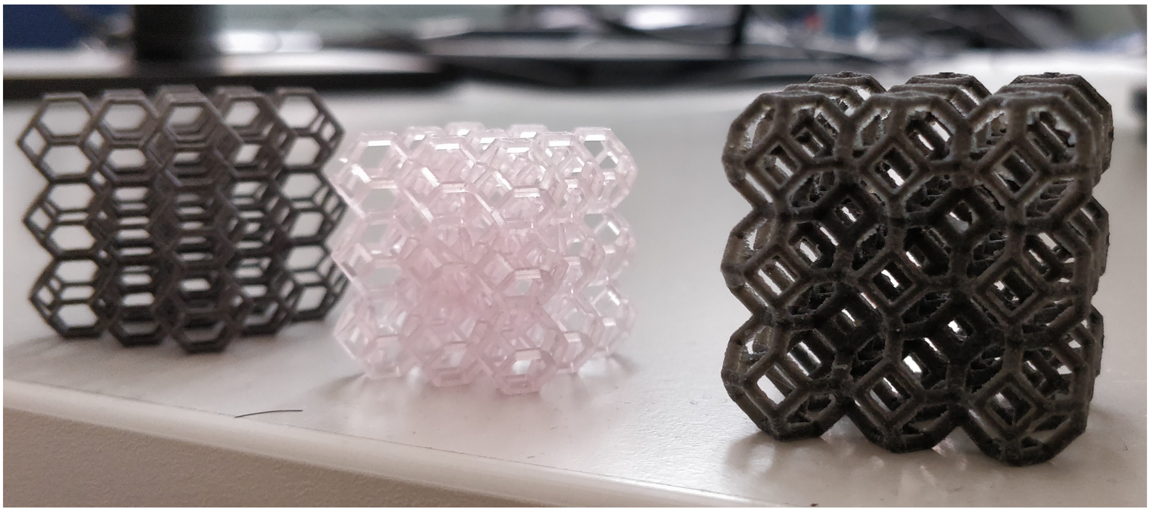
Bachelor/Master thesis projects:
Experimental studies in the Mechanics & Materials Lab



Overview

Opportunities for multiple semester thesis projects exist both at the Bachelor's and Master's level in the experimental laboratories of the Mechanics & Materials research group. We study the mechanics of solids with a specific focus on linking the microscopic and macroscopic properties of a variety of materials with diverse applications in science and technology.

One problem of particular interest is the mechanics of 3D-printed architected mechanical metamaterials. With the rising popularity of 3D-printing techniques, the design and control of material (micro-)structure to tailor material performance to specific real-world environments (such as vibration damping, impact resistance, wave guiding, etc.) have started to become reality. Exploiting state-of-the-art 3D-printing facilities, we design and create 3D truss-based metamaterials (small-scale truss networks such as those pictured above). The following projects are geared towards developing in-house experimental capabilities to characterize the mechanical behavior of those materials systems under different loading conditions both at the level of the individual truss members and the overall structure.

1. **Low-strain-rate multi-axial response of mechanical metamaterials**

We are currently setting up an experimental facility to study the low-strain-rate compression, tension and combined compression-torsion behavior of 3D-printed mechanical metamaterials. Students will work closely with senior members of our team and with our collaborators in the 3D-printing facility to generate truss-based metamaterials and measure their mechanical behavior under different low-strain-rate loading conditions. Students will also have the opportunity to compare the experimental data with computational simulations (developed within the group) for both model validation and computationally-driven design optimization.

2. **A drop weight impact experiment for mechanical metamaterials**

A commonly encountered scenario both in daily life and in specialized environments is high-strain-rate impact loading. The objective of this project is to setup an in-house drop impact experiment to evaluate the impact resistance of 3D-printed mechanical metamaterials (involving the dropping of a dead weight from a designated heigth onto the sample while tracking the material response with high-speed cameras). Students will be involved in the design, analysis, construction and instrumentation of this new experiment setup. Students will also have the opportunity to perform and analyze impact experiments on the truss-based metamaterials printed in-house.

3. **An experiment to measure the mechanical response of soft viscoelastic materials**

The mechanical response of the material constituting each individual truss member in a 3D-printed truss structure is a crucial component in understanding and predicting the static and dynamic mechanical response of the overall structure. The material behavior may range from soft and viscous to stiff and brittle. Our current focus is on the former type of material with fairly a complex time-dependent mechanical response. In addition, the specific material properties may be limited by the parameters used for 3D-printing the overall truss structure.

This project involves developing a small-scale experiment to probe the mechanical response of the material constituting the individual truss members in the various 3D-printed truss structures. Ideally, the setup will be equipped to measure the material response under combined loading (compression, tension and torsion) at different frequencies. Students will primarily be involved in the design, analysis, construction and instrumentation of the experimental setup. Once the setup is functional, students will perform experiments on individual truss members sectioned from the truss structures to be printed concurrently within the group.

Pre-requisites

Interested candidates should have a background and interest in mechanics and dynamics. A working knowledge of experimental mechanics, instrumentation and signal processing is helpful but not necessary. Strong inclination towards learning these skills is however essential. Basic knowledge of commercial design software (e.g., AutoCAD, ProEngineer), analysis software (e.g., Solidworks) as well as basic programming skills (any language of your choice) is an additional advantage.

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