

MECHANICAL ENGINEERING

MUR DM 118 - Design and optimization of AM metal and metal composite materials for space liquid rocket engines cooling systems applications

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Dipartimento DIMEAS
Supervisor	SESANA RAFFAELLA - raffaella.sesana@polito.it
Contact	SESANA RAFFAELLA - raffaella.sesana@polito.it
Context of the research activity	<p>The object of the research is the study, definition and introduction of an innovative class of metallic materials, composite and non-composite, processed using additive manufacturing technologies, whose objective is to improve the thermo-mechanical cyclic behavior of critical components of spatial interest.</p> <p>Progetto finanziato nell'ambito del PNRR - DM 118/2023 - CUP E14D23001790006</p>
Objectives	<p>The primary object of the research concerns the planning of processes aimed at optimizing metal alloys and/or metal-based composite materials having high thermal/electrical conductivity and mechanical strength, of potential spatial interest for combustion chambers for liquid propellant engines, heat exchangers, waveguides and particle accelerators.</p> <p>The study through Design of Experiment with the aim of exploring different combinations of process parameters for the realization of metal alloys and/or composite materials will be of first interest, together with the exploration and the proposition of alternative combinations of chemical species whose processing leads to innovative metallic and/or metallic-based composite materials that best suit the requirements.</p> <p>The search for innovative post-processing systems aimed at improving the physical/mechanical/thermal properties (e.g. heat treatments, surface treatments, etc.) will also be investigated.</p> <p>In addition to an in-depth investigation of nickel-based alloys and copper-based alloys, in the context of the thesis activity, a particular interest will be</p>

directed towards the realization of specimens processed through laser melting additive manufacturing techniques through an innovative procedure of powder mixing. These alloys, which are more properly metal matrix composites, represent an absolute innovation in the field of materials science. To verify the goodness of this new material, micrographic, mechanical (tensile tests, fatigue life, and creep) and thermal analyzes will be carried out during the research. These analyzes will be carried out both at room temperature and at elevated temperatures, also thanks to collaborations with European universities (France and Slovakia).

Skills and competencies for the development of the activity

The candidate is required to have Materials Science skills; in particular, for metallic materials, of the properties and mechanical behavior, in the elastic and plastic range, both statically and with fatigue HCF and LCF. Knowledge of production processes through Additive Manufacturing of metal components is required. In particular L-PBF processes. Knowledge of process and post-processing parameters for copper alloys and steels commonly processed using L-PBF additive technologies is required. Expertise is required in the planning and implementation of experimental campaigns aimed at the creation of specimens according to the logic of 'Design of Experiment'. Expertise in SEM, chemical and thermal analysis is required. The basic knowledge of the severe thermomechanical conditions under which the main space propulsion systems operate is required.