Unstable mechanical metamaterials: principle, design, and characterization

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Metamaterials are characterized by effective properties which are mainly driven by the topology of the microstructure, instead of the properties of its constituents. Following this idea, a lot of unusual and interesting effective properties can be realized, by for example exploiting the capabilities of instabilities [1,2]. By a combination of unstable cells timescale independent effective energy dissipation can be achieved together with a fully reversible deformation. This stands in sharp contrast to the usual (irreversible) plasticity and timescale dependent viscoelasticity of metals and polymers. Additionally instabilities give rise to the design of so-called programmable metamaterials whose constitutive behavior can be changed by the loading history.

In this talk, a brief introduction into the idea of unstable metamaterials is given. The aforementioned properties are demonstrated by both, numerical investigations and experimental results. The talk is concluded with a short discussion about the homogenization of (unstable) metamaterials, which is the object of recent investigation.

[1] T. Frenzel, C. Findeisen, M. Kadic, P. Gumbsch, and M. Wegener, *Tailored buckling micro-lattices as reusable light-weight shock absorbers*, Adv. Mater. 28 (2016), 5865–5870.

[2] C. Findeisen, J. Hohe, M. Kadic, and P. Gumbsch, *Characteristics of mechanical metamaterials based on unstable cells*, J. Mech. Phys. Solids 2017 (submitted).