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Gips Schüle Research Award for three scientists from the University of Stuttgart

Prof. Dr. Harald Gießen from the Institute of Physics (4) as well as Prof. Dr. Alois Herkommer and Dr. Simon Thiele from the Institute of Applied Optics at the University of Stuttgart received the Gips Schüle Research Award 2021 on October 19, 2021. The researchers were awarded the prize, which is valued at EUR 50,000, for the development of 3D printing technology and new materials and processes for producing the world's smallest miniature optics instruments. Together with their teams, they work under the umbrella of the interdisciplinary research center "SCoPE" (Stuttgart Research Center of Photonics Engineering).

The work of the three Stuttgart researchers made it possible to produce 3D-printed lenses with complex surfaces that have a much lower aberration level than conventional lenses and are therefore much more powerful. The scientists also managed to realize multi-lens systems through 3D printing. This made it possible to produce extremely good imaging optics such as ultra wide-angle systems, which are particularly important for endoscopes with the highest imaging quality. 3D printing makes it possible to manufacture both the micro-optics instruments and the support structures in a single process step.

In addition, the scientists developed systems from multiple printing materials that could correct chromatic aberrations of the micro lenses. For this purpose, a large class of new 3D-printable materials was realized by combining polymers and nanoparticles. It was also possible to develop other techniques, such as the use of blackened absorbent materials for the realization of apertures. The researchers developed special simulation programs for the design process of these very small optical devices.

Radical miniaturization

For the first time, it has been demonstrated that high-quality microlenses with diameters of just a few micrometers can be printed directly onto glass fibers. This allowed the realization of a completely new type of optical endoscope that by far exceeds the previous state of the art. 3D printing on miniature CMOS camera chips that work as an optical image sensor has become possible as a result of the research, as has parallel printing of a combination of wide-angle, normal, and telephoto lenses on a chip in order to electronically zoom and change the angle of view. In addition, this technique allowed the scientists to demonstrate a miniature spectrometer with a diameter of 0.1 mm. The extreme miniaturization additionally offers great application potential in areas such as measurement technology, production and process monitoring, robotics, and even autonomous driving. Currently, the team is working on moving or variable micro-optics instruments as well as on techniques for anti-reflective coating, among other things.

First steps toward medical and industrial use

In cooperation with the company KARL STORZ in Tuttlingen, the researchers tested their new technology with medical endoscope systems as part of the PRINTOPTICS project by the Federal Ministry of Education and Research and were able to realize ideas that were previously unthinkable: For example, endoscopes were built that, thanks to their large viewing angle, allow images to be taken simultaneously from the front and from the side, providing true-color and distortion-free images. Moreover, with their small diameter, they fit into the narrowest veins, into the smallest glandular ducts, and even into root canals.

Commercialization of the technology via a startup

Dr. Simon Thiele, who was a doctoral researcher at the Institute of Applied Optics, and one of his Master's degree students founded the spin-off company Printoptics TGU, which has committed itself to the commercialization of this innovative printing technology. It offers the entire value chain, from optical design and development of the printing process to the production of small batches of the optical instruments. New endoscope prototypes are also being developed there. In addition, the company

is developing applications in integrated quantum technology, such as combining single-photon sources and optical fibers. The company is also developing optical tweezers for individual atoms in cooperation with physicists at the University of Stuttgart.

In addition to the more than 30 scientific papers already published, the researchers are concerned with having the technology patented in cooperation with the "Technologie-Lizenz-Büro der Baden-Württembergischen Hochschulen" ("Technology License Office of the Higher Education Institutions in Baden-Württemberg"). The project is supported by the Federal Ministry of Education and Research, the German Research Foundation within the framework of a Research Training Group, the Integrated Quantum Science and Technology (IQST) center, the Baden-Württemberg Foundation, the European Union via an ERC grant (proof of concept), the Ministry of Science, Research and the Arts of Baden-Württemberg, and the Vector Foundation. The researchers particularly emphasize the great cooperation with the company Nanoscribe GmbH in Karlsruhe, which made many of the techniques possible through its high-tech products.

About the awards of the Gips Schüle Foundation

The award ceremony also included the awarding of the Joachim Reutter Prize for Social Innovation to Dr. Oliver Parodi from the Karlsruhe Institute of Technology (KIT). Both of the Gips Schüle Foundation's prizes are based on the motto "Technology for the people". The evaluation criteria are interdisciplinarity, innovation potential, and application relevance in combination with societal benefit. With the Research Award, the focus is on technological innovation, while with the Joachim Reutter Prize, the relevance to social aspects is paramount. This year, 17 proposals were submitted by research institutions and universities throughout Baden-Württemberg. Both prizes were awarded by the retired Minister of Science, Prof. Dr. Peter Frankenberg.

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