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Harnessing snap-through instability for shape-recoverable energy-absorbing structure SUNG KANG, SICONG SHAN, JORDAN RANEY, PAI WANG, FRANCISCO CANDIDO, JENNIFER LEWIS, KATIA BERTOLDI, Harvard Univ — Energy absorbing materials and structures are used in numerous areas for maintaining structural integrity, protection and comfort. To absorb/dissipate energy from shock/vibration, one generally relies on processes such as plastic deformation and damping as the case of metal foams and suspensions. Because plastic deformation and damping induce irreversible change in the energy-absorbing systems such as shape changes and degradation of damping elements by heat dissipation, it would be desirable to develop a new energy-absorption mechanism with reversibility. Furthermore, it would be desirable to implement energy-absorption mechanisms whose behavior is not affected by the rate of loading. Here, we report a shape-recoverable system that absorbs energy without degradation by harnessing multistability in elastic structures. Using numerical simulations, we investigate geometrical parameters that determine the onset of the snap-through and multi-stability. We subsequently manufacture structures with different geometrical parameters and sizes using a scalable direct-write 3D printing approach. We experimentally demonstrate reversible energy-absorption in these structures at strain rates over three orders of magnitudes, with reduced peak acceleration under impact by up to one order of magnitude compared with control samples. Our findings can open new opportunities for scalable design and manufacturing of energy-absorbing materials and structures.

Sung Kang
Harvard Univ

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