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Light Robotics for Nanomedicine

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Technological developments from recent years have led to the emergence of a new field, Light Robotics¹, which explores intelligent optical actuation of microfabricated structures with tailored properties. As one of the pioneers in the field, our group develops microrobots for biomedical applications and advanced light sculpting techniques for their efficient optical manipulation.

Two-photon polymerization enables direct laser writing of structures with a resolution of ~ 200 nm, which can be further improved to ~ 10 nm by post-processing or additional control over the printing process. In combination with surface modification *via* metal deposition or chemical functionalization, such microstructures can be tailored to specific applications for biomedical research purposes, such as localized mixing in microfluidic channels². Light sculpting using methods from the Generalized Phase Contrast (GPC) family allows precise, simultaneous control of several microstructures with six degrees of freedom.

Light-controlled microrobots have already shown potential for biomedical research by e.g. local material delivery and mixing, indirect manipulation of biological samples or *in situ* sample characterization. Our group focuses on further improving the fabrication process by bringing the microrobots closer to the nanoscale or by integrating multiple surface chemistries providing e.g. stealth, biological targetting or drug delivery functionalities. This would expand the applications of the 3D-printed microrobots, particularly for the manipulation and characterization of biological samples, bringing them a step closer towards becoming true "microsurgeons".

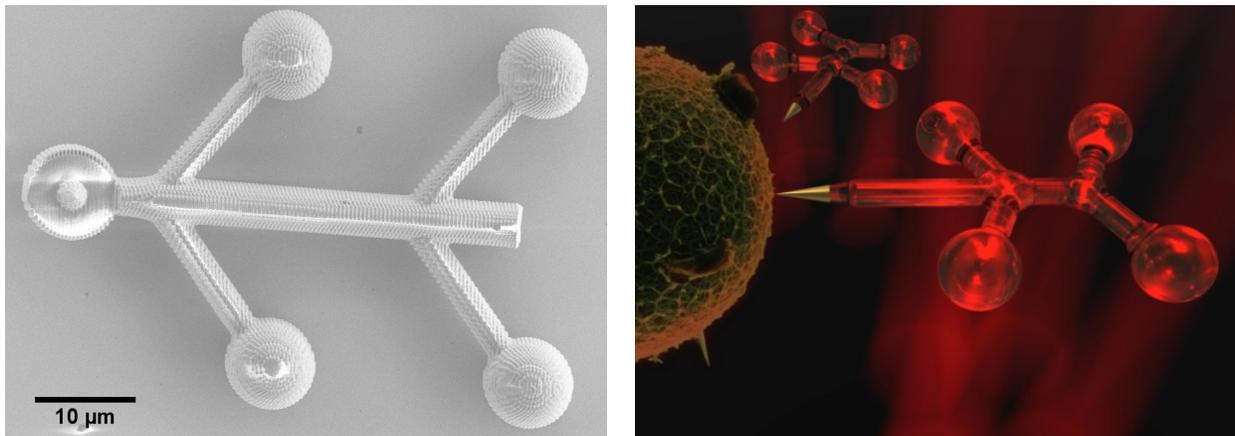


Fig. 1: SEM image of a 3D-printed microrobot (left) and conceptual drawing of such a microrobot performing microsurgery in a biological sample (right).

¹ Glückstad, J & Palima, D. Light robotics: structure mediated nanobiophotonics (Elsevier, 2017).

² Engay, E., Bunea, A.-I., Chouliara, M., Bañas, A. & Glückstad, J. Natural convection induced by an optically-fabricated and actuated microtool with thermoplasmonic disk. *Optics Letters* 16 (43) 2018.