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PROCEEDINGS

Design and Deformation Behavior of Multi-phase Mechanical Metamaterials

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ABSTRACT

Strong and tough mechanical metamaterials are highly demanded in engineering application. Nature inspired dual-phase metamaterial composites was developed and examined, by employing architectured lattice materials with different mechanical properties respectively as the constituent matrix and reinforcement phases. Then, the reinforcement phase was incorporated into the matrix phase with specific patterning. The composite metamaterials were simply fabricated using additive manufacturing. From quasi-static compression tests, the strength and toughness could be simultaneously enhanced after the addition of reinforcement phase grains. Through simulation modeling, effects of dual-phase distribution, elementary architecture, parent material and defects on mechanical properties of dual-phase mechanical metamaterials were investigated. The results shown that the dual-phase distribution pattern affected the distribution of shear bands, lattice fracture toughness, and the energy dissipation during the phase boundary slip. Meanwhile, defects could also guide the deformation mode and help protect the functional phase therein. Additionally, enhancing reinforcement and connection phases, could dramatically improve mechanical properties and energy absorption. Accordingly, the designing rationale for dual-phase metamaterial composites was proposed, and results in this study provided a novel pathway for multi-functional architectured metamaterials.

KEYWORDS

Mechanical metamaterials; bioinspired design; toughening mechanism; additive manufacturing; defects

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