MANAGEMENT AND PRODUCTION ENGINEERING

MUR DM117/CIM 4.0 - Powder Bed Fusion of High-Tech Reflective Materials; Potential, Challenges and Feasible solutions

Funded By	COMPETENCE INDUSTRY MANUFACTURING 4.0 MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	Additive Manufacturing processes are recognized as the future of the manufacturing industry due to their possibilities in terms of shape design, part functionality, and material efficiency. However, a knowledge shortage in the processability of high-tech materials still limits the adoption of these technologies in some industrial sectors. Hence, this research aims to investigate the processability of this kind of materials to find the potentials and challenges to find feasible solutions for this class of materials and broaden their applications in various industries. This project is granted in the frame of PNRR-DM 17/2023. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23002010004
	High-tech alloys are materials that have been engineered to produce specific properties such as strength, corrosion resistance, heat resistance or conductivity, and other desirable characteristics. These alloys are commonly used in aerospace, automotive, medical, and other high-tech applications. For instance, the high electrical and thermal conductivities make copper the most suitable material for producing components with a high heat transfer capability. The material efficiency can be enhanced by designing shell and tube exchangers that allow high heat-transfer coefficients and high turbulence. However, high-performance design often requires many manufacturing operations, including welding, that compromise the heat exchanger's theoretical efficiency. Additive Manufacturing (AM) techniques can solve this problem definitely, but copper manufacturing is still particularly

Objectives	challenging for AM. In this research, several efforts should be carried out to face this topic and show possible solutions based on technological and material modifications. This research will highlight the best practices that can be considered for future works to accelerate the development of high-tech alloys such as copper and copper alloys processed by AM. All in all, this research will highlight the importance, challenges and opportunities when the potentialities of AM processes are integrated with the unique characteristics of high-tech alloys. To enlarge the industrial application of this class of materials processed via metal AM technologies, it is necessary to identify process parameters that optimize the properties of the final parts, such as thermophysical and mechanical properties, tolerances, surface quality, or residual stresses. Furthermore, it is also important to study the efficiency of the process in terms of powder use. This could reduce the material waste and thus the environmental impact of this process. The Interdepartmental Center of Integrated Additive Manufacturing at Politecnico di Torino (IAM@PoliTo) considers collaborating with industrial partners as a central and strategic vision to ensure that the knowledge developed in joint projects will be implemented in the industry. Considering this specific topic, the IAM research group and Competence Industry Manufacturing 4.0 (CIM 4.0) have a well-established collaboration, and this research activity will benefit from this collaboration. The objectives of this PhD are: • To identify the existing application and products of high-tech alloys processed via metal AM processes, detailing advantages and shortcomings. • To identify the potential applications for high-tech reflective materials' main challenges in the processability of high-tech reflective alloys processed via powder bed fusion technologies. • To define the main challenges in the processability of high-tech reflective alloys via powder bed fusion technologies. • To identify the possible solutions for the production of components made of high-tech reflective alloys (both technological and material solutions). • To combine CAE tools and DoE experimental approach for the definition of optimal process parameters for different high-tech alloys. • To perform full characterization of high-tech alloy specimens and analyze the outcomes for different alloys. • To correlate the Process-Structure-Properties relationship in the high-tech reflective alloys parts produced via metal AM processes. • To analyze the results of the assessment activity and define a series of guidelines for selecting the process parameters for different materials with unique properties. The research activity relates to the project that will be implemented in the Spoke 6 of the 3A-Italy program (PE 11-Made in Italy circular and sustainable). The activity will be developed at the Integrated Additive Manufacturing Center at Politecnico di Torino, Competence Industry Manufacturing 4.0 (CIM 4.0) and through a secondment abroad in a research center such as National Center for Additive Manufacturing Excellence (NCAME) at the Auburn University (USA) or German Federal Institute for Materials Research and Testing (BAM) for approximately six months.

Skills and competencies for the development of	The PhD candidate’s skills required are: • Knowledge of Metal Additive manufacturing technologies is required. • Knowledge of Materials processing together with materials characterization is highly preferred. • Knowledge of Machine learning and Python programming language is an advantage.

development of the activity	• A good attitude for lab activities, problem-solving skills, and high motivation to learn through advanced research are requested. • Ability to set priorities, work in a multicultural and multidisciplinary team, plan the work and respecting deadlines are essential.