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Abstract

Wavefront measurements for parameter characterization of 3D printed cylindrical microlenses

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The miniaturization of optics and complete optical systems in medicine and technology is an ongoing and demanding process. It opens up possibilities for a variety of applications, e.g., minimally invasive endoscopy with printed optical elements on optical fibers [1] or the inexpensive replication of hyperspectral imaging devices [2]. Two-photon-polymerization lithography is an additive manufacturing method that meets the increasing demand of precision and high-resolution features. Depending on printing parameters and materials, feature sizes below 100 nm are possible [3]. Determining the optimal parameter set via metrology is crucial for the manufacturing of high-quality optics.

In this project we simulated and printed upright cylindrical microlenses with a size of 1 x 2 x 0.4 mm^3 and a focal length of 5 mm. With the lithography system *Photonic Professional GT2* (Nanoscribe, Karlsruhe, Germany), operating at a wavelength of 390 nm, the cylindrical lenses were printed from the organic photoresist IP-Visio and the hybrid inorganic-organic polymer OrmoComp using a 10x objective. The lenses are of plano-convex shape and are conically optimized for vanishing spherical aberration, assuming a monochromatic and collimated incidence parallel to the optical axis. Designing a setup with cylindrical lenses reduces the number of degrees of freedom. Furthermore, printing in an upright manner yields the advantage of avoiding stitching inaccuracies. In theory, this leads to an easier distinction of perturbing influences during the printing process and thus, an easier optimization of printing parameters.

We developed a wavefront measurement setup in transmission based on a Shack-Hartmann sensor to acquire quantitative information about the lens quality. As the lenses have a rectangular aperture, we used Legendre polynomials to analyze the wavefront in terms of aberrations in x- and y-direction, respectively. The results show wavefront aberrations close to the diffraction limit.

AUTHOR'S STATEMENT

Conflict of interest: Authors state no conflict of interest.

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