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Durable Bistable Auxetics Made of Rigid Solids

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Bistable Auxetic Metamaterials (BAMs) are a class of monolithic perforated periodic structures with negative Poisson's ratio [1]. Under tension, a BAM can expand and reach a second state of equilibrium through a globally large shape transformation that is ensured by the flexibility of its elastomeric base material. However, if made from a rigid polymer, or metal, BAM ceases to function due to the inevitable rupture of its ligaments. The goal of this work is to extend the unique functionality of the original kirigami architecture of BAM to a rigid solid base material. We use experiments and numerical simulations to assess performance, bistability and durability of rigid BAMs at 10,000 cycles. Geometric maps are presented to elucidate the role of the main descriptors of BAM architecture. The proposed design enables the realization of BAM from a large palette of materials, including elastic-perfectly plastic materials and potentially brittle materials.

References

[1] A. Rafsanjani and D. Pasini: Bistable auxetic mechanical metamaterials inspired by ancient geometric motifs, *Extreme Mechanics Letters*, Vol 9 (2), 291(2016).