New two-photon based nanoscopic modalities and optogenetics

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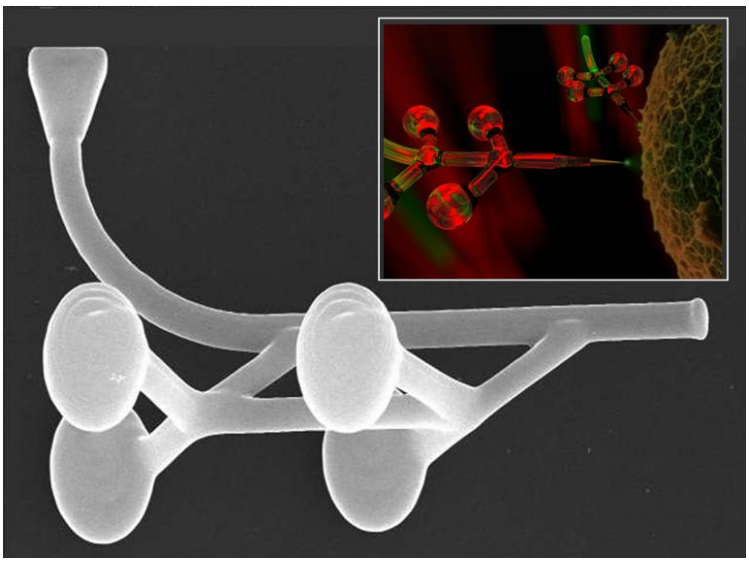
The science fiction inspired shrinking of macro-scale robotic manipulation and handling down to the micro- and nano-scale regime open new doors for exploiting the forces and torques of light for micro- and nanobiologic probing, actuation and control [1-3]. A generic approach for optimizing light-matter interaction on these scales involves the combination of optimal light-sculpting [4] with the use of optimized shapes in micro-robotics structures [5]. Micro-fabrication processes such as two-photon photo-polymerization offer three-dimensional resolutions for creating custom-designed monolithic microstructures that can be equipped with optical trapping handles for convenient mechanical control using only optical forces [6].



These microstructures illustrated above can be effectively handled with simultaneous top- and side-view on our BioPhotonics Workstation to undertake six-degree-of-freedom optical actuation of two-photon polymerised microstructures equipped with features easily entering the submicron-regime. Aided by European collaborators who fabricated test structures with built-in waveguides for us, we were able to put the idea of optically steerable freestanding waveguides – coined: wave-guided optical waveguides - to the test using our BioPhotonics Workstation [7]. We also propose using these techniques for generating two-photon real-time spatially sculpted light for the strongly emerging areas of neurophotonics and optogenetics [4].

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