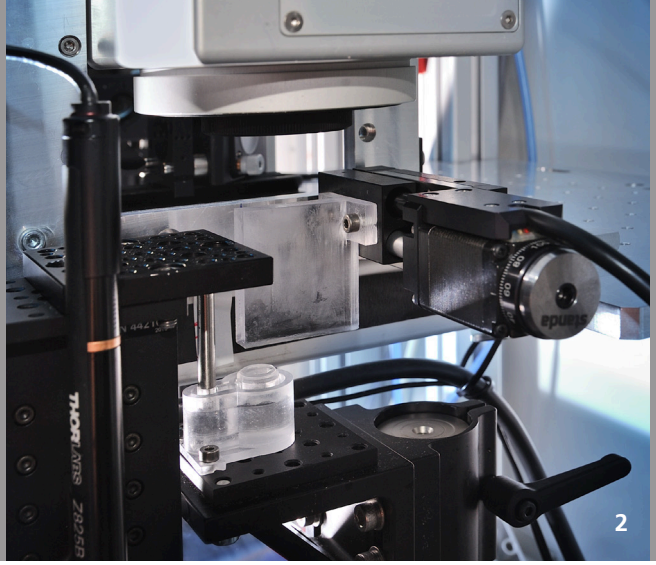

ADDITIVE MANUFACTURING OF HIGH-INDEX POLYMERIC OPTICS

Task

Lenses, prisms, waveguides and other optical components are preferably made of transparent plastics because of their low weight and ease of molding in mass production processes. In particular, several parameters are essential for use in optics: transparency, color, spectral transmission and reflectance, refractive index and optical dispersion. Producing such optics in small batches and individual components is cost-intensive, but they can be made with additive manufacturing significantly cheaper, more flexibly and with more design options. As part of the BMBF-funded VIP+ project »ThIOLens«, Fraunhofer ILT is studying the additive production of polymeric optics with high refractive index for use in ophthalmology.

Method

Fraunhofer is investigating novel photoresists with a high refractive index for the additive production of optical components by means of UV crosslinking. This is where thiol-ene-click chemistry lends itself so well. Here, thiol groups react with unsaturated hydrocarbons by photo-excitation and form sulfur-containing thioether, which contribute to forming high-index polymers with good dispersion properties thanks to their high electron density. In addition to directly influencing the optical properties, thiol-ene-click chemistry also eliminates the need for photoinitiators. Residues of the initiator in the polymer may negatively influence the ageing behavior and biocompatibility of the material.

Results

So far, the institute has developed various materials with refractive indices greater than 1.53 and Abbe numbers greater than 40. These materials show elongations at break of up to 30 percent and E-modules of up to 750 MPa. Components with a chemically active surface could be produced from a non-stoichiometric photoresin. Remaining functional groups allow a subsequent chemical coating of the surface. This way, for example, antireflective coatings or coatings to increase the scratch resistance can be applied in an uncomplicated manner.

Applications

The main application area is ophthalmology. Standardized cell biological evaluations in direct contact show that these materials have no cytotoxic effect. In addition, an application in the field of technical optics is particularly suitable for the harder materials. Here, curing could be directly done on active structures, such as sensor chips. This makes it possible to produce coupling and decoupling structures or beam collimators as well as to write optical fibers on optical chips.

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Contact

Andreas Hoffmann M.Sc.
Telephone +49 241 8906-447
andreas.hoffmann@ilt.fraunhofer.de

1 User interface of the modular software.

2 Laboratory setup of the stereolithography system with scanner, construction platform, resin basin and scraper.

Fraunhofer Institute for Laser Technology ILT, www.ilt.fraunhofer.de
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