POLITECNICO DI MILANO

PhD in INGEGNERIA DEI MATERIALI / MATERIALS ENGINEERING - 41st cycle

THEMATIC Research Field: SUSTAINABLE MATERIALS AND TECHNOLOGIES FOR MANUFACTURING

Monthly net income of PhDscholarship (max 36 months)
1400.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The growing environmental crisis and resource scarcity require urgent changes in industrial practices. Manufacturing, a key driver of global development, must evolve to lessen its ecological impact while maintaining efficiency and competitiveness. Traditional methods often depend on non-renewable materials and generate significant waste, making sustainability a critical challenge. This research is motivated by the need to develop and implement sustainable materials and technologies that enable cleaner, more efficient manufacturing. It aims to support the transition to environmentally responsible production systems by exploring innovative solutions that balance performance, cost, and ecological impact. The main objectives: 1. Identify and evaluate sustainable materials for industrial use, focusing on material properties and lifecycle impact. 2. Investigate advanced manufacturing technologies that reduce energy consumption, minimise waste, and improve recyclability. 3. Develop integrated frameworks combining material selection, process optimisation, and sustainability metrics to guide decision-making. 4. Validate proposed solutions through experimental studies, case analyses, or pilot implementations. The

	ultimate goal is to contribute to creating greener manufacturing ecosystems that align innovation with environmental and social responsibility.
Methods and techniques that will be developed and used to carry out the research	To achieve the objectives of this research on sustainable materials and manufacturing technologies, a multidisciplinary approach will be adopted, combining experimental characterisation, analytical techniques, and environmental assessment tools. Material characterisation will be performed using: •FTIR spectroscopy to identify chemical bonds and functional groups in polymers and composites. •Thermal analysis (TGA, DSC) to evaluate thermal stability, degradation behaviour, and phase transitions. •Optical microscopy for surface morphology and microstructural observation. •Electron microscopy (SEM/TEM) to analyse fine structural details and interfaces at high resolution. •X-ray diffraction (XRD) to determine crystalline phases and structural changes during processing or recycling. Chemical technologies for recycling will be explored to recover and reuse materials, focusing on depolymerisation, solvent-based separation, and reactive extrusion. These methods will be optimised for minimal energy consumption and environmental impact. To assess the sustainability of materials and processes, Life Cycle Assessment (LCA) will be applied. This will quantify environmental impacts across the product lifecycle, from raw material extraction to end-of-life. LCA will guide material selection and process design to achieve lower carbon footprints and greater resource efficiency. Risk analysis will be conducted to evaluate potential hazards and uncertainties associated with new materials and technologies. This includes safety, regulatory compliance, and scalability risks, ensuring that proposed solutions are viable for industrial adoption. The integration of these methods will enable a comprehensive understanding of material behaviour,

	process efficiency, and environmental performance. The research will combine laboratory experimentation, modelling, and data analysis to support the development of sustainable manufacturing strategies.
Educational objectives	The PhD student will acquire advanced knowledge of sustainable materials and innovative manufacturing techniques. They will develop robust experimental skills using methods such as FTIR, XRD, and microscopy. They will learn to apply Life Cycle Assessment and risk analysis for environmental and safety evaluations. The research encourages interdisciplinary collaboration and effective scientific communication. It also promotes ethical awareness and problem-solving for real-world sustainability issues.
Job opportunities	There is a growing demand for professionals who can: •Design sustainable processes and tailored materials for specialised applications; •Innovate greener manufacturing processes; •Assess and report on sustainability and ESG metrics in industrial settings.
Composition of the research group	2 Full Professors 2 Associated Professors 2 Assistant Professors 4 PhD Students
Name of the research directors	Proff. Giovanni Dotelli and Stefano Turri

Contacts
Telephone: 02 2399 3232 / 3252 Email: giovanni.dotelli@polimi.it ; stefano.turri@polimi.it Web-pages of the research group: https://www.cmic.polimi.it/ricerca/elenco-gruppi-di-ricerca/chiplab/ https://www.cmic.polimi.it/ricerca/elenco-gruppi-di-ricerca/mat4en2/

Additional support - Financial aid per PhD student per year (gross amount)

Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities (funding for participation in courses, summer schools, workshops and conferences) - financial aid per year:
1st year: around 1.900 euros
2nd year: around 1.900 euros
3rd year: around 1.900 euros

Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD student:
There are various forms of financial of for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities within the limits allowed by the regulation.