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Shape programmable structures

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ABSTRACT

Shape programmable structures and devices are typically fabricated using shape memory materials and are attracting increasing interest because they can be designed to have multiple properties and functions. However, shape memory materials, such as NiTi-based metal alloys and block copolymers, suffer from severe structural fatigue due to the microstructural changes occurring during each thermal cycle. Moreover, there is only a limited set of shape memory material systems, limiting the possible number of applications for reconfigurable structures and devices. To overcome all these issues and expand the range of applications of shape programmable structures, we designed a library of 2D elastic structures that can be programmed to retain multiple shapes simply by applying a force. The building block of our structure consists of a unit comprising interconnected elastic arches and we demonstrate both numerically and experimentally that geometric nonlinearity and snap-through instabilities can be effectively exploited to reconfigure the system into multiple shapes. Because our system exploits mechanical instability, our findings can be extended to different materials and length scales, outlining a general strategy to effectively design a new generation of shape programmable structures.