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Topology Matters: Expanding the Design Space of Lightweight Mechanical Metamaterials

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Topology matters: expanding the design space of lightweight mechanical metamaterials.

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When considering lightweight mechanical metamaterials, truss-like nanolattices have prevailed as the architecture of choice over the past few years, see [1] and references therein. In such metamaterials, unprecedented mechanical properties can be achieved by exploiting material size-effects. However, little attention has been placed in the development of novel architectures to expand the space of attainable mechanical properties, as most metamaterials in this category are based on well-known lattice configurations.

In contrast, in this work we focus on purely topological aspects of lightweight architectured metamaterials. More precisely, we introduce a new 3D lattice topology that prevents the formation of continuous compression chains within the metamaterial. That is, from a topological perspective, our lattices are continuous in tension and discontinuous in compression. As a result, we show that our lattices prevent failure localization even when subject to extremely large deformations. We also explore other aspects of this new family of lattices, unveiling unprecedented mechanical properties, including the presence of phase transitions and a tuneable dynamic response.

References:

[1] Bauer, J., Meza, L. R., Schaedler, T. A., Schwaiger, R., Zheng, X., & Valdevit, L. (2017). Nanolattices: An Emerging Class of Mechanical Metamaterials. Advanced Materials, 29(40).