

DISORDERED NETWORK METAMATERIALS WITH OPTIMALLY-TAILORED MECHANICS

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Abstract

By incorporating geometric microstructural features, metamaterials have been designed to achieve tunable mechanical properties that go beyond their constituent isotropic material. Despite the number of design frameworks, metamaterials have largely been limited to understanding the properties of individual microstructural geometries without a clear method to achieve a smooth transition between them. With a focus on ultralightweight microstructures, we introduce a new framework for disordered network metamaterials with strut-based connections and perfect tetravalent coordination. These microstructures can achieve both statistically isotropic and anisotropic elastic properties while being capable of smooth, spatially varying transitions and local rotations. To develop structures with optimized stiffness under a weight constraint, we perform homogenization-based topology optimization that simultaneously optimizes the macroscopic structure and the continuous embedding of these metamaterial microstructures.