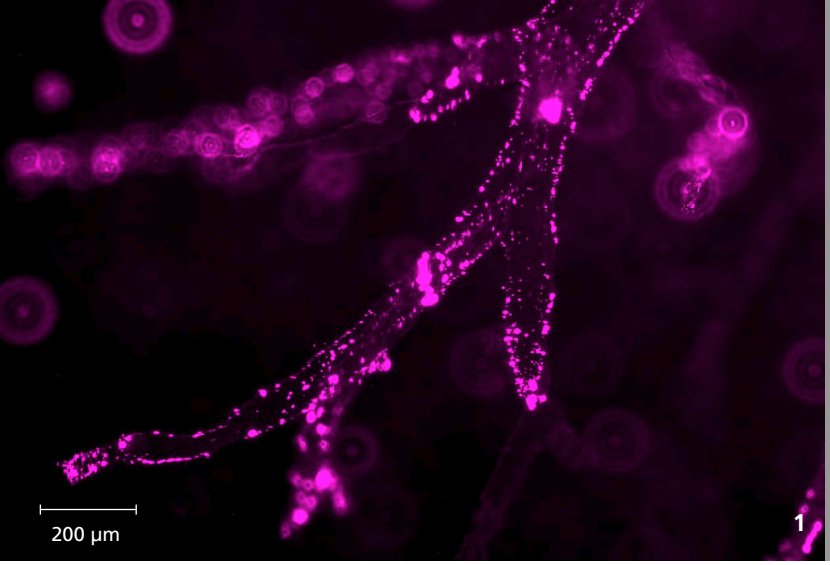

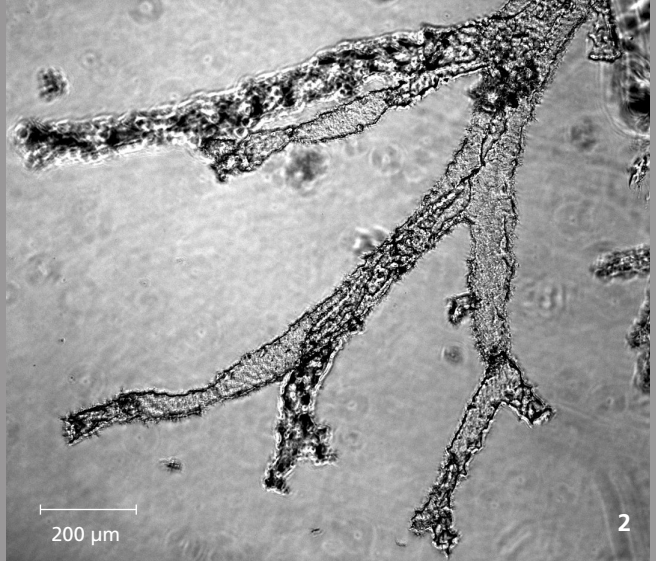

LASER-BASED FABRICATION OF SCAFFOLDS FOR VASCULARIZED, BIOARTIFICIAL HEART MUSCLE

Task

Along with stem cell technology, bioartificial tissue production plays a key role in the treatment of cardiovascular diseases. Today, cardiac myocytes can be generated in vitro from human induced pluripotent stem (iPS) cells. The main obstacle for using bioartificial tissues is the lack of a functional blood vessel structure, which is essential for the supply of the cells at layer thicknesses greater than a few 100 µm. Fraunhofer ILT and partners aim to fabricate vascularized cardiac muscle tissue in vitro. This will be an important step towards fully functional artificial tissues and organs.

Method

The approach pursued in this project combines bottom-up and top-down processes to inscribe blood vessels into biocompatible polymers – tailored hydrogels, to be more precise – by means of laser radiation. Furthermore, it is used to build up three-dimensional scaffolds that are seeded with vascular cells from human iPS cells. As part of the process development, the institute has determined the optimal process parameters such as wavelength, laser power and processing speed for different hydrogels. Furthermore, it is investigating suitable methods for biological and chemical analysis and visualization of the processing results.

Results

In this project, Fraunhofer ILT has been collaborating with several partners: LightFab GmbH, Miltenyi Biotec B.V. & Co. KG, Taros Chemicals GmbH & Co. KG, University Hospital Cologne and the Department of Chemistry at the University of Cologne. With them, Fraunhofer ILT has developed a process that can inscribe vascular structures in a hydrogel using ultra-short pulse (USP) laser radiation. To prove that the generated channels are open, fluorescent nanoparticles were passed through them. In the further course of the collaboration, the partners plan to colonize suitable cells.

Applications

The anticipated product is expected to enable cardiologists to replace damaged heart muscle tissue. The materials and manufacturing processes developed offer improvements for a wide range of tissue engineering areas, especially where vascular structures are required, and thus represent a key to fully functional artificial tissues and organs.

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Contact

Dr. Elke Bremus-Köbberling, Ext: -396
elke.bremus@ilt.fraunhofer.de

Dr. Martin Wehner, Ext: -202
martin.wehner@ilt.fraunhofer.de

1,2 Fluorescence and phase contrast micrograph of a laser-generated vascular structure with dimensions in the µm range.