Origami-inspired deployable auxetic metamaterials

Eidini, Maryam, mareidini@gmail.com; Paulino, Glaucio, University of Illinois at Urbana-Champaign, United States

ABSTRACT

Developing complex spatial objects from a flat sheet of material using origami folding techniques has long attracted attention in science and engineering. Recent research has shown that in origami-based deployable folded sheet materials, such as Miura-ori, metamaterial properties of the patterns are basically because of their folding geometry [1, 2]. In this study, we employ tailored origami folding techniques as a means to create a class of metamaterials. Simple stretching and bending experiments show that these materials exhibit a negative in-plane Poisson’s ratio under extension (i.e., auxetic materials), and a positive Poisson’s ratio under bending. Therefore, similarly to the Miura-ori pattern, the in-plane and out-of-plane Poisson’s ratios of these patterns are of opposite signs, which is an unusual property of such material systems. In-plane Poisson’s ratio and planar stretching stiffness of such class of materials are also studied analytically. Eigenvalue analysis of the patterns and simple experiments show that these patterns are rigid-foldable, flat-foldable, and have only one kinematic degree of freedom. These properties make them appropriate for applications such as deployable architectural ceiling and façades. In addition, they have the potential to be applied as light cellular folded core material among several other possible engineering applications.

REFERENCES