



# PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

**THEMATIC Research Field: DESIGN AND STRUCTURAL RELIABILITY OF MULTI-MATERIAL  
TPMS COMPONENTS MANUFACTURED BY ADDITIVE MANUFACTURING**

**Monthly net income of PhDscholarship (max 36 months)**

**€ 1500.0**

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

Additive Manufacturing (AM) techniques enable the production of complex geometries that are challenging or even impossible to achieve through conventional manufacturing methodologies. This unprecedented geometrical freedom allows for the creation of multifunctional components that combine unique properties, such as excellent thermal performance, a high stiffness-to-weight ratio, and enhanced energy absorption capabilities. Recent advancements now make it possible to fabricate complex structures using multiple materials simultaneously. This breakthrough opens new opportunities for tailoring material distribution at a mesoscopic level, optimizing mechanical and thermal responses based on specific application requirements. The aim of this research is to introduce multi-material capabilities into metamaterials for structural and thermal applications. By leveraging the synergy between different materials, the study explores innovative design strategies to enhance performance, durability, and functionality in advanced engineering applications.

### Methods and techniques that will be developed and used to carry out the research

The methods and techniques for this objective will be:

- Investigation on potential application fields where the use of multi-material Triply Periodic Minimal Surface (TPMS) structures and/or lattice structures can provide a significant impact. Examples include heat exchangers and structures with tunable thermal expansion



	<p>coefficients, which can be adapted based on specific requirements.</p> <ul style="list-style-type: none"> <li>•Development of numerical models based on Computational Fluid Dynamics (CFD) and Finite Element Method (FEM) to optimize the design of the identified components.</li> <li>•Development of predictive models for structural integrity assessment of multi-material components to ensure reliability and performance under operational conditions.</li> <li>•Manufacturing of test samples and experimental validation of mechanical and thermal properties.</li> </ul>
<b>Educational objectives</b>	<p>This project is at the intersection of different disciplines ranging from mechanical/aerospace/nuclear engineering, material science, and advanced manufacturing. The educational objective is to develop the area of interaction among these disciplines to provide the PhD student new skills to be applied to the solution of a complex problem.</p>
<b>Job opportunities</b>	<p>Job opportunities are very wide for this topic, and they could be: 1) R&amp;D project engineer in aerospace, mechanical, and nuclear industry companies.</p>
<b>Composition of the research group</b>	<p>2 Full Professors 2 Associated Professors 1 Assistant Professors 5 PhD Students</p>
<b>Name of the research directors</b>	<p>Prof. Stefano Foletti</p>

<b>Contacts</b>
<p>Email: stefano.foletti@polimi.it phd-dmec@polimi.it</p>

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

<b>Scholarship Increase for a period abroad</b>
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<b>Amount monthly</b>	750.0 €
<b>By number of months</b>	6

<b>Stage and period abroad</b>	
<b>Institution or company where the candidate will spend the period abroad (name and brief description)</b>	
<b>By number of months abroad</b>	0

**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 €6,114.50.

PhD candidates benefiting from this scholarship are required to spend a research period of at least 3 months abroad, joining high-level research groups in their specific research field, as agreed upon with their Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approximately €750/month – net amount). Additionally, candidates who spend at least 3 months abroad are eligible for an extra reimbursement of €3.000 to cover travel expenses.

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