3D Printing Sets New Standards in Microfabrication

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Abstract
The technique of two-photon polymerization (TPP) allows for high precision additive manufacturing based on 3D digital models with sub-micrometer feature sizes and resolution. In addition, 2D and 2.5D topologies can be fabricated with ultra-high aspect ratios and outstanding design freedom with a resolution between electron beam and UV lithography. This talk gives an overview on the technology and its performance and highlights both scientific disruptive breakthroughs and enabled applications in industry.

The benefits of 3D printing are now fully available on the micrometer scale. While TPP was previously known for ultra-fine yet small objects mostly viewed under the scanning electron microscope, now mm^3-scale fabrication has become the novel standard in 3D microfabrication with still sub-micrometer features. This closes the gap to conventional stereolithography formerly considered as highest resolution 3D printing technique.

Unique designs and precision open new applications in multiple fields such as photonics, micro-optics, microfluidics, micro robotics, mechanical metamaterials, and life sciences. In optics and photonics, TPP is - among others - used for the fabrication of photonic crystals, metamaterials [1,2], optical cloaks [3], photonic colours or high-precision micro-optics [4]. Industrial application examples such as wafer-level micro-optics and photonic multi-chip integration [5] will be discussed.

Filters, mixers, complex nozzles, micro-robots or micro-needles for painless drug delivery exemplify the challenges that can be overcome by 3D printing on the micro- to mesoscale. Design freedom, resolution, processing speed and a wide range of materials allow to easily produce tailored 3D scaffolds and matrices for mimicking in vivo 3D physiological environments for cell studies. And mechanical engineers are enabled to design unique mechanical properties previously unachievable by shaping complex microtrusses. Ultra-light yet strong [6, 7] or auxetic [8] materials as well as unfeelability cloaks [9] have been reported.

References

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Figures

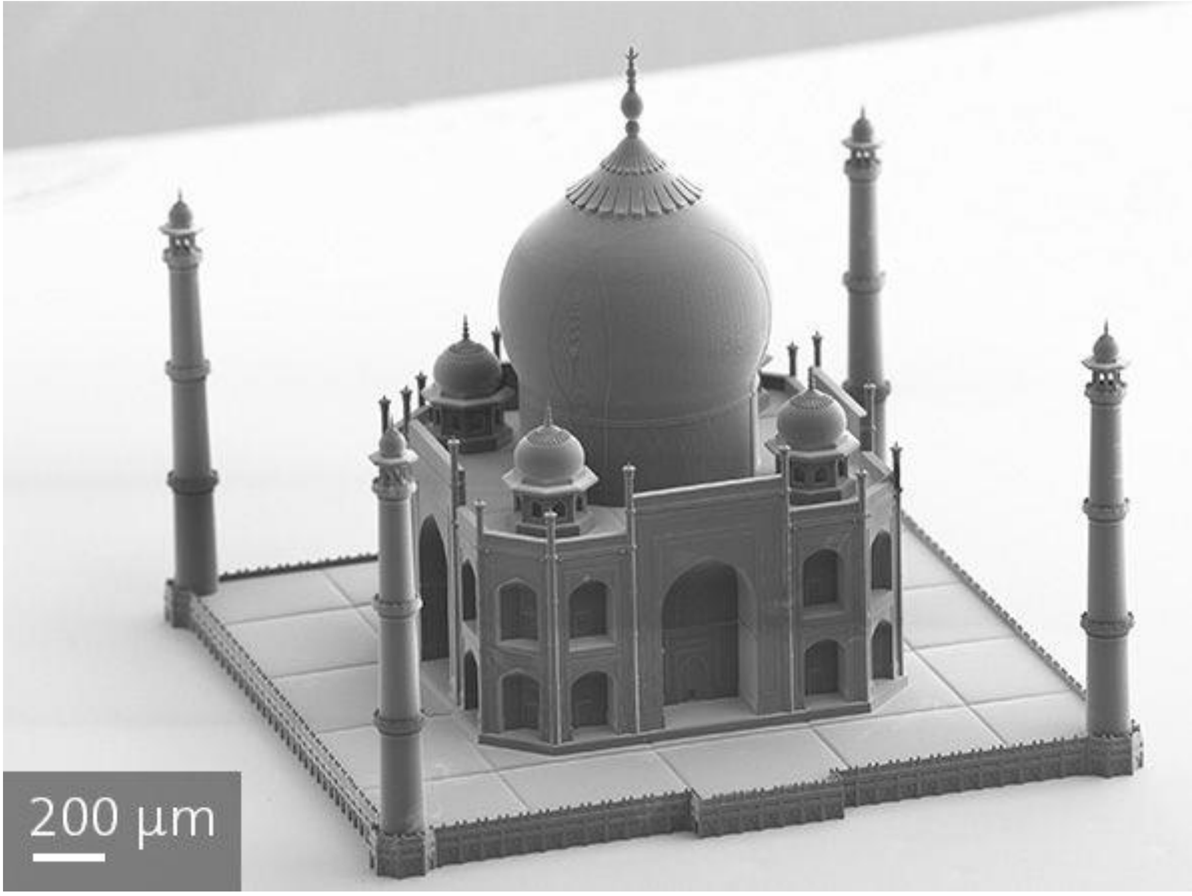

Fig 1: SEM image of the Taj Mahal demonstrating the fine features enabled by Nanoscribe's high-resolution 3D microprinting.

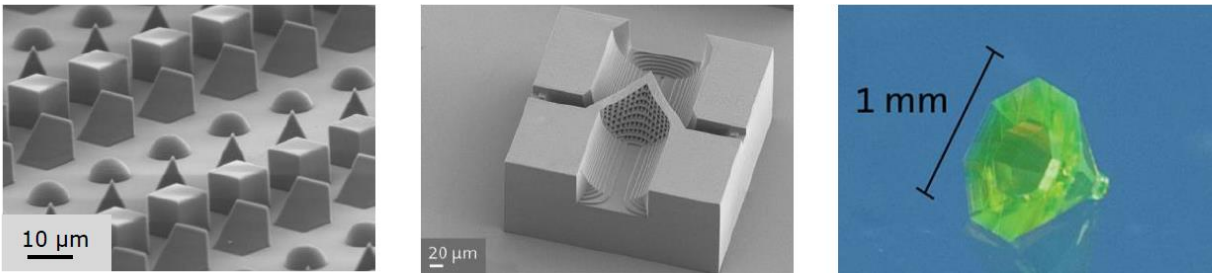

Fig. 2: Application examples: (left) wafer-level micro-optics, (middle) microfluidic filter (design provided by IMSAS) and (right) microfluidic nozzle.