Karlsruher Institut für Technologie

3D MATTER MADE TO ORDER

Bachelor/Master Thesis

Biomimetic Shape Optimization of 3D Printed Glass Nanolattice Metamaterials

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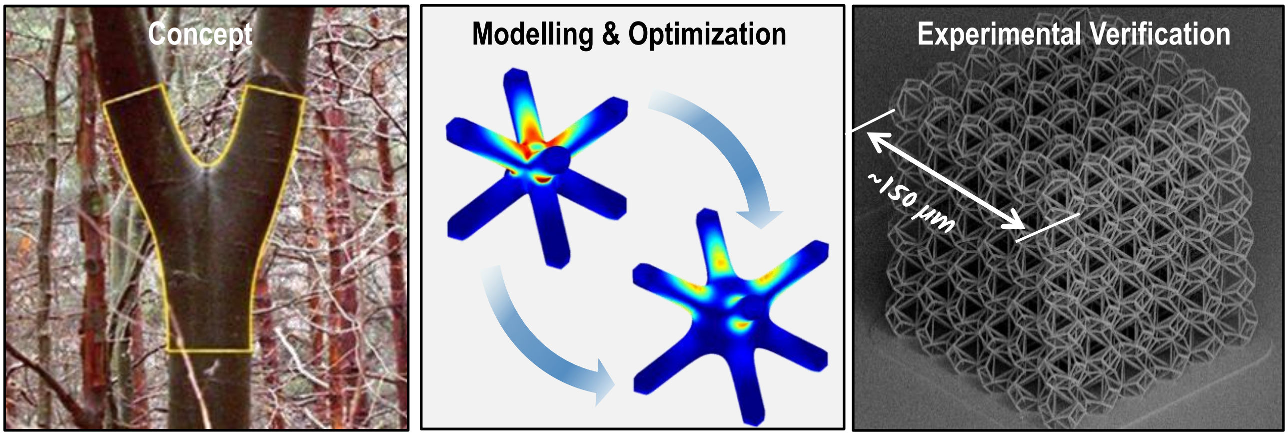
Background

Metamaterials are **artificial materials** constructed from spatially **architected building blocks** (e.g., truss lattices). Through this rational design they achieve unique properties that are classically considered impossible. In nanolattices (1), **miniaturized truss** building blocks leverage material size effects, which grant typically fragile materials like glass **extreme mechanical strength**. However, being still brittle, such glass nanolattices remain highly **sensitive to stress concentrations** at their truss nodes. **Biological** load-bearing structures, such as trees have mastered to eliminate stress concentrations by optimized localized growth (2). Adoption of such **shape optimization** in nanolattices holds vast potential to **significantly improve** their mechanical **performance**.



Your Project

You will develop a node **shape optimization** approach for truss nanolattices. In this, you will conduct systematic parametric **finite element simulations** with optimized biomimetic node designs and emerging engineering shapes to identify a **lightweight** node design that simultaneously minimizes local stress concentrations as well as the overall mass of the **truss structures**. Further refined solutions will be obtained from an implicit optimization routine **modeled after** the stress-induced growth of **trees**. Mechanical **experiments** with **3D-printed** glass **nanolattices** will validate the best optimization results.

Join a **young and dynamic team** with a flat hierarchy and conduct **innovative and timely research** at the intersection of mechanical engineering, materials science, and manufacturing technology. As a member of the Cluster of Excellence 3D Matter Made to Order, our laboratory accesses a vast inventory of state-of-the art instrumentation and is part of a **world class network of experts** in the field of 3D additive manufacturing.

Your Profile

- **Student** in MACH, MatWerk, or related field **at KIT**
- Good knowledge of engineering mechanics, first experience in FEM and MATLAB data analysis helpful
- Enthusiasm for current research topics

(1) J. Bauer *et al.*, **Advanced Materials** *29,* 1701850 (2017)   (2) C. Mattheck, **Design in nature: learning from trees.** (1998)