



# PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 40th cycle

**THEMATIC Research Field: ADVANCED MODELLING AND TESTING OF THE MECHANICAL  
BEHAVIOUR OF COMPOSITE MATERIALS AND POLYMERS**

<b>Monthly net income of PhDscholarship (max 36 months)</b>
<b>€ 1500.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

<b>Context of the research activity</b>	
<p><b>Motivation and objectives of the research in this field</b></p>	<p>Although composite materials and technical polymers, both reinforced and unreinforced, are widely employed for mechanical applications, several aspects of their mechanical behavior still require careful investigation to achieve reliable design tools, particularly in the framework of durability (fatigue and creep). Understanding these aspects is crucial for the development of components that can withstand long-term use in demanding environments without failure. The increasing adoption of new technologies, like additive manufacturing (AM), poses new challenges, related to the specific microstructure and the different manufacturing routes. Additive manufacturing introduces complexities due to layer-by-layer construction, leading to anisotropic properties and unique microstructural features that differ from conventionally manufactured materials. The proposed research aims at investigating and modelling the mechanical behavior of composite materials and polymers, with a focus on additively manufactured materials. This involves a comprehensive approach that combines experimental testing, advanced monitoring techniques, and simulation tools to develop a thorough understanding of the materials' behavior under various conditions.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The research activities will be divided into two main components: experimental and modelling activities.                      Experimental Activities: The experimental activities will focus on both quasi-static and fatigue testing of materials</p>



focus on both quasi-static and fatigue testing of materials and structures. These tests will be enhanced by advanced monitoring techniques to ensure precise and comprehensive data collection. Key techniques to be employed include: Digital Image Correlation (DIC), Micro Computed Tomography (Micro-CT), particularly useful for identifying internal defects, porosities, and the overall internal structure of the materials being tested, and various Non-Destructive Testing (NDT) Methods to assess the integrity and properties of the materials without causing any damage.

**Modelling Activities:** The modelling activities will be centered around the development and refinement of simulation tools within the framework of Finite Element Modelling (FEM). These activities will include: **Development of Simulation Tools:** Creating accurate and efficient simulation models to predict the behavior of materials and structures under various conditions. This involves developing new algorithms and improving existing ones to enhance the precision and reliability of the simulations. **Finite Element Modelling (FEM):** Utilizing FEM to simulate the mechanical response of materials and structures. FEM will be used to analyze the stress, strain, and deformation of the specimens under different loading scenarios. The aim is to gain a deeper understanding of the material behavior and to validate the experimental results. **Integration of Experimental Data:** Incorporating data obtained from experimental activities into the simulation models to improve their accuracy. This includes using DIC data for surface strain validation and Micro-CT data for internal structure representation in the models. The research activity is particularly suited for candidates who have experience in either experimental techniques, such as DIC and Micro-CT, or modelling activities, particularly in FEM. Ideally, the candidate will have experience in both fields, as this dual expertise will allow for a more integrated and comprehensive approach to the research. Candidates with a background in material science, mechanical engineering, or a related field, and who have hands-on experience with these advanced techniques and modelling tools, will be well-prepared to contribute to and benefit from this research project.



<p><b>Educational objectives</b></p>	<p>The Doctor in Mechanical Engineering will be able to define, start and carry out original research by working in a team or leading a research group. Both theoretical and experimental skills will be mastered.</p>
<p><b>Job opportunities</b></p>	<p>The Doctor in Mechanical Engineering will be able to define, start and carry out original research by working in a team or leading a research group. Both theoretical and experimental skills will be mastered. The holder of a PhD in Mechanical Engineering will have job opportunities in structures/organizations aimed at innovation and/or research and technical development, high-tech SMEs, and government departments ruling on public needs. Specifically, the proposed research topic can offer job opportunities in the field of advanced manufacturing of composite structures. Employment statistics of PhDs can be found at:  <a href="https://cm.careerservice.polimi.it/en/employment-statistics/">https://cm.careerservice.polimi.it/en/employment-statistics/</a>                      List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research include:</p> <ul style="list-style-type: none"> <li>•AMADE (Analysis and Advanced Materials for Structural Design) research group of the University of Girona;</li> <li>•KU Leuven;</li> <li>•University of Bristol;</li> <li>•EPFL.</li> </ul>
<p><b>Composition of the research group</b></p>	<p>1 Full Professors                      1 Associated Professors                      1 Assistant Professors                      4 PhD Students</p>
<p><b>Name of the research directors</b></p>	<p>Prof. A. Bernasconi, M. Carboni, Eng. L. Martulli</p>

<b>Contacts</b>	
<p>Phone: +39 02 2399 8222, Email: <a href="mailto:andrea.bernasconi@polimi.it">andrea.bernasconi@polimi.it</a>                      For questions about scholarship/support <a href="mailto:phd-dmec@polimi.it">phd-dmec@polimi.it</a></p>	

<b>Additional support - Financial aid per PhD student per year (gross amount)</b>
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Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

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

Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 6.114,50. Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 750 euro/month- net amount). Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid 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 regulations.