



# PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

**THEMATIC Research Field: CFD SIMULATIONS OF ADDITIVE PROCESSES FOR RECYCLED CFRP**

**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**

Three-dimensional printing (3DP), also known as additive manufacturing (AM), has rapidly evolved over the past few decades. Researchers around the globe have been putting their efforts into AM processes improvement and materials development. One of the most widely used extrusion-based technology under AM processes is Fused Deposition Modeling (FDM), also known as Fused Filament Fabrication (FFF). Numerical simulation tools are being employed to predict the FFF process complexities and material behavior. Specifically, CFD (Computational Fluid Dynamics) simulations can be used to model the additive manufacturing (AM) process of Carbon Fiber Reinforced Polymers (CFRPs) by simulating the flow and heat transfer within the printing material and around the printed part.

In this research project, the main objectives would be to develop CFD simulation modelling for predicting the temperature distribution, pressure, velocity, and viscosity of the molten material as it is deposited layer by layer. This information can be used to optimize the process parameters such as the print speed, temperature, and nozzle diameter to ensure the final part meets the required specifications in terms of mechanical properties, dimensional accuracy, and surface quality.

In addition, CFD simulations can be used to study the flow behavior of the molten material as it is extruded through



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|  | <p>the nozzle and deposited on the build platform. This can help identify potential issues such as flow instabilities, non-uniform deposition, and cooling rates that can affect the quality of the final part.</p> <p>CFD simulations can also help predict the residual stresses and deformations in the printed part, which can occur during the cooling process. This information can be used to optimize the printing process to minimize distortions and residual stresses.</p> <p>Overall, CFD simulations can be used to optimize the AM process of CFRPs, and ensure the final part meets the required mechanical and physical properties. This can help reduce waste, increase efficiency, and improve the quality of the final product.</p> <p>In this specific research the focus would be on the 3D printing of recycled CFRPs.<br/>The developed simulation models require a proper validation through data from experimental campaigns.</p> |
| <p><b>Methods and techniques that will be developed and used to carry out the research</b></p> | <ul style="list-style-type: none"> <li>- CFD simulations tools (e.g., Open Foam, ANSYS, etc.);</li> <li>- Development of specific material modelling of recycled CFRPs;</li> <li>- Proper model updating strategies need to be developed;</li> <li>- Since the model validation is essential, experimental activities on a test bench would be required. Sensorization of the test bench and data acquisition/processing skills would be required.</li> </ul>  |
| <p><b>Educational objectives</b></p>   | <p>The candidate should attend courses/seminars for enhancing his/her soft-skills and specific courses that should help the research development.</p>  |
| <p><b>Job opportunities</b></p>  | <p>Our last survey on MeccPhD Doctorates highlighted a <b>100% employment rate</b> within the first year and a <b>35% higher salary</b>, compared to Master of Science holders in the same field.</p> <p>The research activity will be conducted in cooperation with the Department of Energy (Politecnico di Milano).</p>   |



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| <b>Composition of the research group</b> | 0 Full Professors<br>2 Associated Professors<br>0 Assistant Professors<br>0 PhD Students |
| <b>Name of the research directors</b>    | Prof. Paolo Albertelli, Tommaso Lucchini   |

| Contacts   |  |
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| <i>E-mail:</i> paolo.albertelli@polimi.it                  |  |
| For questions about scholarship/support phd-dmec@polimi.it |  |

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

| Scholarship Increase for a period abroad |         |
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| <b>Amount monthly</b>                    | 700.0 € |
| <b>By number of months</b>               | 6       |

| Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information   |  |
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| <p>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 5.707,13.</p> <p>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.</p> <p>An increase in the scholarship will be applied for periods up to 6 months (approx. 700 euro/month-net amount).</p> <p>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.</p> |  |