

Fabrication of large-scale micro-structures by two-photon polymerization with a long-stroke precision stage

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Abstract

This paper demonstrates the fabrication of large-scale microstructures by two-photon polymerization (TPP) with an integrated long-stroke precision stage. We first design a three-axial stage that combines a piezoelectric transducer (PZT) stage and a stepper-motor stage, and we apply gain-scheduling and robust control with a feed-forward compensator to achieve nano-positioning within a travel range of 10 cm. We then integrate the precision stage with a laser module to manufacture large-scale microstructures, including 1 mm linear gratings, 1 cm parallel lines, and 200 μm Fresnel zone plates (FZPs). We further define performance indexes to evaluate the qualities of these products: the linear gratings achieve an image error of 4.73%, while the 1cm-lines have with an average error of 0.2 μm with a standard deviation of 0.05 μm , and the FZPs attain a focal error of 0.4% and a focus efficiency of 64%. These results confirm the effectiveness of the proposed use of the precision stage and TPP for large-scale micro-structure manufacturing.