PHYSICS

CRT/Unitrento/DISAT - Elastic Metamaterials for Energy-Harvesting Related Applications

Funded By	Dipartimento DISAT FONDAZIONE CRT CASSA DI RISPARMIO DI TORINO [P.iva: 06655250014] Università degli Studi di Trento [P.iva: 00340520220]

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Context of the research activity	This PhD project explores the design, modeling, and experimental validation of elastic metamaterials with tailored dynamic properties for use in energy-harvesting systems, both at macro and micro scales.

Objectives	This PhD project delves into the comprehensive exploration of elastic metamaterials, with a specific emphasis on their design, modeling, and experimental validation for application in energy-harvesting systems across both macro and micro scales. The central objective is to engineer advanced materials with highly tunable dynamic properties, capable of manipulating mechanical wave phenomena to significantly enhance the efficiency of mechanical-to-electrical energy conversion. The research is rooted in the development of novel structural configurations that exhibit unique wave control capabilities, including but not limited to waveguiding, vibration attenuation, topological protection, wave localization, and mode conversion. These functionalities are instrumental in directing, filtering, or trapping mechanical energy in a controlled manner, thereby increasing the effectiveness of energy capture mechanisms. A particular focus is placed on topologically inspired metamaterials, which offer robustness against structural imperfections and environmental disturbances, ensuring stable performance in real-world applications. To achieve these goals, the project adopts a multidisciplinary methodology that integrates rigorous theoretical analysis, advanced numerical modeling techniques—such as finite element and Bloch wave analysis—and hands-on experimental prototyping. The experimental work aims not only to validate the predictive models but also to uncover practical constraints and opportunities that emerge during real-world implementation. This iterative process facilitates the refinement of design principles and the development of scalable fabrication strategies suitable for integration into existing energy-harvesting technologies. Ultimately, the project aspires to contribute both fundamental scientific insights and practical engineering solutions, pushing the frontier of

	metamaterial research toward real-world deployment. By bridging the gap between theory and application, this work paves the way for innovative, efficient, and resilient energy-harvesting devices, with potential impacts spanning wearable electronics, structural health monitoring, autonomous sensors, and beyond.

Skills and competencies for the development of the activity	The ideal candidate should have a strong background in solid mechanics, material physics, and numerical methods, with experience in FEM software (e.g., COMSOL, ANSYS) and elastic wave modeling. Experimental skills and familiarity with laboratory equipment are essential. The candidate should demonstrate analytical thinking, research autonomy, and the ability to work in an interdisciplinary environment, along with proficiency in scientific English.