



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

**THEMATIC Research Field: CORRELATING SHAPE AND PERFORMANCE IN COLD SPRAY  
ADDITIVE MANUFACTURING**

<b>Monthly net income of PhDscholarship (max 36 months)</b>
<b>€ 1400.0</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>Cold spray is a technology based on the use of kinetic energy to induce bonding of metal powders on substrates. The process involves accelerating the powders to supersonic speeds at which adhesion to the substrate is possible. Cold spray is an attractive technique for the creation of 3D products, as it allows us to overcome the main limitations of current additive technologies. However, shape control in this technology is still a significant challenge. This PhD program is intended to develop programming and deep learning approaches for predicting the shape of cold sprayed deposits as a function of feedstock properties, cold spray parameters and kinetics of the robot. The developed numerical model will be linked to the robot for off-line programming and designing deposition strategies to modulate the 3D shape of the deposits considering a wide variation of intricate geometries. Deviations from the desired shape will be minimized before spraying and on-line monitoring and scan strategy correcting tools will be also developed to ensure achieving the near net shape geometry. The project also envisions the development of detailed numerical solutions reinforced with deep learning approaches to correlate the mechanical properties of the architected structures to their geometry.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The project requires developing numerical models and predictive codes using deep leaning approaches, performing experimental cold spray and characterization</p>



	<p>performing experimental cold spray and characterization tests, process monitoring and robot programming. A holistic approach will be developed to correlate the architecture and shape of the cold spray structures to their mechanical performance.</p>
<b>Educational objectives</b>	<p>The educational aim of this project is to train an expert in solid state additive manufacturing technology, its development and characterization, with soft and hard skills able to direct research, development and innovation. The candidate will also gain knowledge and skills in coating and additive manufacturing sector in general and in the numerical and experimental analysis techniques requested for the correct and competitive design, application and characterization of various deposition techniques and surface treatments.</p>
<b>Job opportunities</b>	<p>The thesis is developed within the <b>ERC-2021-CoG research project ArchIDep</b> (Revolutionary solid-state deposition system to obtain heterogeneous materials, GA n. 101044228).</p> <p>Strong collaboration is envisioned with: University of UTBM, Belfort, FRUniversity of Ottawa, CA.</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>
<b>Composition of the research group</b>	<p>1 Full Professors 1 Associated Professors 3 Assistant Professors 5 PhD Students</p>
<b>Name of the research directors</b>	<p>Prof. Sara Bagherifard, Prof. Mario Guagliano</p>

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

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**

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.

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. 700 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.