Technology Offer

TLB
Technologie-Lizenz-Büro
der Baden-Württembergischen
Hochschulen GmbH

Functionalizable lens systems from a 3D printer: Print filters, diaphragms and lenses in one piece and control them with a magnetic field

Background

Sophisticated 3D printing technologies offer a high level of design flexibility and a high resolution in printing. Therefore, the printing of optical elements is an advantageous alternative to conventional production procedures.

Problem

The 3D printing of optical elements has increasingly gained importance in recent years, as it is often more flexible and inexpensive than conventional micro molding processes. 3D printers that can produce complex optical systems are available on the market. Until now, however, one weakness has been that the component to be printed has to be completely transparent in the near infrared range, in particular in the stereo-lithographic procedure. Therefore, no absorbing areas can be printed into the optical system. In addition, the printed components have been rigid until now and could not be made tunable, for example by external actuation.

Solution

As part of a project sponsored by Baden-Württemberg Stiftung gGmbH, scientists at the University of Stuttgart have now developed a new procedure. Functional areas, such as diaphragms and structures for absorbing scattered light, can now simply and precisely be integrated in complex printed 3D optical systems. For this purpose, the micro-optical element is already provided with the smallest of hollow spaces (micro cavities) during printing. These cavities later serve to intake functional substances. The small size of the hollow spaces mean that capillary forces carry out the distribution of liquid in the hollow spaces. The functional liquid is then dried or hardened.

Properties such as the absorption, reflection or scatter properties of the functional areas are precisely defined through the choice of the substance, i.e. the nano particles it contains.

If the hollow spaces are filled with a ferrofluid, the physical properties can be additionally changed by a magnetic field. In this way, multi-lensed zoom or focusing systems are possible which can for example be directly printed onto an image-conductive fiber.

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Development Status

Proof of concept / TRL3

Patent Situation

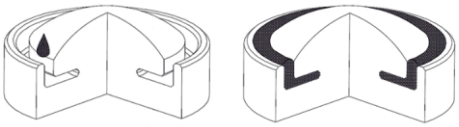
EP 20152575.5 (19/041TLB) and US 2021/0221059 A1 pending
EP 3162549 A1 and US 2017120548 A1 (15/024TLB) pending

Reference ID

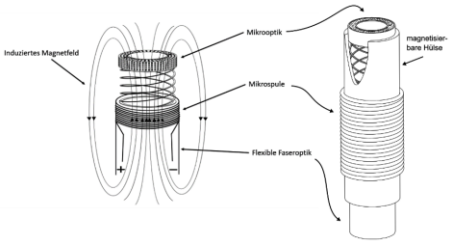
19/041TLB, 15/024TLB

Service

Technologie-Lizenz-Büro GmbH has been entrusted with the exploitation of this technology and assists companies in obtaining licenses. The further development (19/041TLB), which is already integrated here, is already patent pending as well as the previously developed basis technology (15/024TLB).



Schematic drawing of a lens with microcavity being filled with a functional substance (l.); lens with resulting diaphragm (r.) [Uni Stuttgart].



Schematic representation of a fiber-integrated lens system, for which a focusing function is made possible by filling cavities with ferrofluids [Uni Stuttgart].

Advantages

- Expansion of functionalities of optical components, for example through
  - diaphragms
  - color filters
  - achromatic lenses
- Application of customary 3D printers
- Possible when using ferrofluids:
  - zoom lens system
  - adjustable diaphragms
- Simple and cost-effective method
- Simple integration of new materials into the design of the optical system

Application

Printed optical elements with functional areas such as diaphragms and structures for scattered light absorption can now be simply and inexpensively produced by using microfluidic structures. These structures are integrated into the print layout of the optical components and are formed during the 3D print. If a ferrofluid is used in the process, controlled forces can be exerted using a magnetic field, thus realizing active systems.

Publikationen und Verweise

A. Toulouse, S. Thiele, H. Giessen, and A. Herkommer,
"Alignment-free integration of apertures and nontransparent hulls into 3D-printed micro-optics,"
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Andrea Toulouse, Simon Thiele, Harald Giessen, Alois M. Herkommer,
"Super-fine inkjet process for alignment-free integration of non-transparent structures into 3D-printed micro-optics,"
Proc. SPIE 10930, Advanced Fabrication Technologies for Micro/Nano Optics and Photonics XII, 109300W (4 March 2019).
https://doi.org/10.1117/12.2513520