Karlsruher Institut für Technologie

3D MATTER MADE TO ORDER

Bachelor/Master Thesis

Scale-Bridging Additive Manufacturing of 3D Glass Structures – from Nano to Macro

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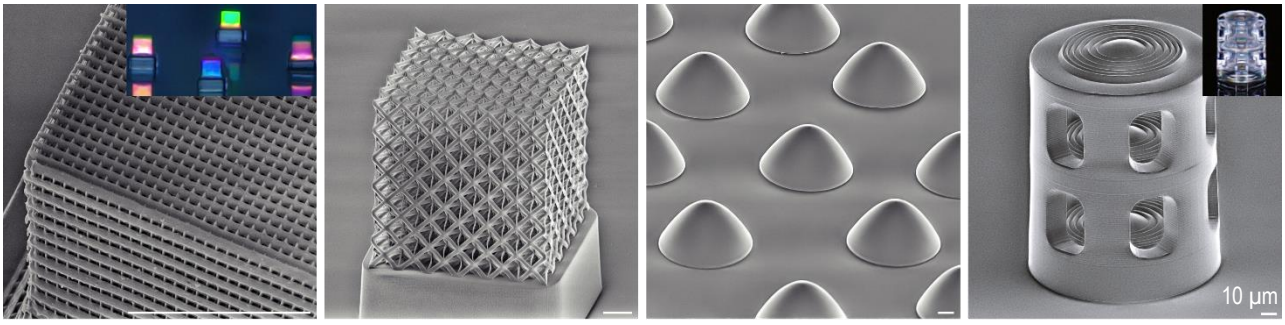
Background

Glass (SiO_2) is a **central** material **for modern high technologically,** such as in optics, biomedicine and microsystem technology. However, with a **softening** point of **1100°C**, it is **historically challenging to shape**. Lately, the 3D-printing of silica glass has greatly advanced, opening the door to novel free-form design concepts. Still, most of these printing approaches rely on high-temperature melting or particle-sintering steps identical to ancient blowing techniques and established industrial processes. 3D-printable **pre-glass polymers overcome this limitation**. Opposed to slurries of discrete particles, which must be sintered at high temperature to form a continuum, pre-glass polymers already are continuous silicon-oxygen molecular networks which can convert to transparent glass at only 650°C. This has recently been demonstrated to facilitate the **sinterless 3D-printing** of complex glass structures **at the nanoscale** (1). **This thesis** aims to **expand** this unique **low-temperature glass printing** route from the nanometer- **to the macroscale.**



Your Project

You will **design and 3D-print** a catalogue of pre-glass polymer test **structures** with sizes spanning from nanometers to millimeters. To successfully convert test structures to silica glass you develop suitable **thermal processing** protocols. In this, you will systematically study the size-dependent thermal decomposition behavior of the printed structures via optical **microscopy** and simultaneous **thermal analysis**. From your results you develop an understanding of the material's size-dependent thermal decomposition kinetics and derive heating recipes which circumvent cracking and loss of transparency with increasing size.

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, providing diverse opportunities for your individual professional development.

Your Profile

- Student in MatWerk, MACH, or related field
- Knowledge of polymers & ceramics, material characterization, MATLAB & 3D-printing advantageous
- Enthusiasm for current research topics and interest in a scientific career

(1) J. Bauer, et al. *A Sinterless Low-Temperature Route to 3D-Print Nanoscale Optical Grade Glass,* **Science**, 380, 960-966 (2023)