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Multifunctional Composite Structural Elements for Sensing and Energy Harvesting

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Abstract : This study presents a new generation of lightweight and mechanically tunable structural composites with sensing and energy harvesting functionalities. This goal is achieved by integrating metamaterial and triboelectric energy harvesting concepts. Proof-of-concept polymeric beam prototypes are fabricated using 3D printing methods based on the proposed concept. Experiments and theoretical analyses are conducted to quantitatively investigate the mechanical and electrical properties of the designed multifunctional beams. The results show that these integrated structural elements can serve as nanogenerators and distributed sensing mediums without a need to incorporating any external sensing modules and electronics. The feasibility of design self-sensing and self-powering structural elements at multiscale for next generation infrastructure systems is further discussed.

Keywords : multifunctional structures, composites, metamaterial, triboelectric nanogenerator, sensors, structural health monitoring, energy harvesting
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