POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

THEMATIC Research Field: DESIGN AND IMPLEMENTATION OF CUSTOMIZED HETEROGENEITY THROUGH COLD SPRAY 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	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. 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 this challenge and aims at defining cold spray design, implementation and evaluation procedures that lead to optimal heterogeneous structures made of two or more constituent phases. The project will account for the interaction of 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 experimental tools for cold spray deposition of multi-material systems, employing a range of deposition strategies to implement and quantify both chemical and geometrical heterogeneity indices. Comprehensive experimental analyses will be systematically performed to assess how varying degrees and types of heterogeneity influence the mechanical

	and types of heterogeneity influence the mechanical performance of cold spray additive manufactured components, with particular focus on microstructural characteristics, interfacial properties, as well as static and fatigue behaviors. Furthermore, multiscale finite element modeling techniques will be developed and applied to rigorously simulate and predict structural failure mechanisms within the integrated deposits, thereby providing deeper insights into the correlation between heterogeneity and the overall integrity of the manufactured structures.
Educational objectives	The educational objective of this project is to train a highly qualified specialist in cold spray additive manufacturing, equipped with a comprehensive set of both technical and transferable skills necessary to lead research, development, and innovation within this domain. The PhD candidate will be trained to acquire advanced competencies that are applicable across various industrial sectors, with a particular emphasis on the broader field of additive manufacturing. Throughout the course of the program, the candidate will gain proficiency in a diverse array of numerical modeling and experimental methodologies essential for the rigorous and competitive implementation and characterization of additive manufacturing processes. The educational trajectory is designed to foster critical thinking, problem-solving abilities, and interdisciplinary collaboration, thereby preparing the candidate to contribute effectively to both academic research and technological advancement in industrial settings.
Job opportunities	Companies/Organizations/Research Centers aimed at innovation and/or research and technical development, high-tech SMEs, government departments in the field of automotive, aeronautics, surface engineering. Collaborations are envisioned with: •Paris-Saclay University (FR) •Institute of Physics of Materials Institute of Physics of Materials of the Academy of Sciences (CZ) •Impact Innovations (DE)

Composition of the research group	1 Full Professors 1 Associated Professors 2 Assistant Professors 16 PhD Students
Name of the research directors	Prof. Sara Bagherifard

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

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 € 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). Additionally, PhD 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 of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.