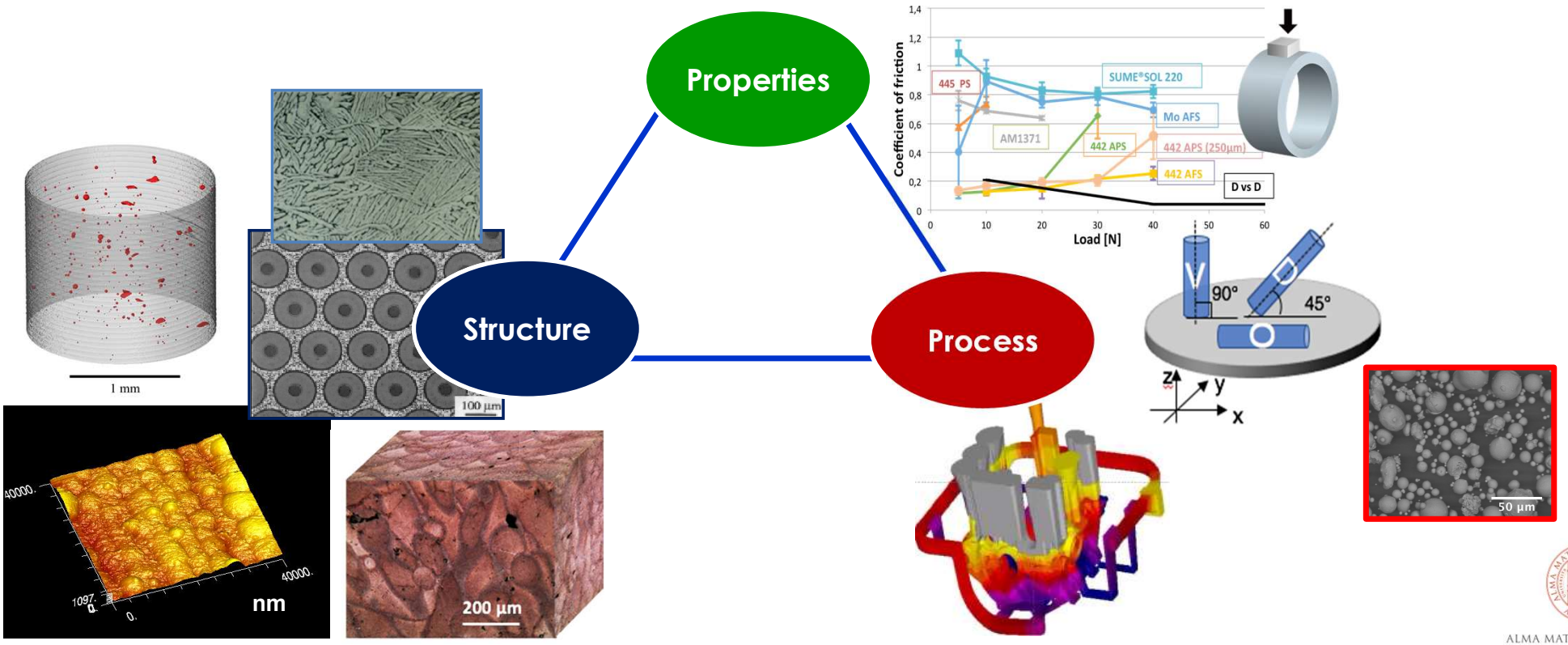
Area Metallurgia

- Dip. Ingegneria Industriale (DIN)

METALLURGY GROUP

- **Metals and alloys** *(steels, cast irons, Al, Ti, Mg & Cu alloys)*
- **Metal Matrix Composites (MMCs)**
- **Surface engineering** *(overlay coatings, thermo-chemical treatments, conversion processes)*



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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 Perferritic Nodular Cast Irons
- **Aluminium alloys:** optimization of chemical composition of casting and wrought alloys to increase thermal stability. Optimization of heat treatment conditions of alloys produced by Additive Manufacturing. High-recycled-content secondary alloys.
- **Titanium alloys:** optimization of heat treatment and surface conversion treatments parameters for α+β alloys (including alloys produced by Additive Manufacturing).

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 Al, Mg and Ti alloys; (iii) Study of the influence of overaging on the fatigue strength at high temperature of Al alloys.
- **Additive manufacturing of metallic materials:** investigations of microstructure-property-process relationships
- **Surface engineering of metallic materials for automotive/motorsport/aerospace applications:** coating/treatment selection & optimisation

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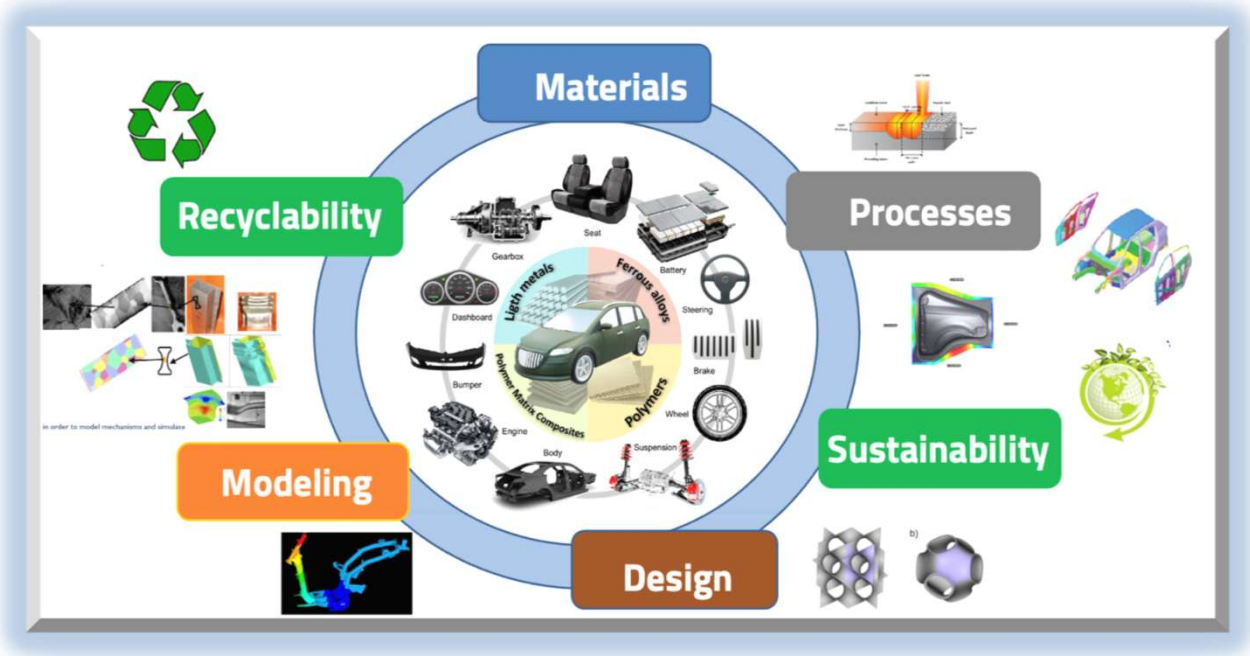
Metallurgy Group

ONGOING PROJECTS



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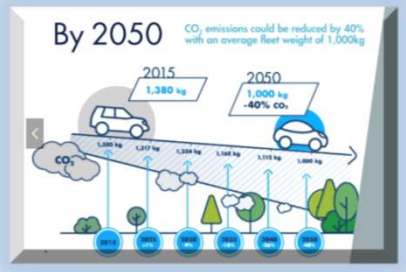
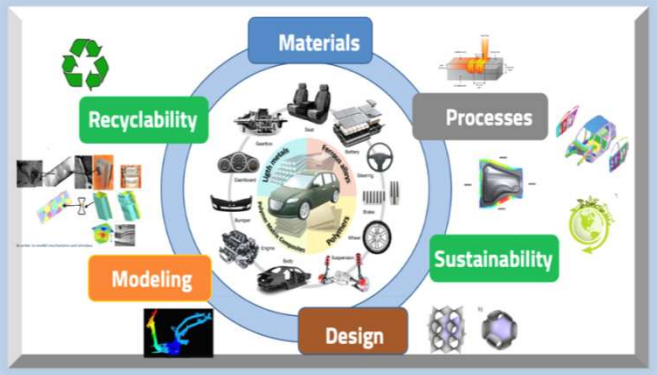
SPOKE 11 - Innovative Materials & Lightweighting

Innovative Materials: Leveraging **lightweight** and advanced materials like **aluminum alloys**, **high-strength steels and cast irons, polymers and composites,** to **reduce vehicle weight and enhance energy efficiency.**

Sustainability in Focus: **Lightweighting reduces fuel consumption and CO_2 emissions**, contributing to greener and more sustainable transportation solutions.



Improved Performance: Structural lightweighting enhances vehicle agility, safety, and battery range in electric vehicles, driving innovation in mobility.



Circular Economy: Prioritizing recyclable and reusable materials to **minimize environmental impact** and ensure **resource efficiency**.

Multidisciplinary Approach: Combining engineering, materials science, and design to optimize the balance between strength, durability, and weight reduction.

Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

ALERT

Leghe di ALluminio per componenti soggetti a fatica E fretting: Rivestimenti e Trattamenti superficiali integrati

COORDINATORE:
Ing. Davide Santachiara

DTM TECHNOLOGIES · IN4 Università degli Studi di Ferrara · CIRI MECCANICA AVANZATA E MATERIALI · SENTIERO INTERNATIONAL CAMPUS · UNIMORE InterMech · CURTI · Peen Service

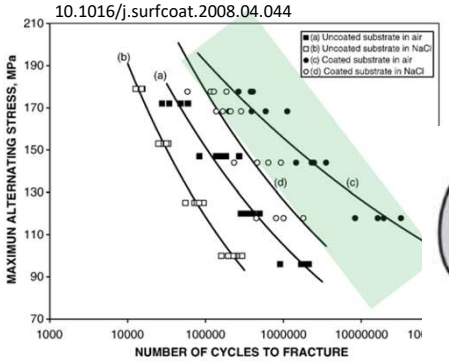
Progetto finanziato nell'ambito del PR-FESR Emilia-Romagna 2021-2027 «Priorità 1 – Ricerca, innovazione e competitività» (2024-26)

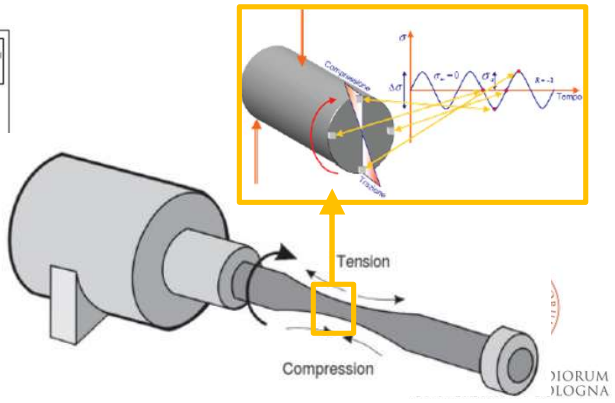
https://alertproject.eu/

Comportamento a **fatica (flessione rotante)** lega **AA7050 T7451 rivestita con diverse combinazioni (HVOF+Fase vap)**

OBIETTIVI

- determinazione della resistenza a fatica di **leghe di alluminio** (Al), anche fabbricate con processi AM, per applicazioni aeronautiche ed aerospaziali in presenza di usura e fatica da *fretting*;
- selezione e applicazione di **trattamenti superficiali e rivestimenti** resistenti al *fretting* ottimizzati per aumentare la resistenza a fatica delle leghe selezionate
- estensione delle soluzioni sviluppate a **componenti strutturali per applicazioni *space***





MAGMOVE

MAteriali maGnetici sostenibili nei MOtori elettrici ad elevata efficienza per la transizione VErde

https://www.magmove.it/

Progetto finanziato nell'ambito del PR-FESR Emilia-Romagna 2021-2027 «Priorità 1 – Ricerca, innovazione e competitività» (2024-26)

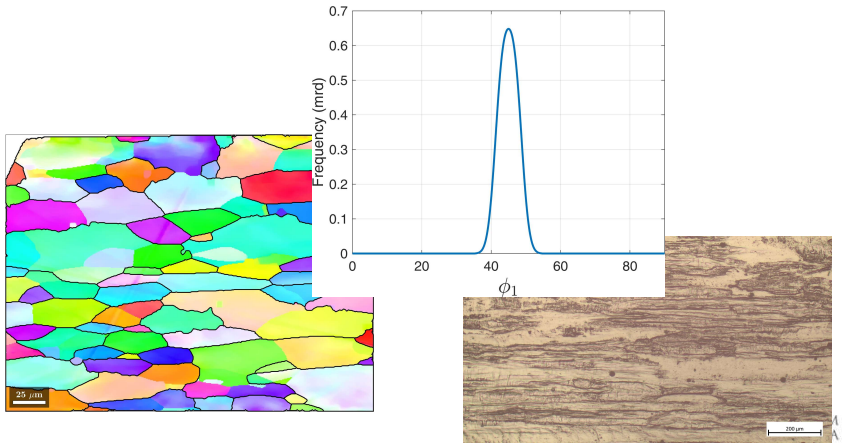
COORDINATORE:
Prof. Sergio D'Addato

CIRI MECCANICA AVANZATA E MATERIALI

OBIETTIVI

- **Innovazione dei materiali magnetici *hard* e *soft***, componenti fondamentali per dispositivi di conversione movimento-elettricità quali motori elettrici e generatori eolici o idroelettrici, e il loro test in un prototipo di motore.
- L'innovazione riguarda il miglioramento delle prestazioni magnetiche, riducendo al contempo il contenuto di **materie prime critiche**, e aumentando la **sicurezza di approvvigionamento** per le industrie regionali e nazionali.

Miglioramento del comportamento di materiali magnetici *hard* e *soft* attraverso l'ottimizzazione compositiva e di processo

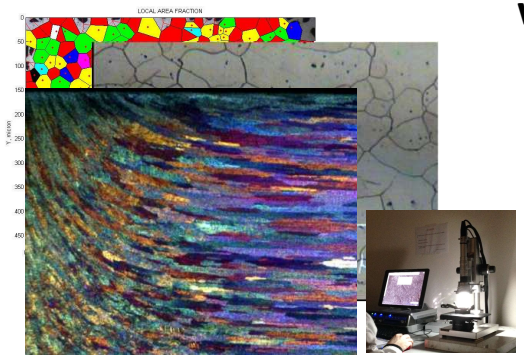


Metallurgy Group: testing equipment

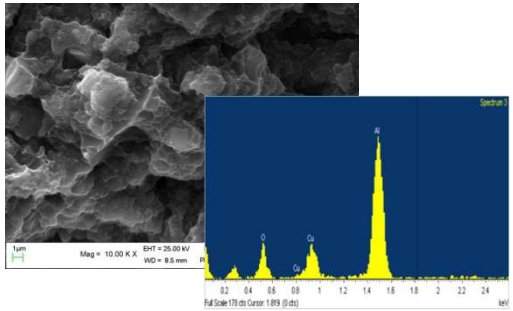
Microstructural, compositional and fractographic analyses

Full characterization with sub-micrometric resolution

- **Optical microscopy**

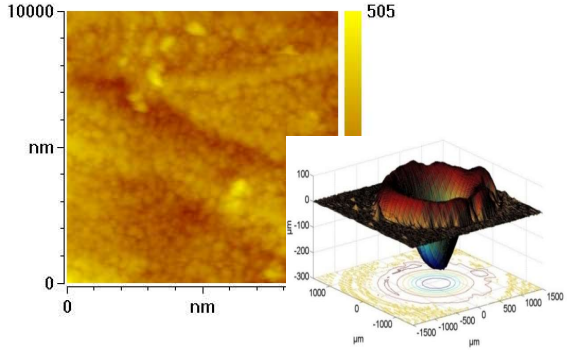


- **Scanning Electron Microscopy (SEM) with Energy Dispersive Spectroscopy (EDS)**

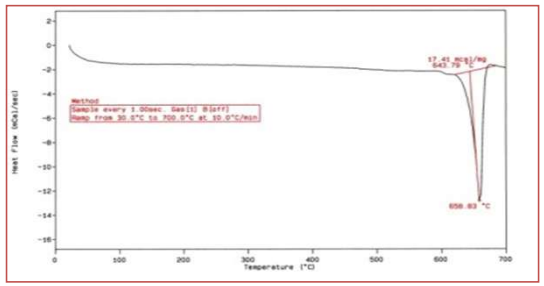


Topographic characterization

- **Contact stylus profilometer**
- **Optical profilometer**

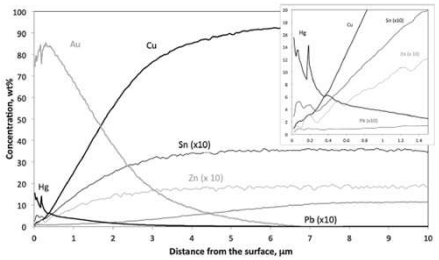


- **Thermal analysis (DTA+TGA)**



- **Micro/Nano mechanical testing**

- **GD-OES Spectroscopy**



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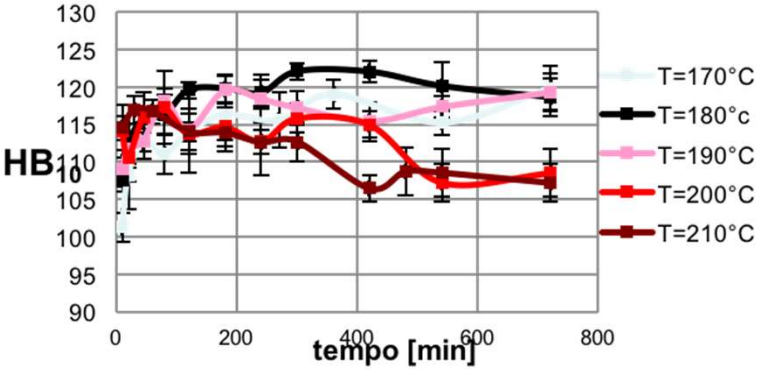
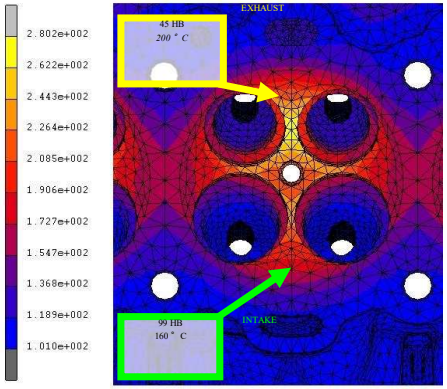
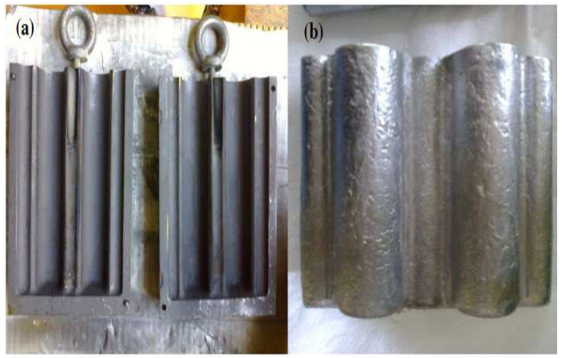
Metallurgy Group: testing equipment

Production of new alloys (Al, MMC, …)
Heat treatment optimization (Ferrous and non-ferrous)

- **Casting**
- **Heat treatments design**
- **Thermal degradation**
  (aging curves for Al alloys)







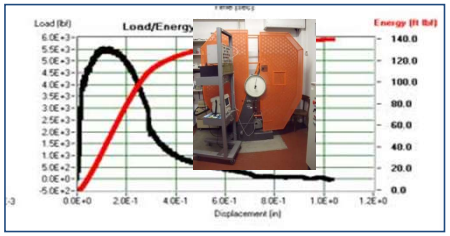
Metallurgy Group: testing equipment

Mechanical properties

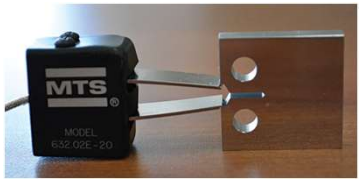
Room and high temperature

- **Hardness and micro-hardness**

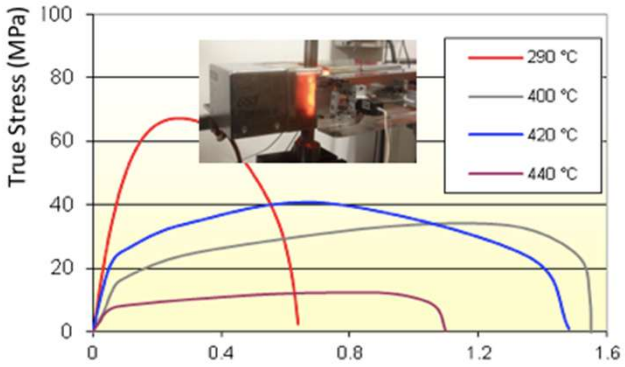
- **Impact tests @ RT, low and high T**

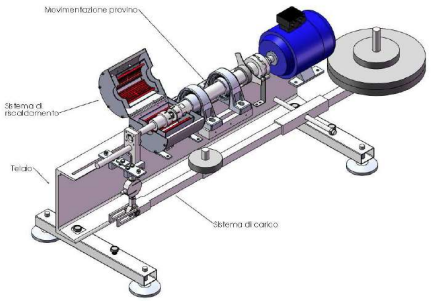


- **Fracture toughness**

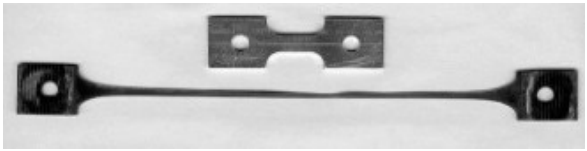


- **Room and high temperature (<800 ° C) Tensile tests**

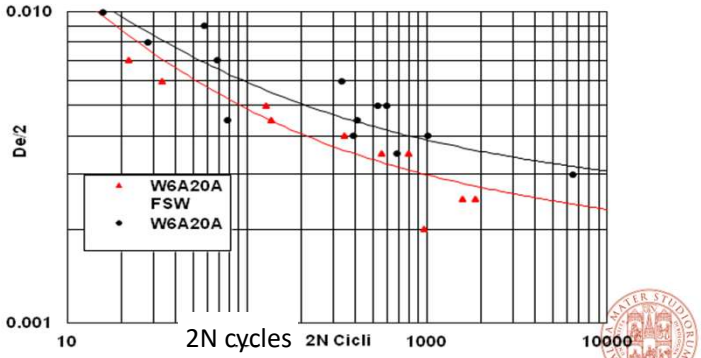




- **Superplasticity**



- **Fatigue testing**
  - ✓ **Bending fatigue tests**
  - ✓ **Push-pull fatigue tests**
  - ✓ **At room and high T(< 400° C)**



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Metallurgy Group: testing equipment

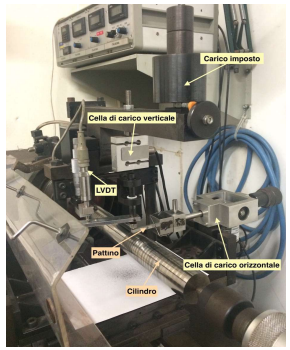
Tribology

Room and high temperature

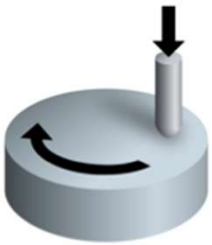
- **Sliding tests**

✓ **Block-on-ring (unlubricated, room T)**

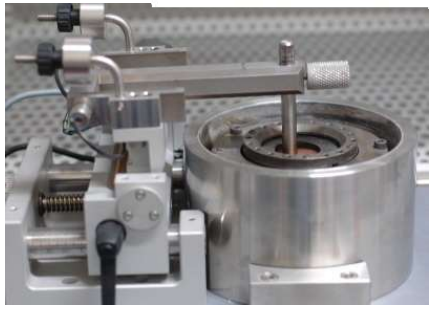
✓ **Pin(ball)-on-disk (Dry or lubricated, up to 600° C, continuous or reciprocating motion)**



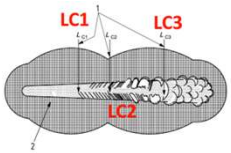
Block on Ring

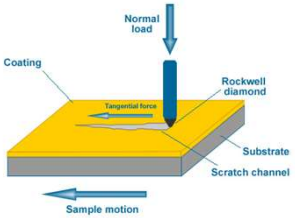


Pin on Disk

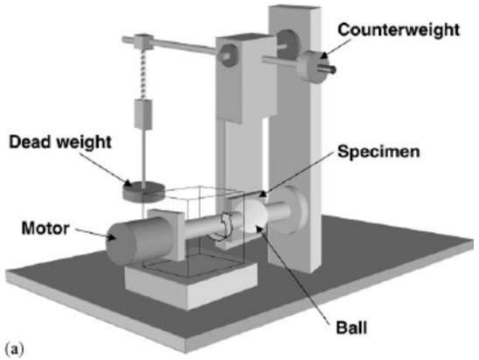


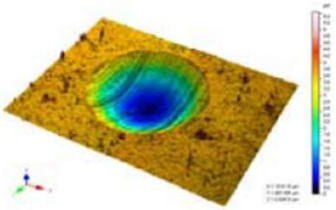
- **Single-asperity (scratch test)**

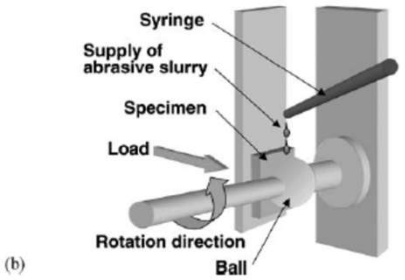


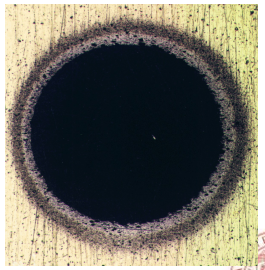


- **Micro-Scale Abrasion (wet, water-based slurry with abrasive particles, e.g. SiC)**







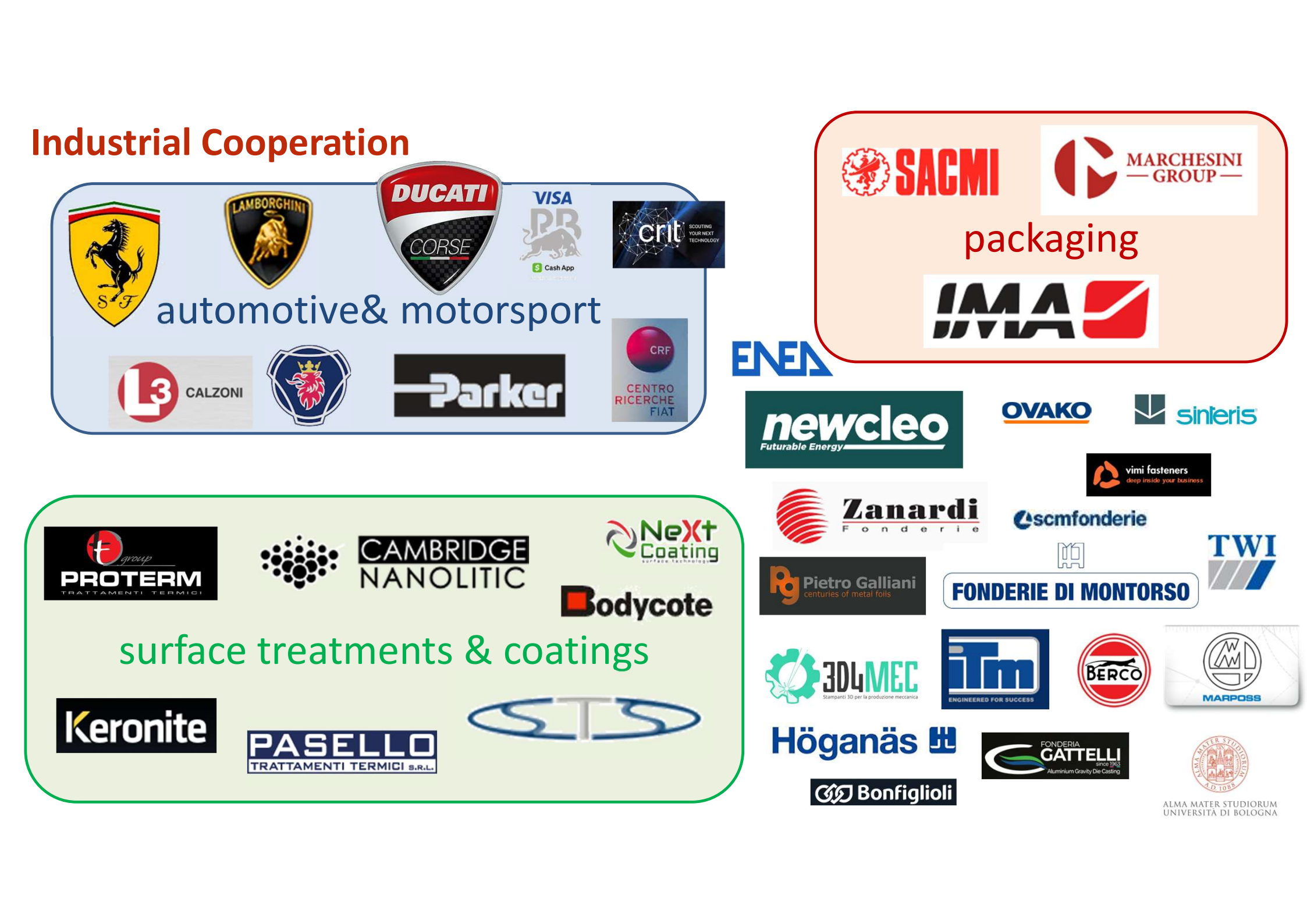


Industrial Cooperation

automotive& motorsport

packaging

surface treatments & coatings



Metallurgy Group: Master Thesis Topics

1. Process-Microstructure-Properties relationships in alloys for structural lightweighting (produced by innovative processes or with high recycled content)

2. Surface engineering (overlay coatings, conversion treatments) of alloys for high-performance applications

3. Structural materials for nuclear energy generation systems (fission/fusion): compatibility with coolants

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