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# Topology optimization of multiphase architected materials for energy dissipation

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**Abstract**

In this article, we study the computational design of multiphase architected materials comprising a stiff phase, a dissipative phase, and void space, with enhanced vibration damping characteristics under wave propagation. We develop a topology optimization framework that maximizes a figure of merit comprising of effective stiffness, density and effective damping. We also propose novel material interpolation strategies to avoid the blending of different phases at any given point in the design domain. This is achieved by carefully defining different penalization schemes for different components of the merit function. The effective stiffness of the periodic multiphase material is calculated using homogenization theory and the Bloch-Floquet theorem is used to obtain its damping capacity, allowing for the investigation of the effect of wave directionality, material microarchitecture and intrinsic material properties on the wave attenuation characteristics. It is shown that the proposed topology optimization framework allows for systematic tailoring of microstructure of the multiphase materials for wide ranges of frequencies and densities and results in the identification of optimized multiphase cellular designs with void space that are superior to fully dense topologies.

*Keywords:* Topology Optimization, Multiphase Cellular Materials, Dissipative Materials, Optimal Damping, Architected Materials, Bloch-Floquet Theorem

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