POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

THEMATIC Research Field: ADDITIVE MANUFACTURED HETEROGENEOUS MATERIALS OBTAINED WITH COLD SPRAY

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 low working temperature of cold spray technology offers a unique possibility to deposit a wide variety of composite materials by mixing two or more constituent powders. Materials that are sensitive to high temperature or to oxidation can easily be deposited by cold spray, without the challenges associated with other commonly used additive manufacturing techniques that are based on melting and solidification. However, there are still some issues to be resolved before we can gain full control on the deposit characteristics in cold spray. While it is possible to precisely control the chemical composition of the powder mixture before spraying, the compositional yield in the deposit remains uncertain. The compositional deviation with respect to the feedstock is mainly due the differences in thermo-mechanical and morphological properties of different phases. Apart from that, the contribution of each phase to the mechanical performance of the integrated structure varies depending on their respective mechanical properties. This thesis plans to tackle these challenges and aims at defining cold spray design and evaluation procedures that lead to optimal structures made of two or more constituent phases. The project will account for the interaction of the dissimilar powders and estimates their respective contribution to the load-bearing capacity of the integrated structure.
Methods and techniques that will be developed and used to carry out the research	The research involves using various tools including multiscale finite element modelling (process simulation

	multiscale finite element modelling (process simulation (single and multiple particle impact), structural failure modelling of the integrated deposit, and advanced experimental analysis for depositing and evaluating the performance of multi-material cold spray additive manufactured parts (microstructural and interface properties, static and fatigue tests, etc.).
Educational objectives	The aim of this project is to educate an expert in cold spray additive manufacturing, with soft and hard skills able to direct research, development and innovation in this field; the PhD student will develop skills and attitudes that can be translated in other industrial fields. The candidate will also develop knowledge and skills in additive manufacturing sector in general and in the numerical and experimental techniques requested for a correct and competitive application of kinetic additive manufacturing processes.
Job opportunities	The research work is carried out within the European Research Council (ERC)-2021-CoG research project **ArcHIDep** (*Revolutionary solid state deposition system to obtain heterogeneous materials*, GA n. 101044228). Collaborations are envisioned with: École des Mines de Paris - Université PSL (FR), Helmut Schmidt University (DE), Impact Innovations (DE), University of Brno and Institute of Physics of Materials (CZ). Our last survey on MeccPhD Doctorates highlighted a **100% employment rate** within the first year and a **35% higher salary**, compared to Master of Science holders in the same field.
Composition of the research group	1 Full Professors 1 Associated Professors 2 Assistant Professors 4 PhD Students
Name of the research directors	Prof. Sara Bagherifard

Contacts
Email: sara.bagherifard@polimi.it *Phone:* 02-23998252

For questions about scholarship/support phd-dmec@polimi.it

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.