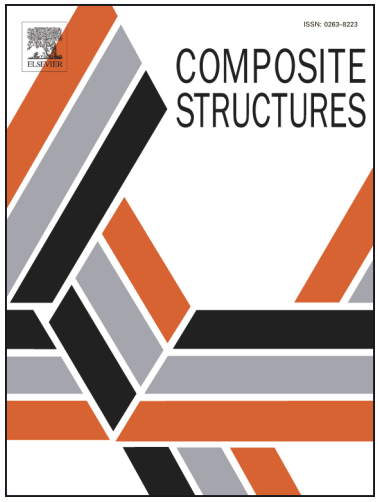

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Bi-material microstructural design of chiral auxetic metamaterials using topology optimization

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Abstract: This paper presents a new bi-material microstructural design method for chiral auxetic metamaterials. Based on the independent point-wise density interpolation (iPDI) and a bi-material model, optimal design problem of periodic unit cells is formulated using nodal density variables. The design objective is to minimize the Poisson's ratio while satisfying the specified volume constraints of the hard and soft materials, and the effective elastic properties of the bi-material microstructure are computed by the asymptotic homogenization method under periodic boundary conditions. This topology optimization problem is solved with a gradient-based mathematical programming algorithm on the basis of the sensitivity analysis. Several numerical examples, regarding design of anisotropic, orthogonal anisotropic and isotropic bi-material microstructures of chiral auxetic metamaterials, are given to demonstrate the effectiveness of the method. It is shown that the proposed bi-material design optimization method can be used to improve the performance of chiral auxetic metamaterials through enlarging the design space.

Keywords: Mechanical metamaterial; chiral auxetic metamaterial; bi-material microstructure; topology optimization; independent point-wise interpolation