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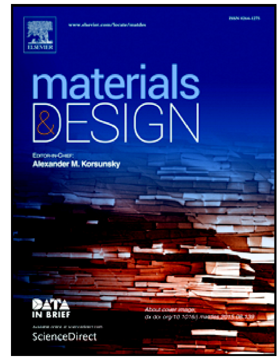

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Macroscopic mechanical response of chiral-type cylindrical metastructures under axial compression loading

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Abstract.

Chiral cellular structures inspired by the microstructure of biomaterials can display auxetic performances, such as negative Poisson's ratio (NPR), negative stiffness, energy dissipation, and acoustic absorption. In this study, novel chiral-type cylindrical shells were designed and fabricated via 3D printing method. Theoretical analysis, finite element analysis, and experiments were conducted to investigate the mechanical properties and deformation characteristics of cylindrical shell with various categories of chiral-type cells. Results revealed that the anti-chiral shell and chiral–axial shell can achieve auxetic behavior, namely, NPR behavior and compressive-twist response, which are beneficial for energy absorption and vibration isolation performance. Given the distinction in the geometrical configuration of unit cell, the cylindrical shells exhibited extremely diverse mechanical properties. The analytical formulae of axial compressive modulus were deduced based on Euler–Bernoulli beam theory, and the applicability and accuracy were verified. The new mechanical metastructures offer potential applications as smart actuators, biomechanical devices, and sensors in various industries.

Keywords: auxetic cellular structure; negative Poisson's ratio; compressive-twist coupled response; finite element method.

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