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Architecting Stress- and Temperature-Induced Phase Transformation

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Phase transforming cellular materials are architectured materials whose unit cells have multiple stable configurations. If designed correctly, these materials can absorb energy by allowing controlled snap-through mechanisms as the cells transform between different stable configurations. Most previous works on architecture materials with snap-through mechanisms focused on material behavior when the material is loaded in one direction. Mostly because, most of the designs were limited to 1D behavior. In this work, we propose a new family of 2D structures defined by the number of axis of symmetry through a combined analytical, computational and experimental approach. This includes a new family of cellular architectures that employ cylindrical shell elements dissipate energy by triggering local snap-through instabilities. Physical samples were manufactured and tested in loading and unloading cycles. Ancillary analytical and computational analysis guided the design and help understand the different mechanisms acting in the system for energy dissipation. Our mechanical tests have shown key similarities in deformation modes with the simulations, and verified that there is significant energy dissipation due to snapping instabilities as expected. We also look at the application of these mechanisms to the design of temperature-induced phase transformation taking into advantage design and combination of materials to produce shape memory and actuation capabilities.