MECHANICAL ENGINEERING

Valland S.p.A. - Design and validation of lightweight structures with enhanced thermo-mechanical properties

Funded By	VALLAND S.P.A. [P.iva/CF:00859800146]
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Context of the research activity	The PhD project, funded by Valland S.p.A., focuses on the design and development of lightweight lattice structures manufactured through metal additive manufacturing for applications in structural, energy generation, and thermal management systems. The research aims to optimize periodic cellular geometries—particularly Triply Periodic Minimal Surfaces (TPMS)—for enhanced mechanical performance and heat transfer efficiency. Activities include modeling, thermo-structural simulation, process parameter optimization, and experimental validation through prototype fabrication and testing in an industrial environment.
Objectives	The research program is funded by Valland S.p.A., a company operating in the field of industrial valves, advanced materials, and innovative processes based on additive manufacturing. The project focuses on the design, prototyping, and testing of lightweight structures based on periodic cellular architectures for applications in structural components, energy generation, and thermal management. Lattice structures offer high strength-to-weight ratios, particularly when manufactured in metal through additive manufacturing technologies. In particular, Triply Periodic Minimal Surface (TPMS) structures are highly efficient for heat sinks and heat exchangers due to their large specific surface area and excellent thermal exchange capabilities. The research activities will include: - A preliminary state-of-the-art review on metallic AM structures for cooling, heat exchange, or other energy-related applications. - Geometrical modeling of periodic cells optimized for conduction–convection heat transfer in exchangers and heat sinks. - Thermo-structural analysis using finite element software. - Investigation and testing of suitable materials and corresponding process parameters. - Fabrication of sample structures and optimization of additive manufacturing process settings. - Experimental testing of complex structures, including the possible design and realization of dedicated test benches and prototype systems aimed at

	product-level applications.

Skills and competencies for the development of the activity	Mechanical design skills, stress and structural analysis capabilities, and proficiency in developing engineering models. Ability to manage complex geometries and detailed designs using advanced CAD software. Experience in finite element modeling, including convergence and error management. Previous experience in the design and analysis of TPMS lattice structures, preferably supported by a master's thesis or equivalent academic work on the topic.