UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

L'economia circolare, tecnologia e creazione di valore

Approfondimento sulle competenze accademiche e di ricerca di UniTN, nuove modalità di collaborazione per le imprese

Massimo Pellizzari, Università di Trento, Dipartimento di Ingegneria Industriale

Matteo Benedetti, Università di Trento, Dipartimento di Ingegneria Industriale

2018-2022 DIPARTIMENTO DI ECCELLENZA MIUR

2023-2027 DIPARTIMENTO DI ECCELLENZA MUR

THE DEPARTMENT OF INDUSTRIAL ENGINEERING

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

ACADEMIC STAFF

Full professor: **18**
Associate professor: **32**
Assistant professor: **15**

ADMINISTRATIVE AND TECHNICAL STAFF

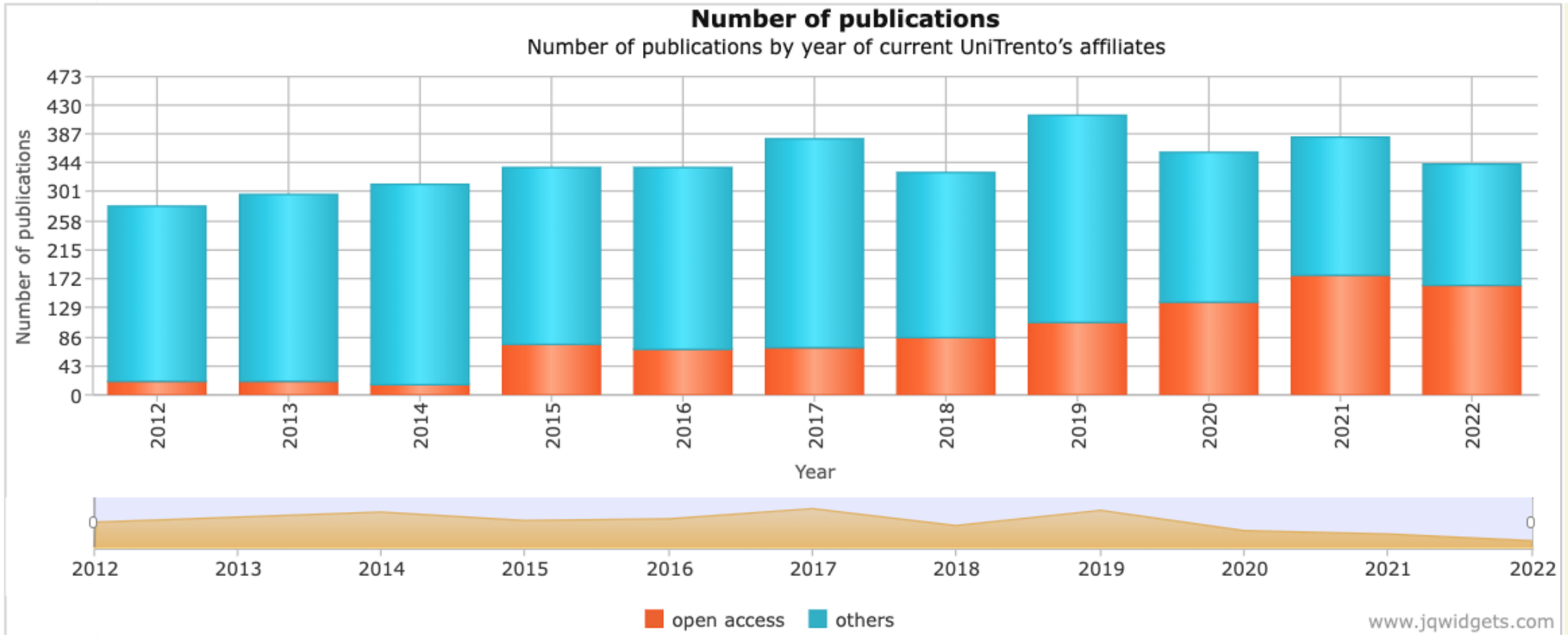
People: **26**

JUNIOR RESEARCH STAFF

PhD student: **62**
Research collaborator: **7**
Research fellowship holder: **32**
Research grant holder: **5**

EXTERNAL STAFF

Visiting professor: **1**
Teaching fellow: **4**
Guest: **16**
Teaching assistant: **45**



Publications by Type	
Type	Count
journal paper	2383
conference paper	1048
chapter	139
extended abstract	94
poster paper	34
other publication	22
book	16
patent	11
report	9
entry	8

Last update: Jan. 2024

Scientific Production

Research funding

Codice	Indicatore	Fonte	2020	2021	2022
D01	Nr. progetti finanziati su bandi esterni, iniziati nell'anno	DSRV	10	14	16
D02	Nr. progetti finanziati iniziati nell'anno coordinati dalla struttura accademica	DSRV	6	7	11
D03	Nr. progetti finanziati dall'Unione Europea (Horizon Europe, H2020, EIT, varie DG, …) iniziati nell'anno	DSRV	10	8	6
D04	Nr. progetti finanziati da enti esteri o sovranazionali diversi dall'UE, iniziati nell'anno	DSRV	0	0	1
D05	Nr. progetti nazionali (PRIN, FISR, …) finanziati, iniziati nell'anno	DSRV	0	1	7
D06	Nr. progetti regionali (PAB, Caritro, Euregio, …) finanziati, iniziati nell'anno	DSRV	0	5	2
D07	Valore economico dei progetti finanziati su bandi esterni (D01), iniziati nell'anno, in migliaia di euro	DSRV	446	1.133	2.132
D08	Proventi da ricerche con finanziamenti competitivi, in migliaia di euro (Indicatore AVA3)	Bilancio	1.151	1.206	1.104
D09	Nr. progetti di Ateneo finanziati (Bandi di Ateneo per giovani ricercatori Starting, MSCA+1,…)	DSRV	1	6	0
D10	Finanziamento di Ateneo per la ricerca alla Struttura, in migliaia di euro	DSRV	194	186	262

ERC - STG – 2 projects at UniTrento

- INSPIRE - Integrated Structural and Probabilistic Approaches for Biological and Epidemiological Systems – Department of Industrial Engineering – Giulia Giordano
- flEAP- Fluid gap Electro-Active-Polymer machines for a new generation of mechatronic systems - Department of Industrial Engineering - Giacomo Moretti

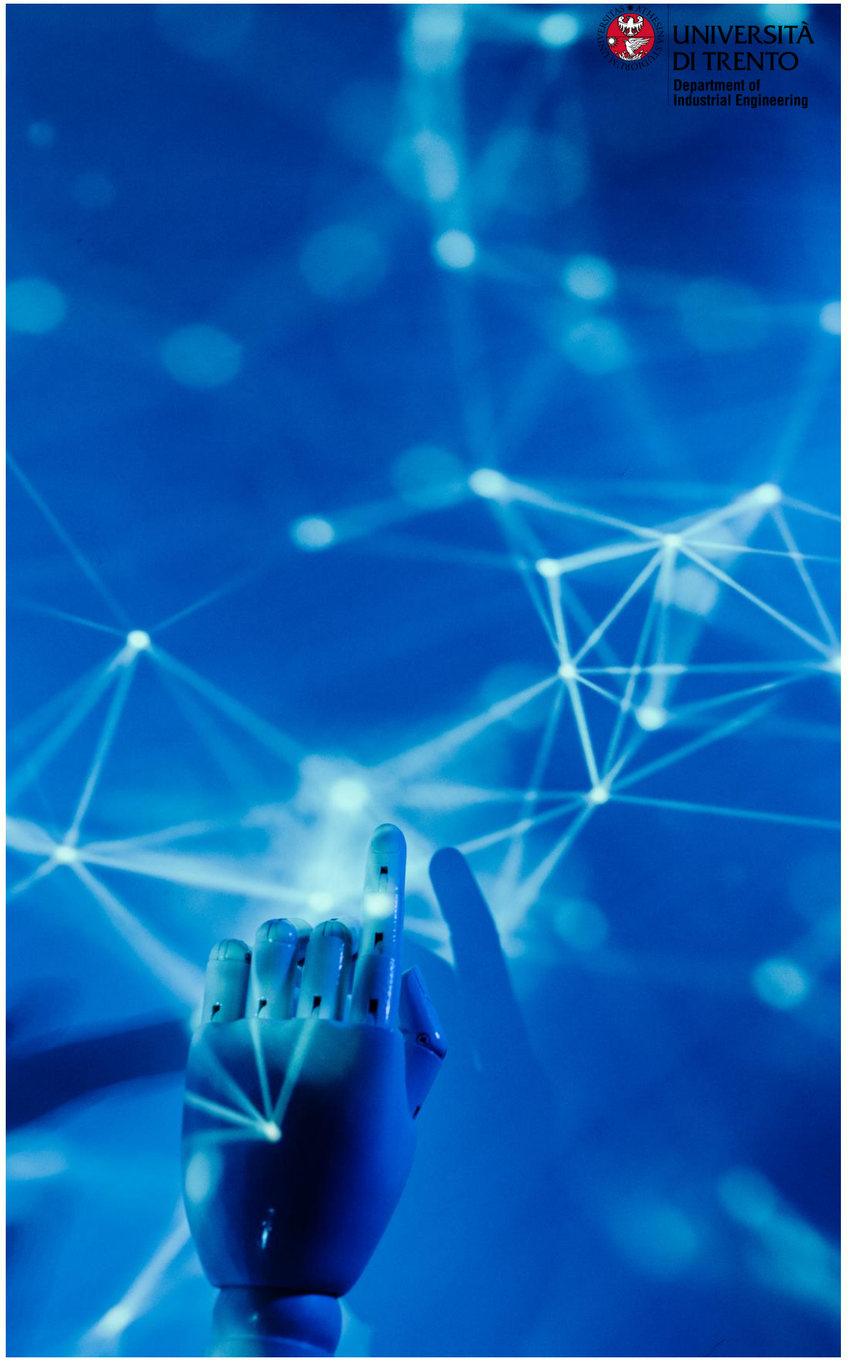
DEPARTMENT OF EXCELLENCE

2018-2022
DIPARTIMENTO DI ECCELLENZA
MIUR

6,6 million euros of funding
for a project aimed at developing flexible and wearable mechatronic systems based on multifunctional materials

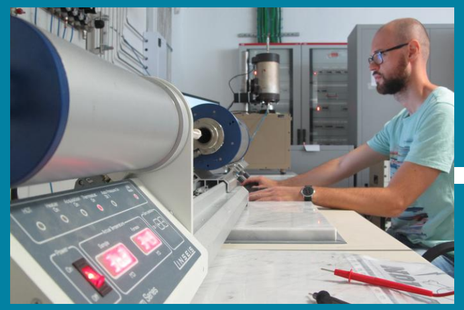
2023-2027
DIPARTIMENTO DI ECCELLENZA
MUR

7,12 million euros of funding
for the creation of an international hub focused on sustainable robotics and the connected technologies and disciplines



UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

MAIN RESEARCH FIELDS

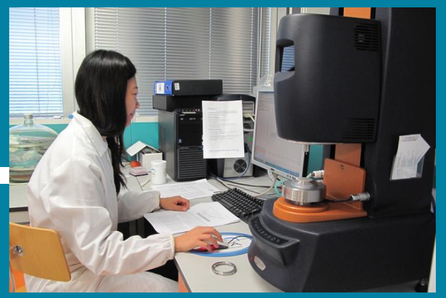


MATERIALS

MECHATRONICS

ELECTRONICS

MANAGEMENT



BIOMEDICAL

RESEARCH LABS

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

1 MATERIALS

- Advanced Characterization of Materials
- Coatings and Corrosion Control
- Design methods for Industrial Engineering
- Glass & Ceramics
- Integrated Quantum Photonics
- Materials Chemistry
- Mechanical design and machine elements
- Metallurgy
- Polymers and Composites

2 MECHATRONICS

- Dynamical Networks and Systems Biology
- Electro-mechanical Transducers & Drives
- Food Engineering
- HICREST
- Nonlinear Control Systems
- Robotic Systems
- Scientific Computing
- Vehicles

3 ELECTRONICS

- Embedded electronics systems, measurements and tracking
- Integrated sensors and detectors
- Smart grids and renewables integration

4 MANAGEMENT

- Industrial plants, Production systems e Logistics
- Managing high product variety
- Operations Research
- Organization Studies

5 BIOMEDICAL

- BIOtech

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

EDUCATION

Undergraduate courses (duration: 3 years)

- Industrial Engineering
- *Human Centered Medical Systems Engineering (interuniversity)*

Master courses (duration: 2 years)

- Materials Engineering
- Mechatronics Engineering
- Management and Industrial Systems Engineering
- Bioengineering for Personalized Medicine

Doctoral courses (duration: 3 years)

- PhD programme in Materials, Mechatronics and System Engineering
- *PhD programme in Industrial Innovation (interdepartmental)*

Official language: English

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

INDUSTRIAL ENGINEERING

BACHELOR PROGRAMME

Main focuses:

- **Materials for sustainable industry**
- **Robotics and Mechatronics**
- **Management**

MATERIALS ENGINEERING

MASTER PROGRAM

2 different tracks:

- Manufacturing and Product Development
- Energy, Environment and Sustainable Development

EIT Master Programme on Sustainable Materials

suma
Master Programme on
Sustainable Materials

eit RawMaterials ACADEMY

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

MECHATRONICS ENGINEERING

MASTER PROGRAMME

3 different tracks:

- Mechanics
- Electronics and Robotics
- Intelligent vehicles

EIT Master programme in Autonomous Systems

eit Digital

MANAGEMENT AND INDUSTRIAL SYSTEMS ENGINEERING

MASTER PROGRAMME

2 different tracks:

- Design and sustainability
- Management and digitalization

EIT Master programme in
Zero-Defect Manufacture for a Circular Economy

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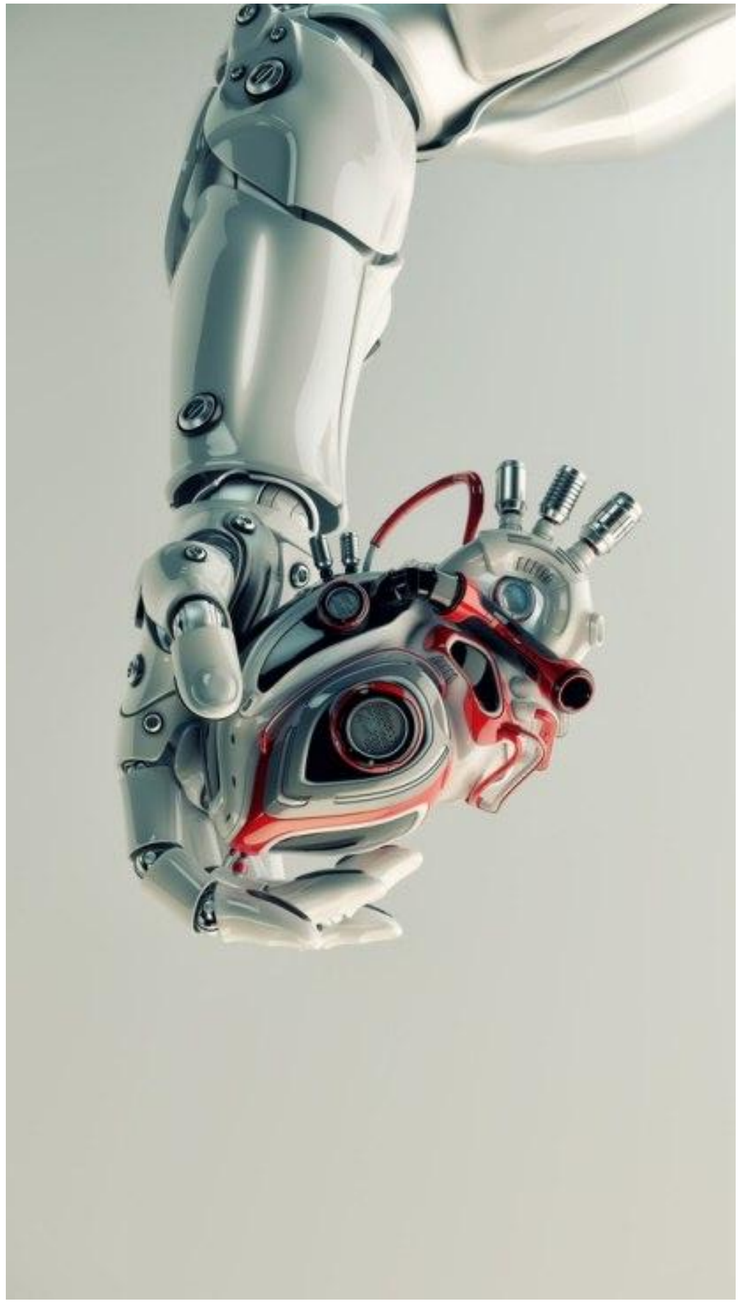
Department of Industrial Engineering



UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

BIOENGINEERING FOR PERSONALIZED MEDICINE

MASTER PROGRAMME

2 different tracks:

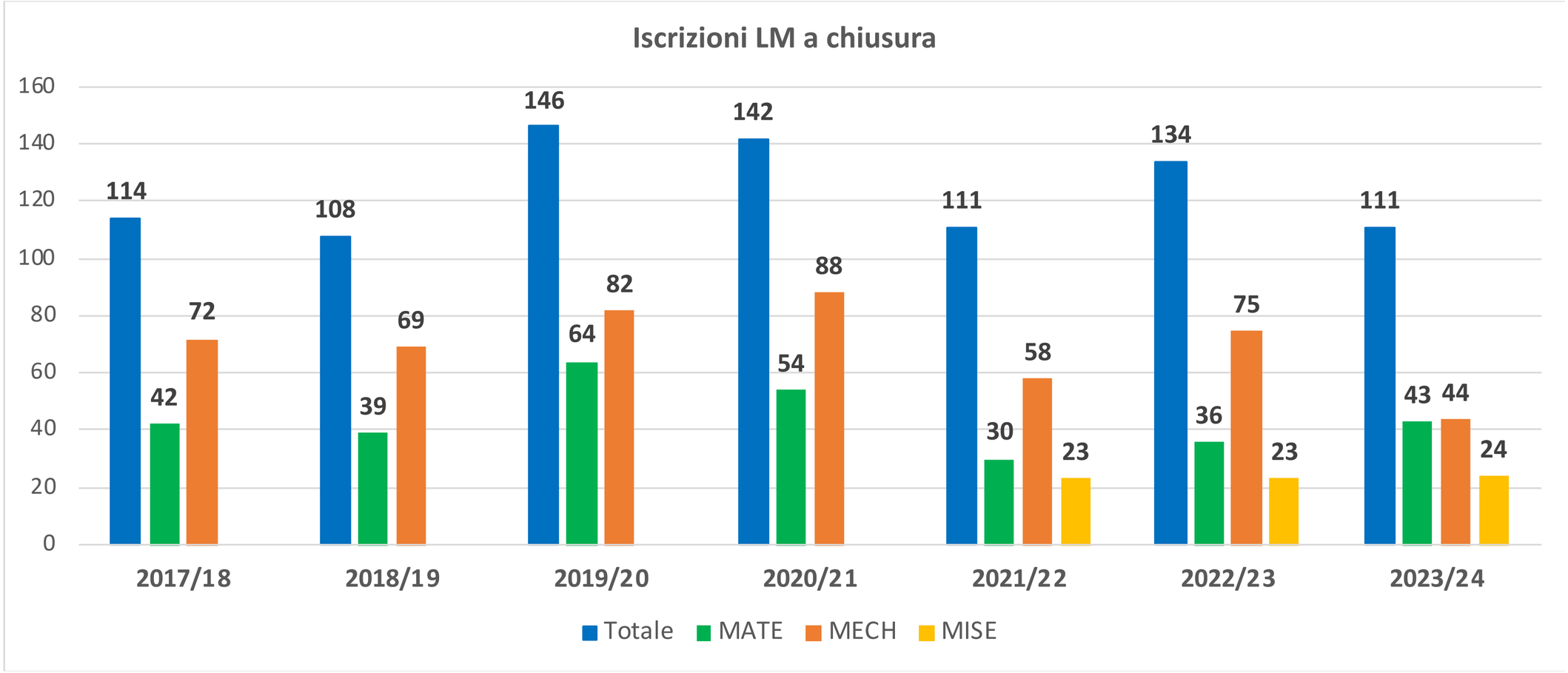
- Digital Health
- Emerging and Sustainable Medical Technologies

Enrollment data

MASTER PROGRAMS

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

Average ~ 124 students/year



MATE = Materials Engineering MECH = Mechatronics Engineering MISE = Management and Industrial System Engineering

Sustainability teaching

Courses

MATERIALI PER L'INDUSTRIA SOSTENIBILE LT IE)

- Materiali per la mobilità sostenibile

MATERIALI PER L'INDUSTRIA SOSTENIBILE (LM ME)

- Circular economy for materials processing (LM ME)
- Recycling and sustainable materials (LM ME)
- Electrochemistry for energy and environment
- Laboratory of sustainable materials processing and characterization

- Sustainable materials management (LM SME)

EIT Master Programme on Sustainable Materials

suma
Master Programme on
Sustainable Materials

eit RawMaterials ACADEMY

Sustainability teaching

Challenge-based learning courses

Circular Economy for materials processing

Project: Recycling of high speed steel from grinding swarf

Production of grinding swarf

Problem (company Julia Utensili, Tarcento, UD)

- The manufacture of high speed steel (HSS) cutting tools produces a large stream of solid waste, called **grinding swarf**
- Grinding swarf comprises microscopic steel grindings, grinding media (non-metallic particulates such as silicon carbide, aluminum oxide, etc.), and other non-hazardous solids, all of which are covered with a residue of adsorbed cutting oil.
- This oil is used as a grinding coolant as well as **lubricant** and usually contains a phosphorous ester, a water-soluble additive that is introduced to improve the tribology of the grinding process.
- The swarf stream still contains approximately 20% by weight of this non-biodegradable oil (i.e. **80%wt of steel**) that cannot be totally removed by simple draining or centrifuging.

Sustainability teaching

Challenge-based learning courses

Circular Economy for materials processing

Project: Recycling of high speed steel from grinding swarf

Production of grinding swarf

Scenario

- Formerly, **swarf was landfilled** either as a solid or a hazardous waste, depending on its regulatory definition in different states. Landfilling incurs a significant **disposal cost** as well as environmental burdens and was challenged by the increasingly strict **regulations**.
- In addition, this operation causes a serious **loss of high-quality alloy steel** (10 million pounds per year in the US, equivalent to almost 40% of the raw materials, *old data 2000*).

Sustainability teaching

Challenge-based learning courses

Circular Economy for materials processing

Project: Recycling of high speed steel from grinding swarf

Production of grinding swarf

Challenge

To evaluate possible solutions for separating and recycling high speed steel from grinding swarf

The students are requested to evaluate

- The available technologies to separate the steel fraction from the grinding swarf;
- The market and price situation, development and scenarios;
- To evaluate the environmental and economic impact of recycling;

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

MATERIALS, MECHATRONICS AND SYSTEM ENGINEERING

PHD PROGRAMME

It aims at **educating professionals able to play a key role** in the research, design and production fields of industrial engineering

Based on a **multidisciplinary approach**

Examples of research topics:

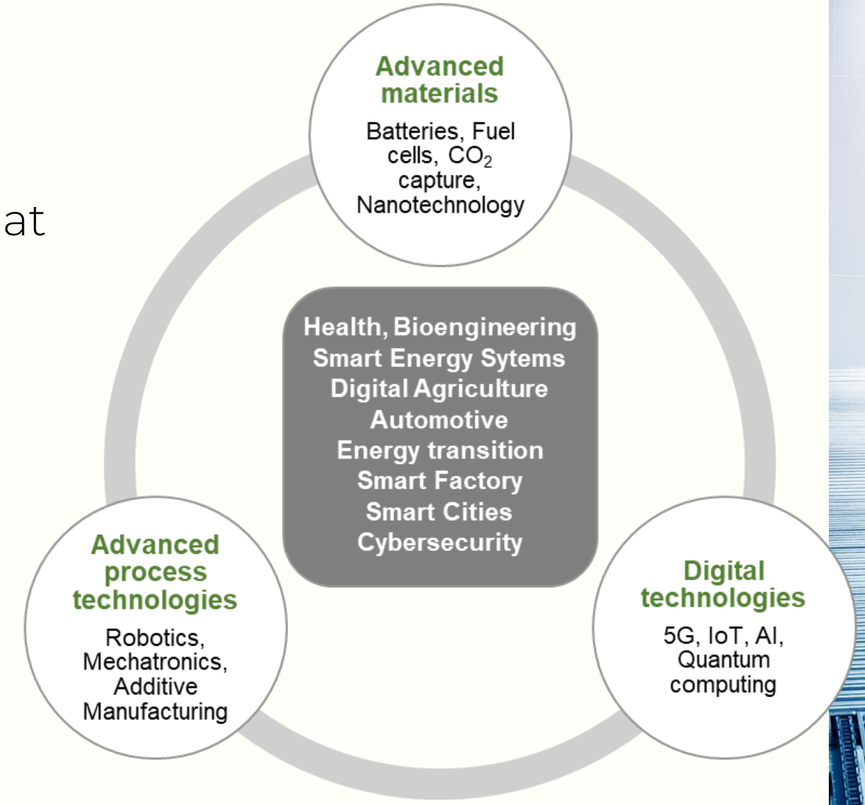
- biomaterials and biomedical technologies
- materials for energy
- intelligent machine tools and machining processes
- product innovation
- embedded systems
- wearable computing
- risk analysis
- project management

INDUSTRIAL INNOVATION

PHD PROGRAMME
(in collaboration with DISI, DICAM, DEM, DIF and FBK)

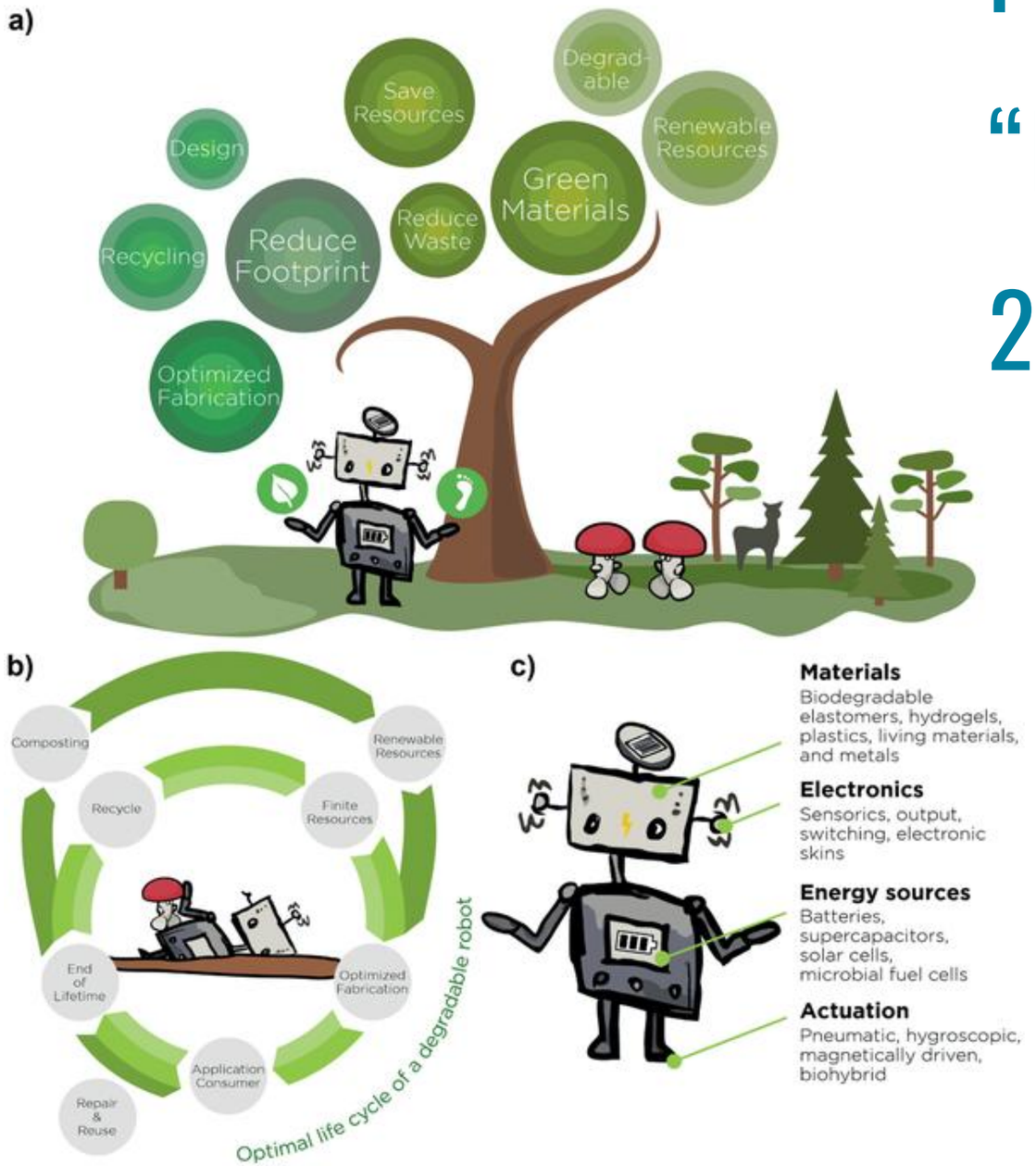
Goals:

- Training of professionals with in-depth knowledge of industrial problems and expertise in the search for innovative solutions that require **interdisciplinary knowledge**.
- Establishment of paths that enhances PhD students' **entrepreneurial, managerial and innovation process management skills** focused on market needs, providing specific training and opportunities to undertake professional experiences in industrial contexts with a high R&D intensity.



Progetto

“Dipartimento di Eccellenza 2023-2027”



Progetto “Dipartimento di Eccellenza 2023-2027”

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

Struttura: 5 pilastri portanti

P1. Progetto di ricerca dipartimentale

- Tematica scientifica: **ROBOTICA SOSTENIBILE** (aumentare l’efficienza dei robot, ridurne l’impatto ambientale e aumentare il contributo della robotica alla transizione verde). Ambiti applicativi: ambiente, salute, industria.
- 3 livelli: tecnologie abilitanti, componenti, sistemi integrati

P2. Laboratorio dipartimentale interdisciplinare (SUNRISE Lab)

- SUstaiNable RobotIcS Enabling Laboratory
- Aree scientifiche: energia; materiali e strutture; sensori/attuatori/elettroniche; controllo

P3. Dottorato internazionale

- Co-supervisione e periodo minimo presso sedi estere (possibilmente co-tutela)
- 3 cicli di dottorato

P4. Reclutamento (disponibili su progetto DE in base al quintile = 2.55 POE)

- 1 PA, 2 RTD_B, 2 PTA (livello D) = totale 2.60 POE (cofin Ateneo 0.05 POE)
- Scouting internazionale

P5. Co-finanziamento (0.7 POE)

- 0.05 per PTA + 1 RTD_B (0.65 POE già previsto su piano triennale) = 0.7 PO COFIN (28%)

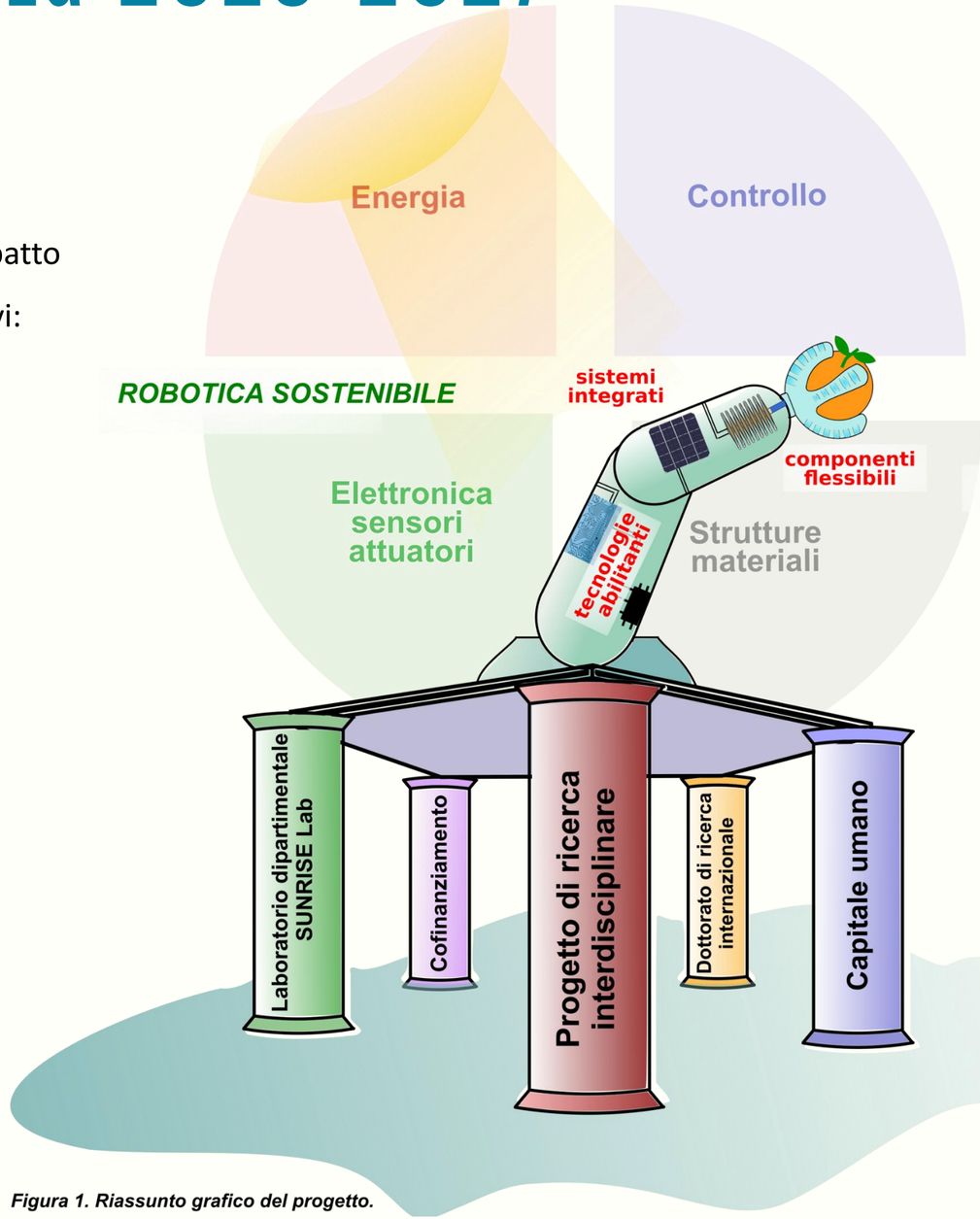


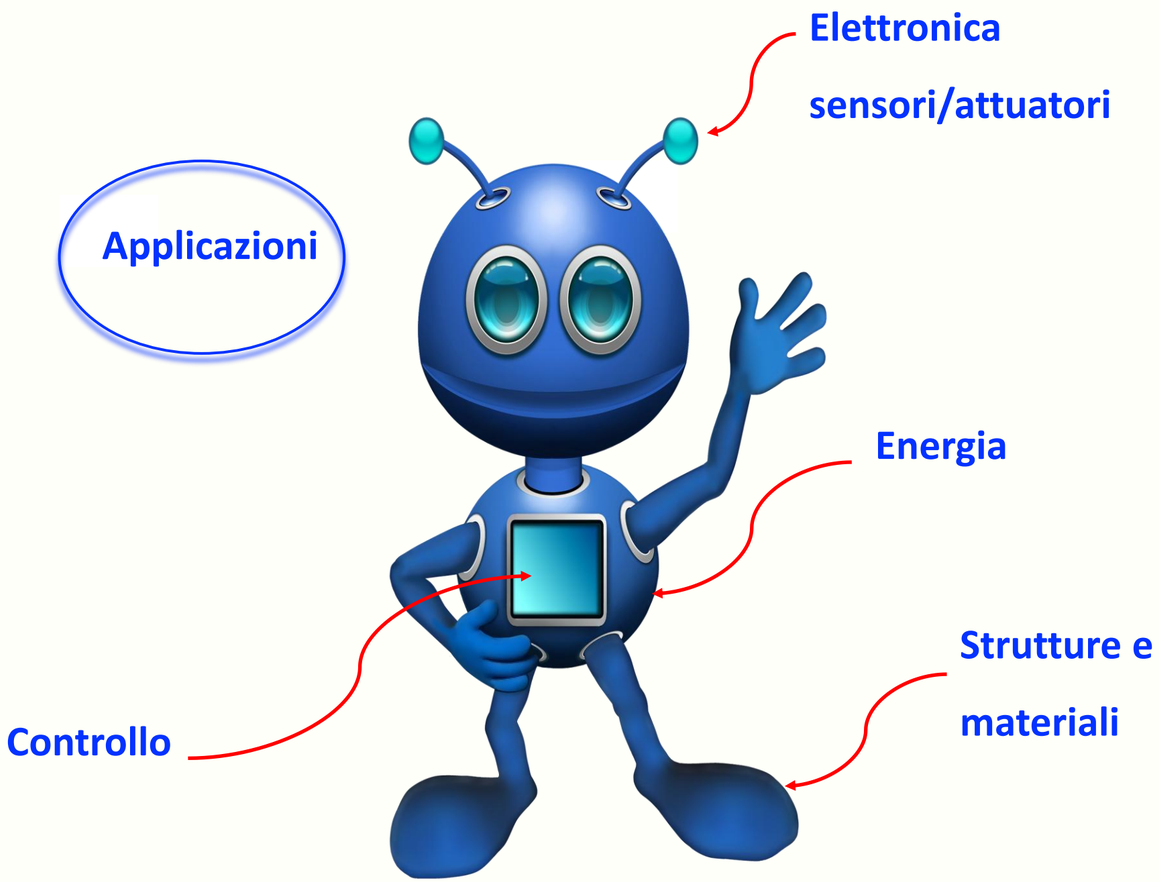
Figura 1. Riassunto grafico del progetto.

Progetto “Dipartimento di Eccellenza 2023-2027”

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering

P2. Laboratorio multidisciplinare:

SUstaiNable RobotIcS Enabling Laboratory (**SUNRISE_Lab**).



- ✓ **Strutture e materiali**: light-weigth design, nuovi materiali a **minor** impatto ambientale (da fonti **rinnovabili**, da **riciclo**), materiali più durevoli per **allungare** il ciclo di vita (ambienti estremi), design for disassembling, materiali **biodegradabili**, materiali **autoriparanti**, nuovi processi di fabricazione **neat-shape** (stampa 3D)…

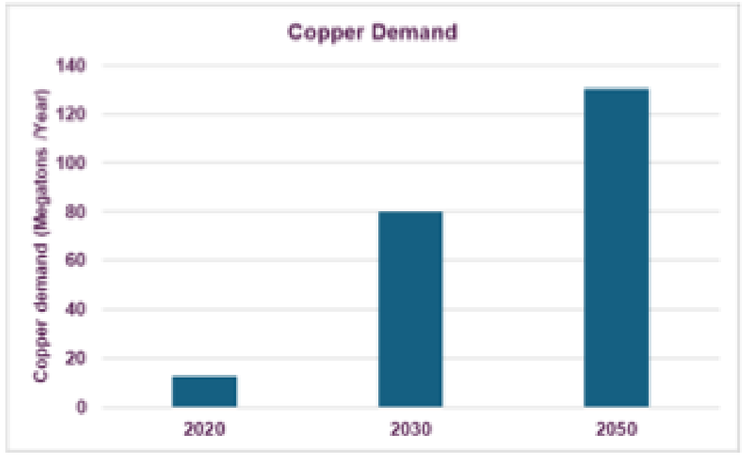
- ✓ **Elettronica/sensori/attuatori:** , sistemi embedded, nuovi sistemi di memoria e comunicazione a bassa consumo, elettronica flessibile e organica, nuovi sistemi di localizzazione, nuovi attuatori biomimetici ad elevata **efficienza**, nuovi sensori multifunzionali, sensori distribuiti (pelle elettronica).

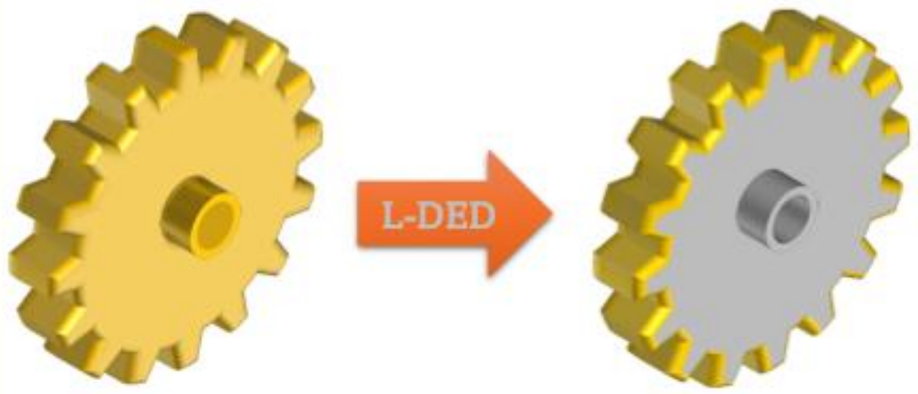
- ✓ **Energia:** sistemi per la raccolta e conversione di energia (**energy harvesting**), sistemi per **l’accumulo** di energia, batterie strutturali, batterie **riciclabli** o **biodegradabili**, supercapacitori, celle solari, ottimizzazione dei percorsi e delle traiettorie a minima energia, low-power design, sistemi battery-less.

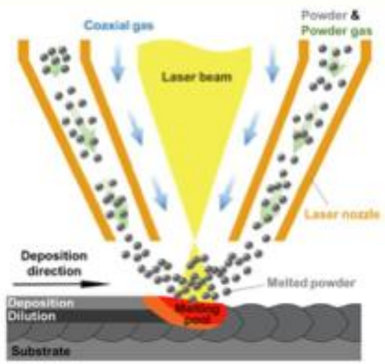
- ✓ **Controllo :** controlli ibridi e nonlineari, sistemi di auto-apprendimento, armonizzazione di machine learning (in particolare reti neurali) e metodologie di controllo classiche. , human-robot interactions, imitation learning

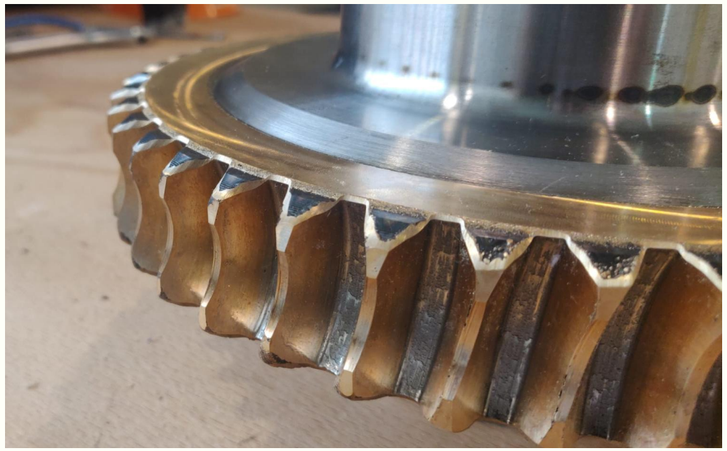
Case study 1: efficient use of bronze in worm gears

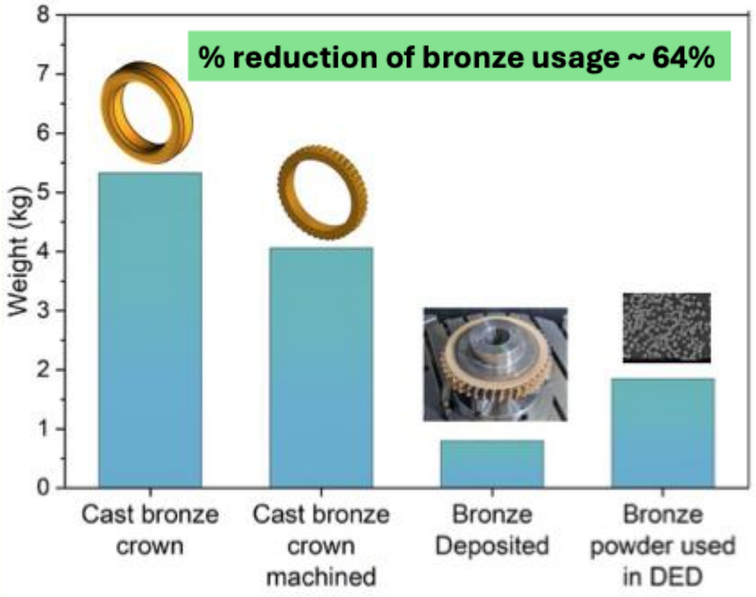
UNIVERSITÀ DI TRENTO
Department of Industrial Engineering











con il contributo di
FONDAZIONE CARITRO
CASSA DI RISPARMIO DI TRENTO E ROVERETO

Contact: matteo.benedetti@unitn.it

Case study 2: Inconel powder feedstock from scraps

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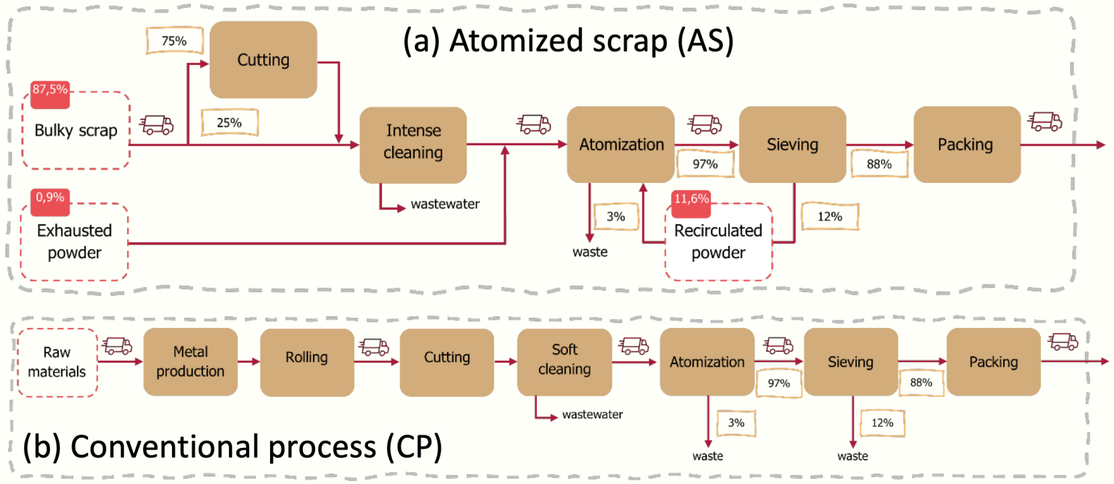
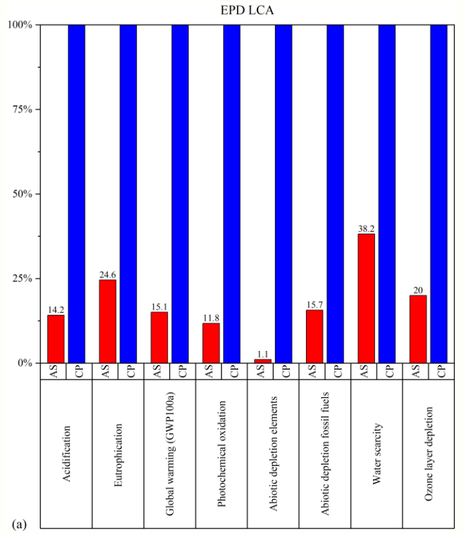
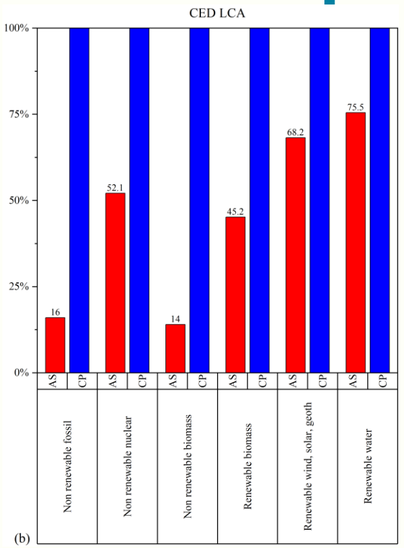
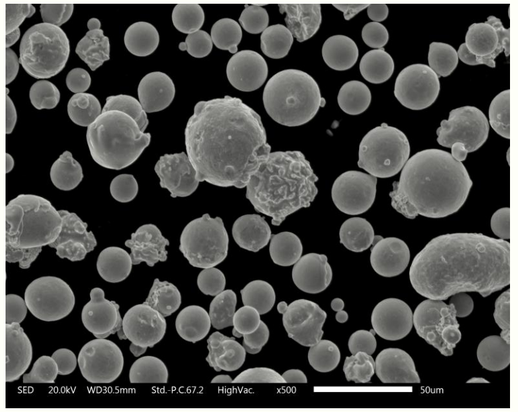
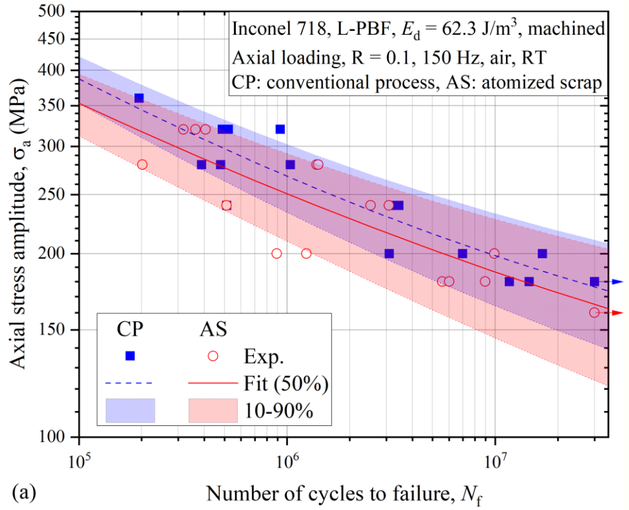
Department of Industrial Engineering











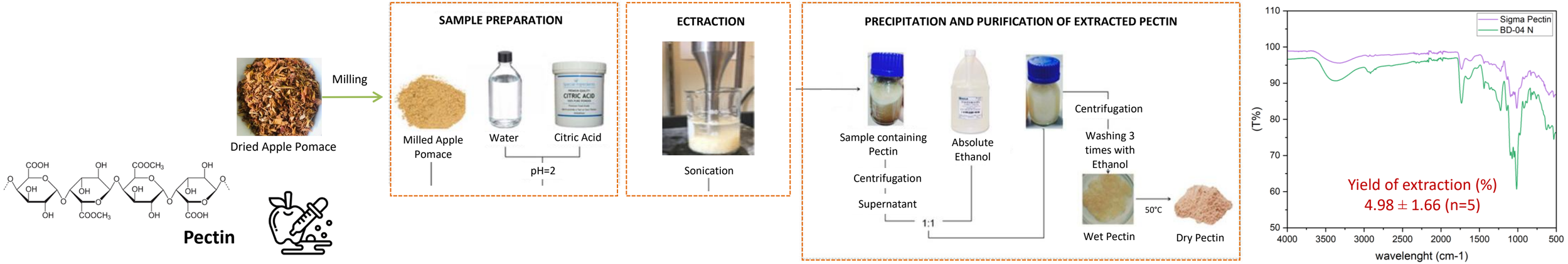
Contact: matteo.benedetti@unitn.it

Finanziato dall'Unione europea NextGenerationEU
Ministero delle Infrastrutture e dei Trasporti
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
MUR PRIN
RePowder
UNIVERSITÀ DI TRENTO
UNIVERSITÀ DI PISA

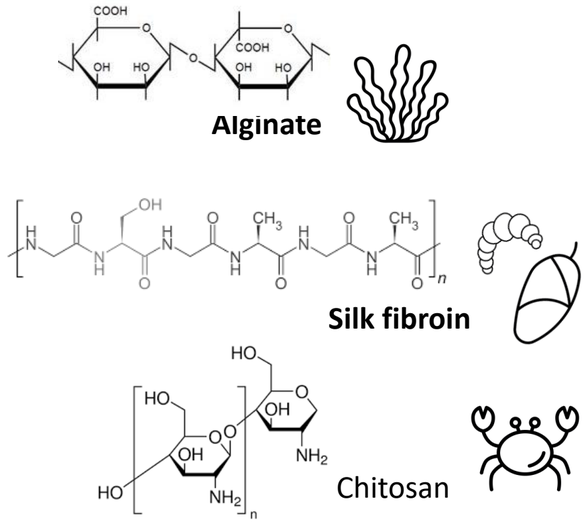
Use of natural-based materials in health

UNIVERSITÀ DI TRENTO
Department of Industrial Engineering
BIOtech
Biomedical Technologies

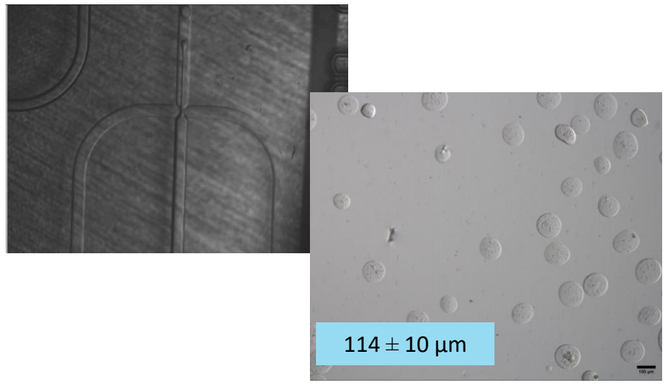
Extraction and characterization of polysaccharides from natural-derived byproducts



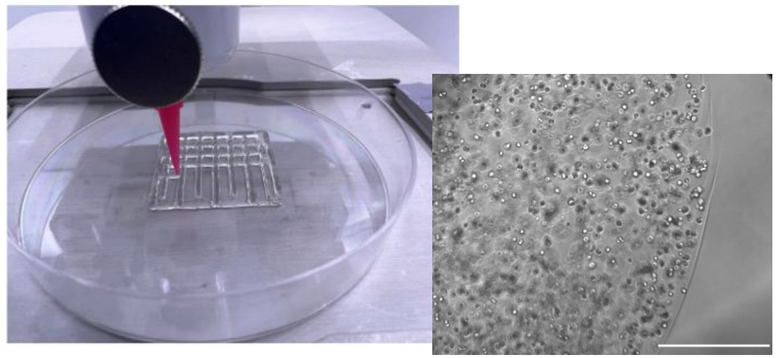
Manufacturing of Safe and Sustainable by Design (SSbD) biomaterials for biomedical applications



Controlled manufacturing of microparticles for drug release



Additive manufacturing (extrusion-based) for regenerative medicine

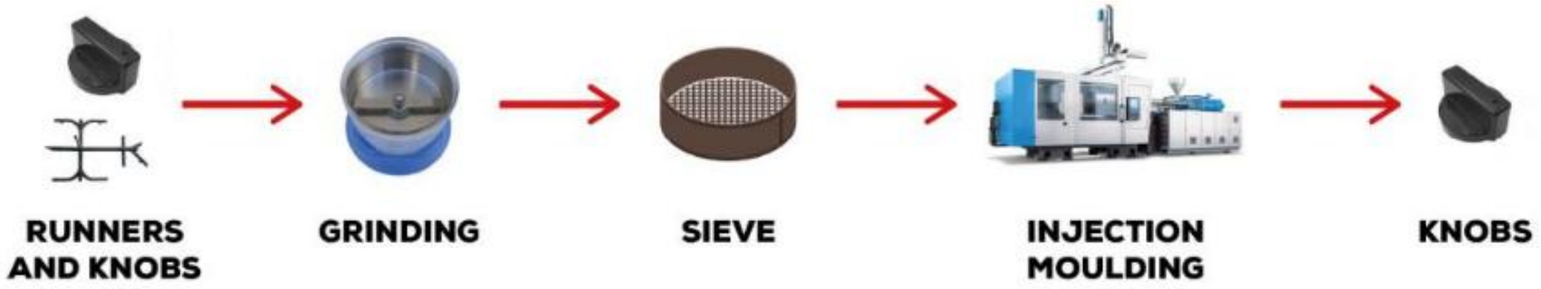


Contact: annalisa.tirella@unitn.it

Progetto ELETTROPLAST

Sviluppo di componenti per ELETTROdomestici eco-sostenibili tramite materiali PLASTici innovativi

Bando Caritro Ricerca e Sviluppo 2022/2023



Manopola originale

100% resina fenolica vergine

Manopola a ridotto impatto ambientale

15% resina fenolica riciclata

DATA INIZIO PROGETTO: 01/12/2023

DATA FINE PROGETTO: 30/11/2025

RESPONSABILE PROGETTO: prof. Andrea Dorigato andrea.dorigato@unitn.it

RICERCATORE COINVOLTO: dott. Daniele Rigotti

PARTNER AZIENDALE: Nuova Saimpa S.r.l. (TN)

UNIVERSITÀ DI TRENTO | Dipartimento di Ingegneria Industriale

Laboratorio di Vetro&Ceramici

Attività di ricerca in ambito di Economia Circolare

Tematica n. 1: recupero e riciclo di vetro da pannelli fotovoltaici e di isolanti in fibra di vetro / roccia per la produzione di manufatti in vetro e/o vetroceramica




Tematica n. 2: recupero e selezione di aggregati dalla demolizione di edifici (*construction demolition waste, CDW*) quale materia prima seconda per la realizzazione di manufatti per l'edilizia mediante tecniche di sinterizzazione a freddo (*cold sintering*)

Contact: vincenzo.sglavo@unitn.it