High-quality 3D Printing of Micro-Optical Elements with 3D two-photon grayscale lithography (2GL®)

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In this paper, we introduce a 3D generalization of Nanoscribe's two-photon grayscale lithography (2GL®) process. 2GL® is a method that uses a fast laser power modulation to avoid layer discretization artifacts thus resulting in smooth surfaces even for a large spacing between exposure layers [1, 2, 3]. Our approach achieves a ten-times speedup compared to traditional layer-based two-photon lithography and enables the printing of intricate 3D structures such as stacked micro-optics. It is seamlessly integrated with a computer vision system to allow for aligned fabrication on photonic integrated circuits or optical fibers, thereby enabling novel hybrid photonic devices. We demonstrate the effectiveness of this new approach through visual comparisons of benchmark structures printed with traditional two-photon polymerization and 2GL®, as well as a series of automatically aligned 3D complex optical elements printed on optical devices. This advancement expands the potential applications of 2GL® and offers a promising solution for additive manufacturing of high-precision 3D structures with free-form surfaces.

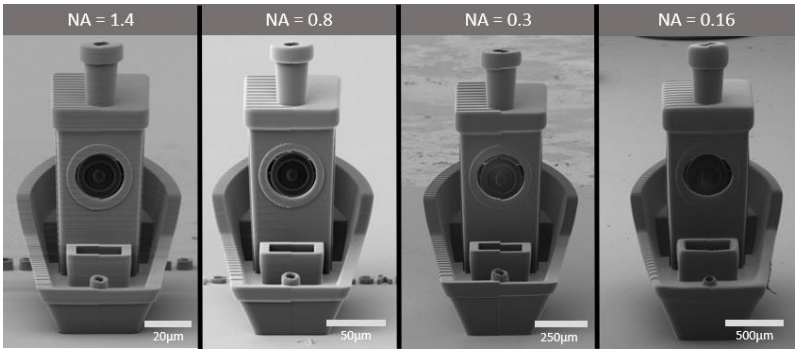

Fig. 1 Scanning electron microscope images. Comparison between 2PP (left side of the boat) and 2GL ®. (right side of the boat). The structures were fabricated using different objectives with a wide range of numerical apertures and magnifications.

References

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