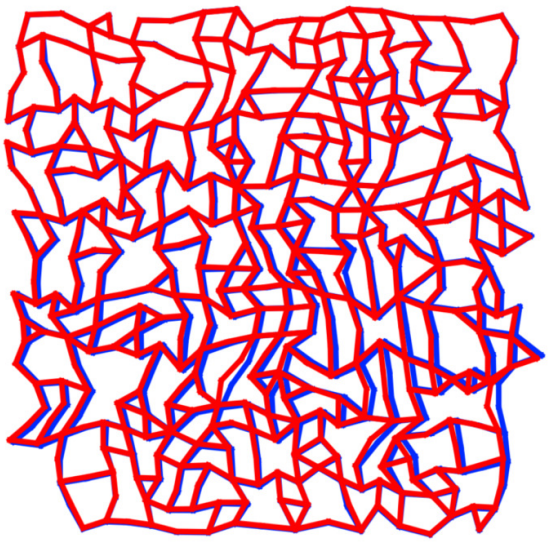
CHiMaD | Center for Hierarchical Materials Design
chimad.northwestern.edu

Auxetic Metamaterials From Disordered Networks

Daniel R Reid, Nidhi Pashine, Justin M Wozniak, Heinrich M Jaeger, Andrea J Liu, Sidney R Nagel, and Juan J de Pablo



Caption: A compressed 500-node experimental network with comparison to simulation. Image compares the experimental configuration with that predicted from simulation at a strain in the vertical direction of 0.04. In red is shown a rendering of the experimental configuration and in blue is shown the simulated configuration at the same strain.

Scientific Achievement

We have introduced a realistic model that incorporates angle-bending forces into the mechanics of networks. A sequential pruning strategy of select bonds in this model was then devised and implemented that enables engineering of specific mechanical behaviors upon deformation, both in the linear and non-linear regimes. In particular, it was shown that the Poisson's ratio can be tuned to arbitrary values. The model and concepts were validated by preparing physical realizations of the networks designed in this manner. These were produced by laser cutting two-dimensional sheets and were found to behave as predicted. We have also exploited the networks' susceptibility to tuning in order to design networks that possess a distribution of stiffer and more compliant bonds, and whose auxetic behavior is even greater than that of the homogeneous networks.

Significance

Taken together, our findings establish that pruned networks represent a promising platform for the creation of novel mechanical meta-materials and a platform to design materials for impact mitigation.

Citation

"Auxetic metamaterials from disordered networks," by Daniel R Reid, Nidhi Pashine, Justin M Wozniak, Heinrich M Jaeger, Andrea J Liu, Sidney R Nagel, and Juan J de Pablo. arXiv:1710.02493.