Size-dependent and tunable elastic and geometrical properties of nano-structured hierarchical cellular materials

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Abstract

The basic building blocks of nano-structured hierarchical cellular materials are nano-sized wires or plates. Due to the effects of surface elasticity and the initial stress/strain, their bending, torsion, stretching and transverse shear rigidities are not only size-dependent, but also tunable and controllable over a large range. Based on the closed form results of the bending, torsion, stretching and transverse shear rigidities of nanowires [1, 2] and nano-plates [3,4], the analytical results for the size-dependent and tunable elastic and geometrical properties are obtained for the first order nano-sized regular honeycombs [4,5]and open-celled foams[6], and the similar results are obtained for the first order nano-sized random irregular Voronoi honeycombs[7] and random Voronoi open-celled foams by computer simulation. Further, the size-dependent and tunable elastic and geometrical properties are obtained for nano-structured hierarchical and self-similar regular and irregular honeycombs and open-celled foams. The obtained results indicate that some very interesting and much desired elastic and geometrical properties, which do not exist in conventional cellular materials, become possible in their nano-structured hierarchical counterparts.

Keywords: Size effects, Elastic properties, Honeycombs, Open cell foams.

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