Plasticity can yield doubly-negative post-buckling behaviour in hard metastructures

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Abstract

Perforating a structure with a series of holes can render it auxetic. The negative Poisson's ratio that emerges beyond the buckling threshold is a consequence of geometric nonlinearities introduced by the holey topology. Here, we explore the buckling behaviour of hard, holey structures which exhibit distinct post-buckling behaviour to their elastic counterparts. In particular, we observe both negative Poisson's ratio and a negative stiffness in hard materials that deform plastically as they buckle. We demonstrate that the post-buckling softening behaviour is a consequence of material constitutive nonlinearities in the rotation and shear response of the structural microarchitecture.

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