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Cluster of Excellence *liv***Mat**S
FIT – Freiburg Center for Interactive Materials and Bioinspired Technologies,
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Limitations of various 3D printing techniques* (HiWi, BSc, MSc)

Additive manufacturing becomes a more and more widely spread manufacturing technique, gradually replacing "classical" subtractive manufacturing in the engineering world. Various approaches united by the umbrella-term "3D printing" extend from meter-sized concrete 3D printing to nanoscale two-photon lithography. However, it is clear that due to the nature of the techniques, they all have some limitations related to the minimum feature size, the complexity of the achievable geometry, and selection of the materials. This project aims to study these limitations for various 3D printing techniques on micro and millimeter scale.

It is evident that every additive manufacturing technique has the minimal (critical) size of the feature that can be produced. For FDM printing, this critical size is about 0.1 mm (minimal layer thickness), for DLP/SLA, it is about 0.01 mm (pixel size), and for Polyjet, it is about 20 microns. In some sense, subtractive manufacturing (e.g., laser cutting) also has a similar critical size, defined by the cutting tool's radius. At the same time, from a mechanical point of view, it is possible to define another critical size attributed to additive manufacturing solely. For example, for FDM printing, it is expected that the effective properties of the printed samples could depend on their size. It seems logical to assume that the effective properties of the samples with 100 and 200 layers should be practically the same, but with a decrease in the number of layers from 100 to 10, it is possible that local imperfections might start to play a significant role directly affecting the effective properties. Therefore, it is reasonable to introduce the second critical size that distinguishes cases when (1) the sample can be treated as homogeneous, (2) local imperfections noticeably affect the effective properties. In this project, we will explore this homogenization limit for various 3D printing techniques. The results of this study will significantly contribute to the deeper understanding of the limitations of 3D printing processes, and they will be later employed in other studies associated with the topological optimization of the structures.

The skills that you can acquire during this project:

1. 3D printing (FDM, SLA, Polyjet)
2. Mechanical testing
3. CAD modeling

Please feel free to contact us if you have any questions.

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