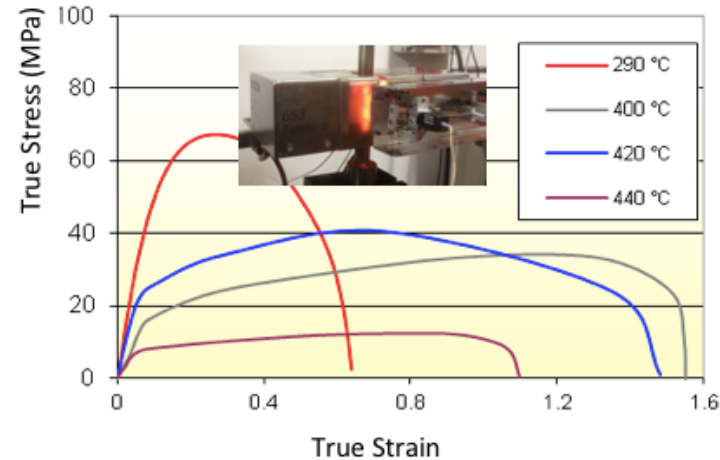
- Impact tests @ RT, low and high T



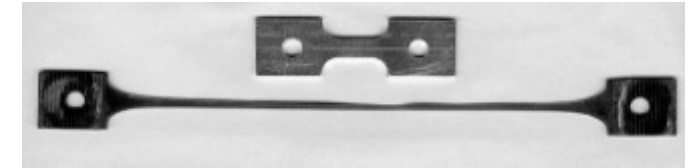
- Fracture toughness



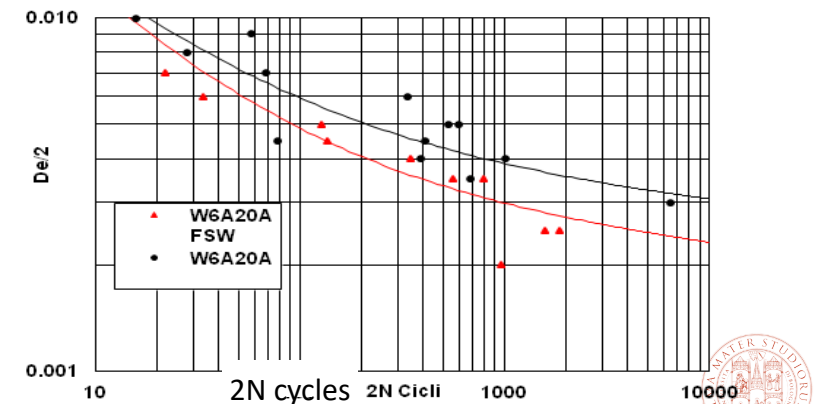
- Room and high temperature (<math><800^\circ\text{C}</math>) Tensile tests



- Superplasticity



- Fatigue testing
- ✓ Bending fatigue tests
- ✓ Push-pull fatigue tests
- ✓ At room and high T (<math><400^\circ\text{C}</math>)

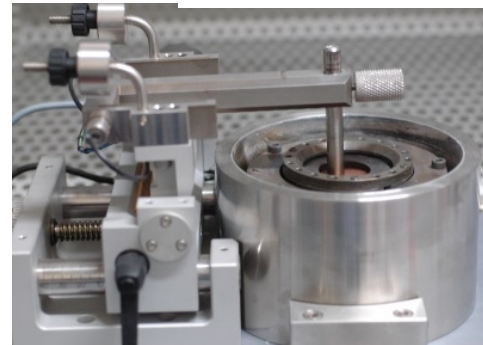
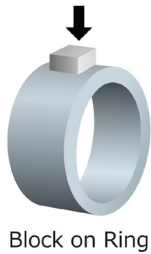
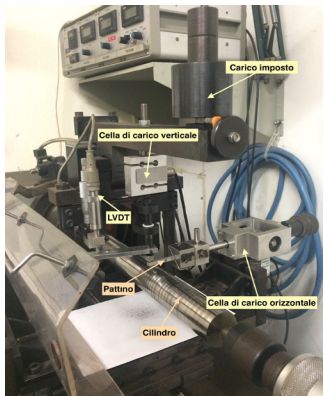


Metallurgy Group: testing equipment

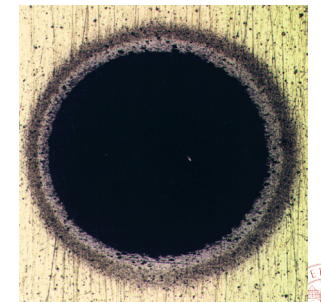
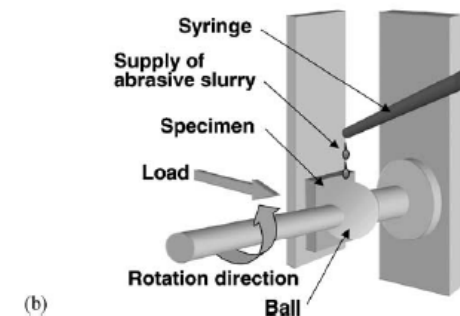
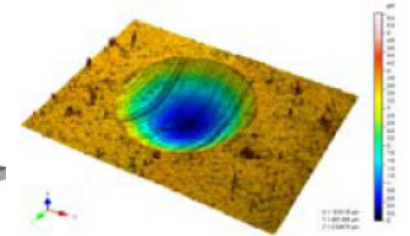
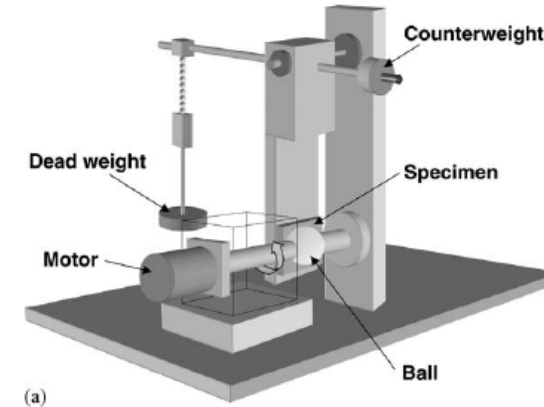
Tribology

Room and high temperature

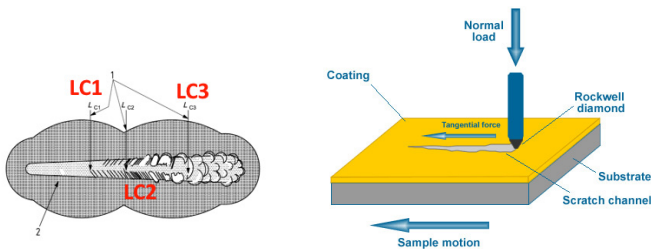
- Sliding tests
 - ✓ Block-on-ring (unlubricated, room T)
 - ✓ Pin(ball)-on-disk (Dry or lubricated, up to 800° C, continuous or reciprocating motion)



- Micro-Scale Abrasion (wet, water-based slurry with abrasive particles, e.g. SiC)



- Single-asperity (scratch test)



Metallurgy Group: research activities

- **Steels:** Optimization of heat treatment and surface finishing of high strength steels obtained by Powder Metallurgy and stainless steels produced by additive manufacturing.
- **Cast irons:** Evaluation of the effect of high temperature exposure on microstructure and mechanical properties (hardness, tensile strength, impact toughness) of: Ferritic, Perlitic, Ausferritic and Perferferritic Nodular Cast Irons
- **Aluminium alloys:** optimization of chemical composition of casting and wrought alloys in order to increase their thermal stability. Optimization of heat treatment conditions of alloys produced by additive manufacturing.
- **Titanium alloys:** optimization of heat treatment and PEO processing parameters for $\alpha+\beta$ alloys

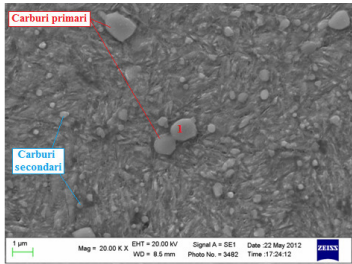


Metallurgy Group: research activities

- **Tribology:** identification of friction and wear mechanisms, aiming at metal components optimisation (w/out surface modifications)
- **Fatigue:** (i) Assessment of the influence of heat treatment conditions and shot peening on the fatigue behaviour of innovative tool steel produced by powder metallurgy processes; (ii) Evaluation of the effect of surface treatments on fatigue behaviour of Mg and Ti alloys; (iii) Study of the influence of the overaging on the fatigue strength at high temperature of Al alloys.
- **Surface engineering of metallic materials for tribological applications:** coating/treatment selection & optimisation
- **Additive manufacturing of metallic materials:** investigations on microstructure-property-process relationships

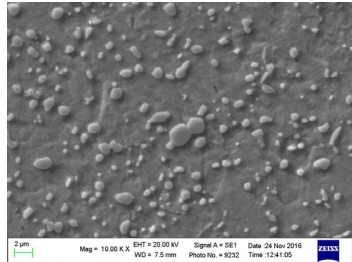


Metallurgy Group: Industrial Cooperation



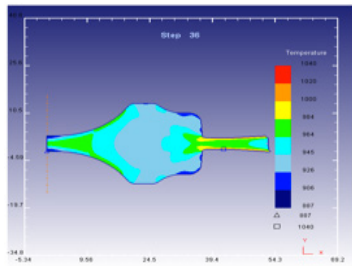
High strength steels obtained by Powder Metallurgy and Electron Slag Remelting (in collab. with Ducati)

→ Fatigue and tensile behaviour

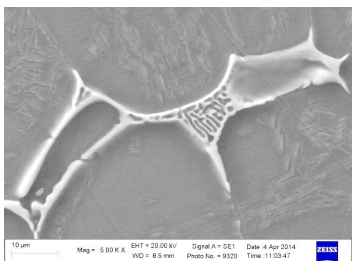


Martensitic stainless steels, tool & maraging steels: heat treatment optimization to improve mechanical properties and corrosion resistance (in collab. with Sacmi)

→ Heat treatment optimization (retained austenite quantification, Tensile tests)



Titanium alloys: high temperature deformation, heat & cryogenic treatment and welding processes (in collab. with TWI, VIMI Fasteners; Pasello TT, Poggipolini)

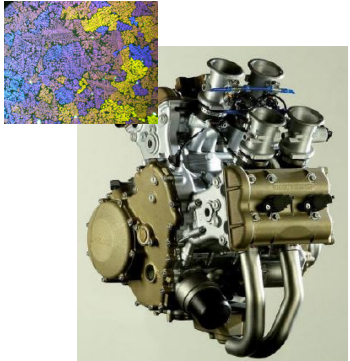


Magnesium alloys (high content of Rare Earth Elements), in collab. with Ducati:

→ heat treatment optimization, microstructural and mechanical characterization (tensile and fatigue tests), surface treatment (PEO)

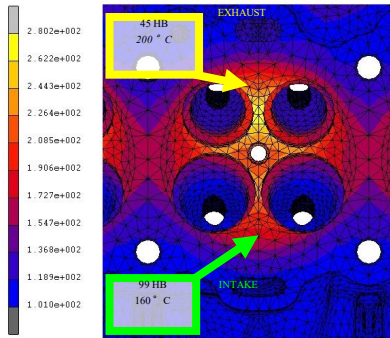


Metallurgy Group: Industrial Cooperation

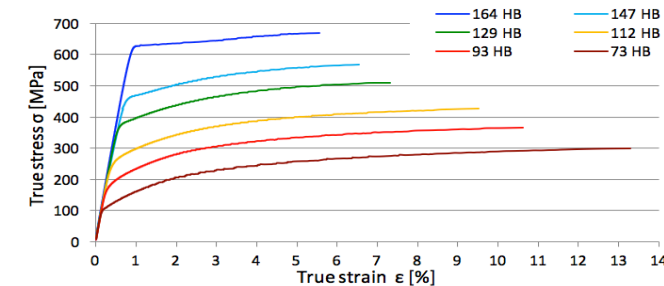
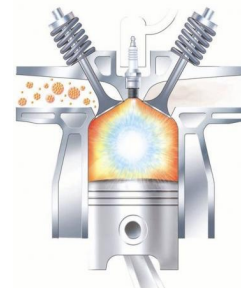
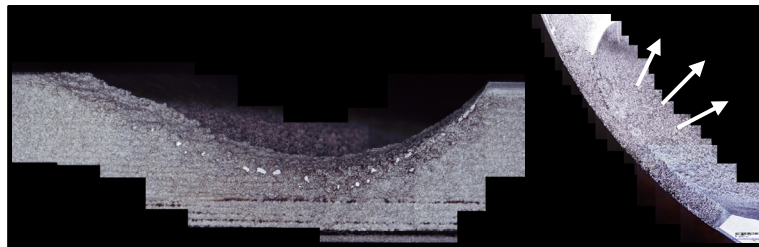
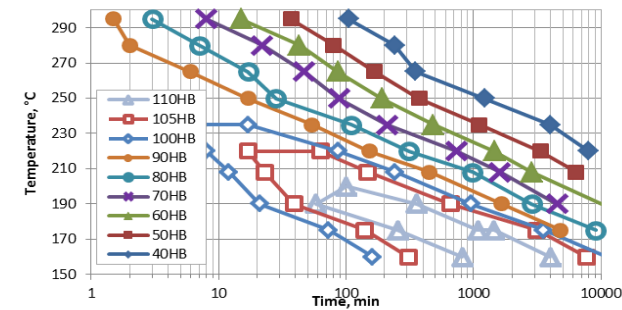


Development and characterization of aluminium alloys for high temperature applications: correlation between microstructure and tensile/fatigue properties (in collab. with Ducati)

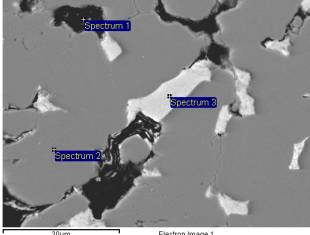
Optimization of casting process and heat treatment of cast aluminium alloys (in collab. with Ducati, Ferrari, Scania)



Al alloys for pistons: study of the effects of thermal exposure and knock-induced damage (in collab. with Ducati, Ferrari)

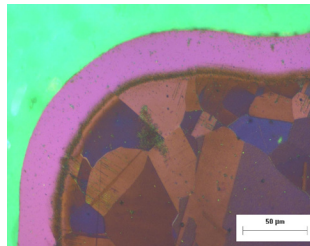


Metallurgy Group: Industrial Cooperation



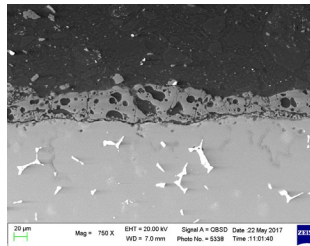
Coated systems for improved wear resistance – *Failure analysis and wear behaviour of tribocomponents* (in collab. with **Calzoni-Parker**)

→ **Coating selection and Tribological testing**



Low-temperature plasma carburizing of austenitic and martensitic stainless steels (in collab. with **Bodycote** and **UFPR, Brazil**)

→ **Fatigue and wear behaviour; duplex DLC coatings**



Magnesium and aluminium surface treatments (in collab. with **automotive companies** and research centres)

→ **Fatigue and wear behaviour**



Spark Anodising of Ti6Al4V for prosthetic joints - *development of surface treatment and assessment of tribological behaviour* (in collab. with **Nanosurfaces Industries**)

→ **Microstructural & micromechanical characterization**

→ **Tribological testing (dry sliding)**



Metallurgy Group: On going projects

ACMEC

Additive manufacturing e tecnologie Cyber-physical per la MECcatronica del futuro

Development of specific and integrated **Electric Motors**, made of **Fe-Si alloys** produced by **Powder Bed Additive Manufacturing** (Selective Laser Melting, SLM), with topological optimisation of geometries in order to reduce material consumption and enhance performance.

Production of **gear shifting mechanisms** by additively manufactured **Ni-Ti Shape Memory Alloy (SMA)**.

RIMMEL

RIVESTIMENTI MULTI-FUNZIONALI E MULTI-SCALA PER COMPONENTI MECCANICI IN ACCIAIO E LEGHE DI ALLUMINIO FABBRICATI CON ADDITIVE MANUFACTURING

<https://rimmel.nano.cnr.it>

The project focuses on the **development of multifunctional coatings for mechanical components produced by additive manufacturing**. Goals of RIMMEL are: (i) to improve the mechanical and tribological performance; (ii) to increase the corrosion resistance; (iii) to produce hydrofobic and oleophobic coatings.

The projects are funded by **European Regional Development Fund (POR-FESR 2014-20)**.



Metallurgy Group: On going projects

NEWMAN

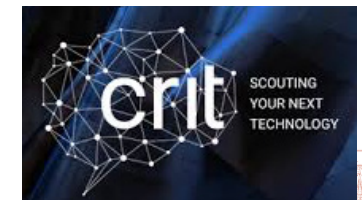
Nickel frEe poWders for high perforMAnce compoNents

The project is funded by the **European Institute of Innovation and Technology**. It focuses on the development of new **Ni-free powders** to produce high **performance components for the automotive industry**, by means of Powder Metallurgy.



Partners of the project:

- University of Bologna
- University of Ghent
- CRIT
- Höganäs
- SINTERIS
- CRF
- VICIVISION



Contatti

Prof.ssa Lorella Ceschini

Dipartimento DICAM

lorella.ceschini@unibo.it

Prof.ssa Carla Martini

Dipartimento DIN

carla.martini@unibo.it

Prof. Alessandro Morri

Dipartimento DIN

alessandro.morri4@unibo.it

Prof. Angelo Casagrande

Dipartimento DIN

angelo.casagrande@unibo.it

