POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

THEMATIC Research Field: MICRO-SCALE DEFORMATION MECHANISMS IN ADVANCED NI-BASED SUPERALLOYS VIA IN SITU SEM HIGH TEMPERATURE MECHANICAL TESTING

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	In the engineering sector of high-temperature materials for energy technology applications, it is of a fundamental importance to evaluate the actual mechanical performances of critical components before and after in field service. Indeed, during their life, mechanical performances degrade due to the extreme conditions parts are exposed to. Understanding the effect of real operating conditions on microstructure and mechanical properties evolution at micro-scale is of paramount importance to properly assess the mechanical performances and avoid unexpected component failures.The objective of the research is to shed light on the correlation between manufacturing process, microstructure and mechanical properties of high-performance materials used for the most critical sections of gas turbines adopting advanced micro-mechanical tests.In the proposed research, alloy families of interest are Nickel-based superalloys produced both via additive manufacturing and investment casting. The ultimate scope of this research is to further explore and refine the performance limits of advanced materials and related processes to improve critical parts life with a positive impact on the whole parts lifecycle.
Methods and techniques that will be developed and used to carry out the research	The experimental part of the project will focus on investigating the deformation mechanisms at high temperature of selected Nickel-bases superalloys. Such activity will involve novel advanced microstructural

	activity will involve novel advanced microstructural characterization via electron microscopy techniques such as: scanning electron microscopy (SEM), Energy Dispersive Spectroscopy (EDS) and Electron Back Scatter diffraction (EBSD). Focused Ion Beam (FIB) may also be used for further detailed investigations. High temperature deformation mechanisms will be investigated via an advanced *in-situ* micro tensile testing system fitted in the SEM. The system is computer-controlled by a dedicated software platform integrated with the SEM. The system will be also used to evaluate the microstructural stability of selected alloys exposed to a combination of extreme temperature and stress. Conventional mechanical testing via standard equipment may also be carried out for comparing different scales. Metallurgical thermodynamic calculations via commercial software may also be carried out to support experimental observations.
Educational objectives	The main educational objective of the position is to set up new experimental techniques to characterize the micro-scale deformation mechanisms of Ni-based alloys produced by new technologies such as Additive Manufacturing and conventional alloys. The candidate will develop a strong knowledge of microstructural factors affecting the mechanical performance under extreme conditions for important mechanical components in the energy field.
Job opportunities	List of Universities, Companies, Agencies and/or Nationalor International Institutions that are cooperating in the research Companies: Baker Hughes, Auburn University, National Center for Additive Manufacturing Excellence (NCAME) Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared Master of Science holders in the same field.
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Prof. Luca Patriarca

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Contacts
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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, fundingfor 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-levelresearch 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 activitiesby the PhD candidate. There are various forms of financial aid for activities of support to theteaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.