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SpiderWeb honeycombs

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ABSTRACT

A new class of hierarchical fractal-like honeycombs inspired by the topology of the “spiderweb” were introduced and their small and large deformations were investigated analytically, numerically, and experimentally. Small deformation elasticity results show that the isotropic in-plane elastic moduli (Young’s modulus and Poisson’s ratio) of the structures can be controlled over several orders of magnitude by tuning dimension ratios in the hierarchical pattern of spiderweb, and the response can vary from bending to stretching dominated. In large deformations, spiderweb hierarchy postpones the onset of instability compared to stretching dominated triangular honeycomb (which is indeed a special case of the proposed spiderweb honeycomb) and exhibits hardening behavior due to geometrical nonlinearity. Furthermore, simple geometrical arguments were obtained for large deformation effective Poisson’s ratio of first-order spiderweb honeycombs, which show good agreement with numerical and experimental results. Spiderweb honeycombs exhibit auxetic behavior depending on the nondimensional geometrical ratio of spiderweb.