Employing thermal activation to tune auxeticity in periodic lattice structures

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Abstract

Auxetic periodic lattice structures are characterized by a negative Poisson's ratio, a property which is useful in a variety of fields such as architecture, soft robotics, and bio-medical devices. The auxeticity stems from the topology and the geometry of the struts. The current literature reports a wide range of unit cells that exhibit an auxetic response, with Poisson's ratios that range from 0 to near -1.
In this talk I will present a design concept for smart structures that transition from non-auxetic to auxetic via thermal excitation. The lattice is made of bi-layer struts with different thermo-mechanical properties, such that thermal excitation leads to bending. As a result, the lattice can be programmed to transition to an auxetic design.

To investigate the thermo-mechanical behavior, we employ moderate rotations theory, which captures the response of beams that experience large deflections, and model the thermally induced geometric changes of the struts in the lattice. I show that an appropriate design and choice of thermo-mechanical properties can result in a thermally induced transition from non-auxetic to auxetic behavior. In addition, temperature enables one to control the degree of auxeticity in the lattice.

To demonstrate the concept, I will present two periodic lattices and show that temperature can be used to program the Poisson's ratio over a wide range. The findings from this work can be used to design lattices with thermally tunable properties.

References

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