

Miniature 3D-printed objects inside the body

Dr. Andrea Toulouse from the Institute of Applied Optics receives €1.8 million in funding from the Carl-Zeiss-Stiftung as part of the CZS Nexus program to establish a new junior research group. She conducts research in the field of micro-optics and fiber-based 3D printing. Her vision is to develop 3D printers that will one day be able to build biological tissue directly inside the body.

"Leading my own independent junior research group allows me to advance endoscopic 3D printing with both responsibility and freedom," says Andrea Toulouse. With two doctoral students from engineering and one from biotechnology, the group will also have an interdisciplinary focus. This is important because developing a useful organic 3D printer is a research task that can only be solved through interdisciplinary collaboration.

3D printing processes using light are already quite common today for producing cartilage, muscle, or lung tissue in the laboratory, for example. However, the second step always involves a complicated implantation process, as typical printers are far too large to be used on site. A thin, endoscopic 3D printer that can be inserted into the body and seamlessly prints tissue where it will later perform its function would be more practical.

Project aims to fill research gap

The new research group called "3D Endoscopic Microfabrication" (3DEndoFab) aims to close this gap. The key components here are miniaturization, the use of light-based processes with high resolution, and the replacement of the previously used non-biodegradable photoresists with bio-inks. "Our group aims to develop a 3D-printed micro-optic, no larger than a grain of salt, that can be positioned on the tip of a glass fiber." There, it will shape light in such a way that even complex tissue structures can be printed in 3D with micrometer resolution, i.e., on the scale of human cells," explains Andrea Toulouse. With her junior research group, she aims to develop this technology. Close interdisciplinary collaboration with Prof. Michael Heymann from the Institute for Biomaterials and Biomolecular Systems will also enable exploration of fundamental biological questions - for instance, could small climbing frames guide the body's own cells in how to grow? And could such a regeneration process be initiated so that the body could complete this process on its own?

The feasibility of 3D printing through an optical fiber has already been demonstrated in the previous project EndoPrint3D. In this project, Andrea Toulouse - serving as spokesperson - together with Prof. Alois Herkommer (Institute of Applied Optics), Prof. Michael Heymann, and Prof. Harald Giessen (4th Physics Institute), with support from the Carl-Zeiss-Stiftung, successfully tested endoscopic 3D printing using ultrashort femtosecond pulses. Based on this, the central research questions for the new 3DEndoFab group are now: Which methods of light-based 3D printing are best suited for endoscopic use in a biomedical context? And how can fiber-based 3D printing be implemented in a minimally invasive, efficient, and safe manner?

Cross-disciplinary approach

It is important to Andrea Toulouse "to think ideas through to the end" and to establish a clear connection to medical applications. To facilitate the transfer to clinical applications, she will integrate her group into the new Bionic Intelligence Tübingen Stuttgart (BITS) research network under the umbrella of Cyber Valley. The network's co-spokesperson, Prof. Syn Schmitt, has already supported the funding application. The Biomedical Systems and Robotics for Health profile area at the University of Stuttgart will also be strengthened by the junior research group, and there could be a wide range of opportunities for interdisciplinary collaboration with other members in the profile area.

About the Carl-Zeiss-Stiftung

The Carl-Zeiss-Stiftung's mission is to create an open environment for scientific breakthroughs. As a partner of excellence in science, it supports basic research as well as applied sciences in the STEM subject areas (science, technology, engineering and mathematics). Founded in 1889 by the physicist and mathematician Ernst Abbe, the Carl-Zeiss-Stiftung is one of the oldest and biggest private science funding institutions in Germany. It is the sole owner of Carl Zeiss AG and SCHOTT AG. Its projects are financed from the dividend distributions of the two foundation companies.

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Further information

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