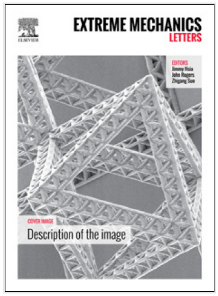

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Mismatch Strain Programmed Shape Transformation of Curved Bilayer-Flexible Support Assembly

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Abstract

Shape transformation in three dimensional (3D) structures is of interest in the design of engineered systems capable of accomplishing particular tasks that are unachievable by two dimensional (2D) architectures or static 3D ones. One approach involves the incorporation of stimuli responsive materials into the structural assembly to induce such transformations. In this work, we investigate the transformation of a curved bilayer ribbon supported by a flexible assembly that belongs to a family of complex three dimensional architectures. Through finite element analysis, we identified key design parameters and their effects on the deformation behavior of the assembly when it is subjected to an external stimuli in the form of a mismatch strain. Our results show that the behavior of the curved bilayer in response to the stimuli could be tuned by controlling the structural properties of the assembly. Our calculations also reveal a diverse set of deformation mechanisms including gradual flipping, snapping and creasing of the curved bilayer under specific circumstances. The design principles established in this work could be used to engineer 3D sensors, actuators for traditional and soft robotics, electronic device components, metamaterials, energy storage and harvesting devices with on-demand functional capabilities enabled by 3D transformations.

Keywords: Programmable matter, Mechanical instability, 3D architecture, Shape transformation, Finite element analysis.