

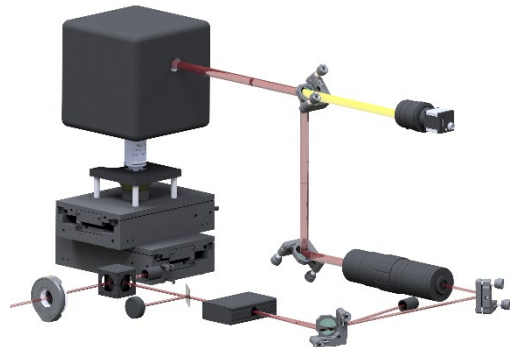
## Master Thesis

### Composite material and complex structures for 4D printing with 2PP

The emerging field of **4D printing** introduces time as the fourth dimension, revolutionizing manufacturing by using smart materials like hydrogels and polymers that respond to external stimuli such as temperature, humidity, and light. These stimuli trigger changes in the structure or function of 3D-printed objects, leading to self-assembly, self-actuation, or self-sensing behaviors. While self-assembly in multimaterial printing has been extensively studied, research on self-actuation and self-sensing in single-material 4D-printed structures has recently gained attention.



Achieving precise fabrication and accurate quantification of structural changes is crucial for reproducible results. **Two-photon polymerization (2PP)** offers a precise and reliable 3D fabrication technique, enabling the creation of complex structures with spatial resolution below 100 nm in a single step, without the need for selective chemical etching or reflow processes. This makes 2PP suitable for fabricating true 3D- and 4D-printed objects when appropriate materials are chosen.



*This thesis aims to develop the composite materials for high precision fabrication of complex structures using two-photon polymerization and evaluate their 4D properties.*

#### Task assignment:

- Review of the state-of-the-art materials for 4D printing and their applicability for 2PP
- Development of testing patterns/models for fabrication by two-photon polymerization
- Composite material preparation and evaluation of 4D properties of the fabricated structures

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**Die Masterarbeit kann auch auf Deutsch verfasst werden.**