ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Mechanics & Materials Laboratory
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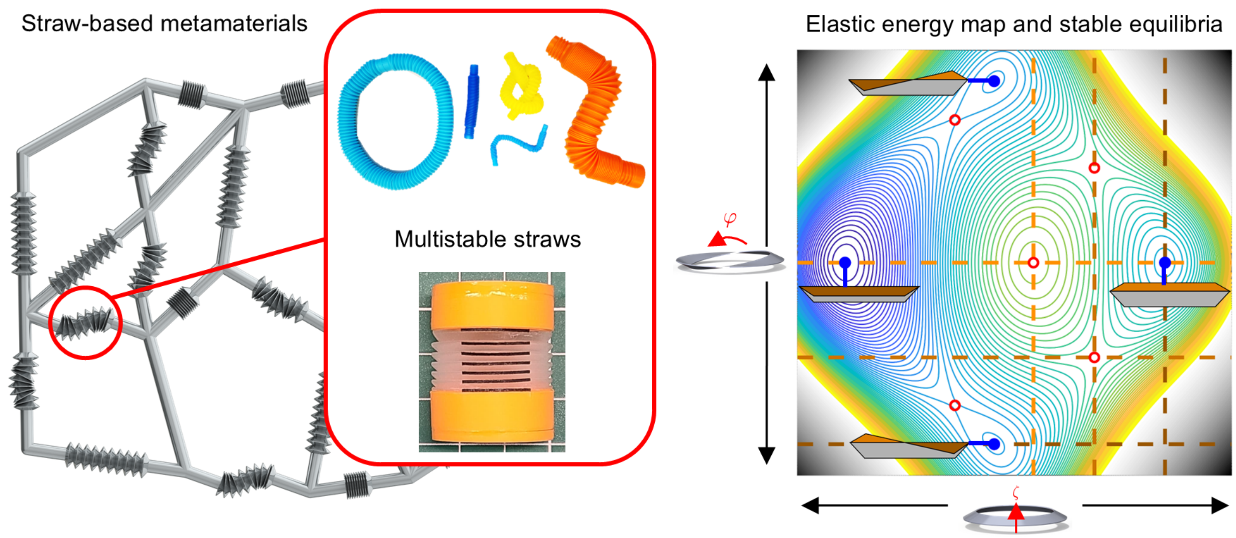
Semester Project/Master's Thesis

Experimental study for 2D straw-based metamaterials with large number of unit cells



Description:

Reconfigurable metamaterials whose shapes and properties can be tailored thanks to the multistability of their constituent unit cells, have attracted significant attention due to their unique characteristics. For example, hierarchical structures composed of repeated bistable elements show extreme properties such as large elastic deformations with zero Poisson's ratio, as well as multiaxial complex stable states. Such properties have cross-disciplinary importance and they can be vital for a large variety of applications spanning from deployable structures and soft robots to shock absorption.

Our ongoing research deals with truss metamaterials, whose members are modelled as "bendy-straws" which are characterized by local multistability. Namely, under suitable design parameters each constituent segment of every straw has four stable equilibria in 2D and infinite stable equilibria in 3D, which provide a straw-based truss metamaterial, a myriad of stable configurations. Thus, a careful design of such metamaterials can lead to a structures with different operative stable configurations, having distinct static and dynamic properties.

The goal of this project is to experimentally investigate 2D straw-based metamaterials composed of a large number of unit cells. The blow molding technique will be utilized for batch fabrication of the unit cells. The initial focus is on achieving consistent quality and high reproducibility by optimizing the fabrication parameters. Once fabricated, the straws will be characterized using a 2D motion platform, a 6-axis force sensor, and our established computer vision algorithm. Special attention will be given to mitigating out-of-plane motion during testing to ensure accurate results. The experimental findings will be used to validate the mechanical properties predicted by computational models, including variable Poisson's ratio and Young's modulus.

Pre-requisites:

- A background in mechanical design and manufacturing
- Literacy in computer aided mechanical design
- Literacy in Matlab coding
- Strong technical skills and willingness to take part in developing fabrication method

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