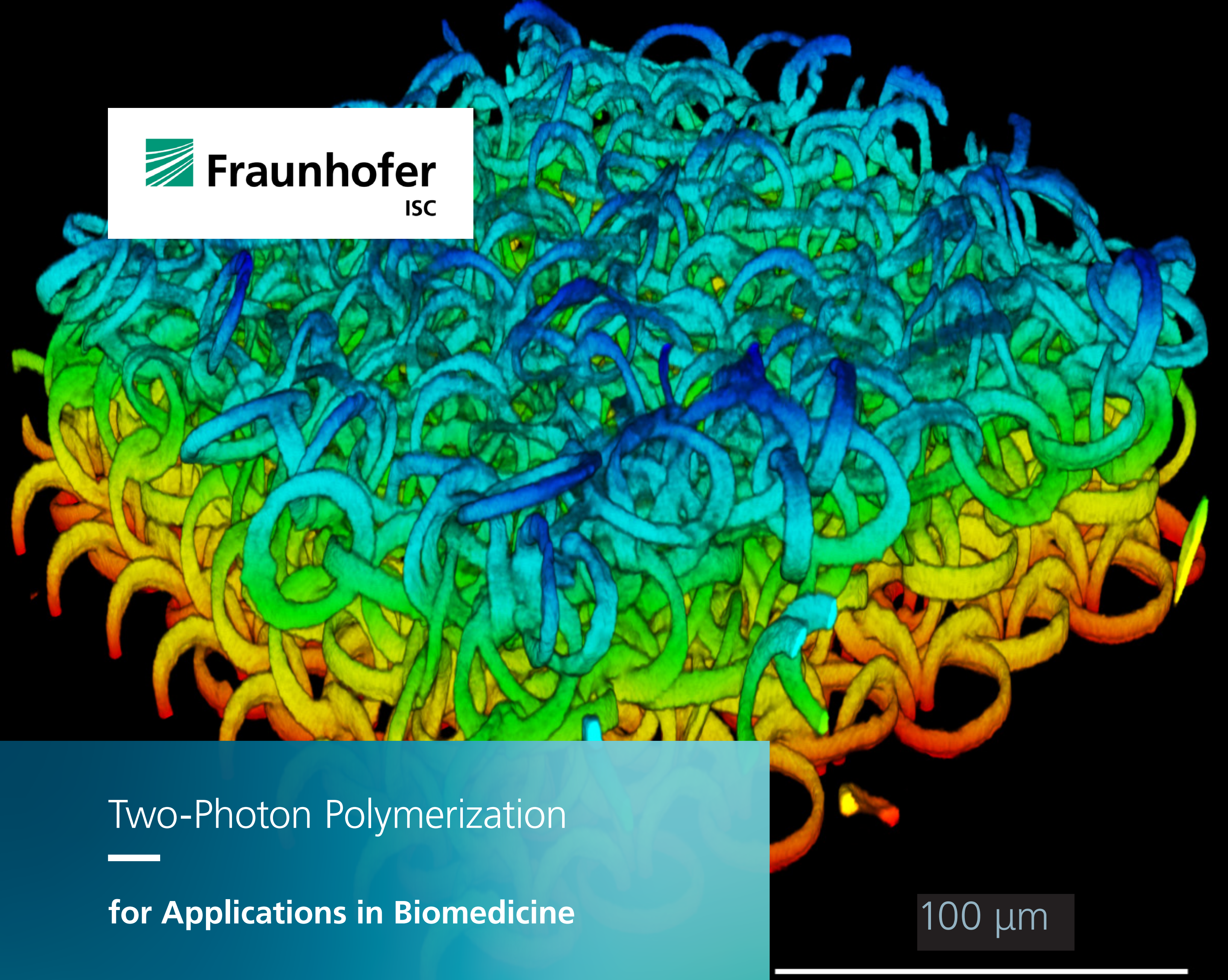
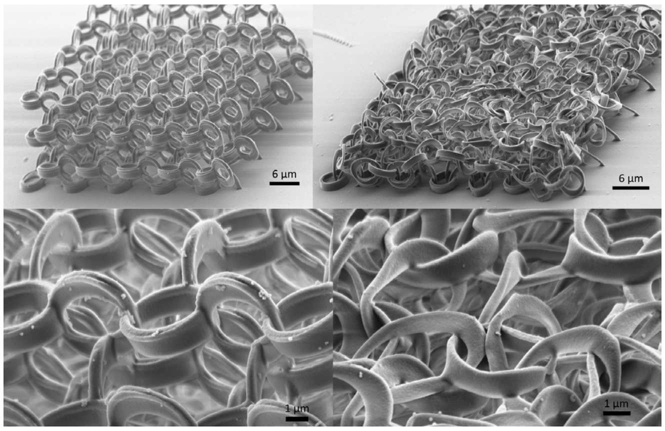


Two-Photon Polymerization

for Applications in Biomedicine

New challenges in medicine

An aging society poses enormous challenges to medical care. The rising demand for prostheses, implants, and artificial tissue in the treatment of cancer and age-related diseases, implicates a growing need for novel bioactive materials. To mimic the physiological 3D environment of living cells, many aspects of material properties have to be considered and adapted, since the native extracellular matrix is a highly complex, dynamic and heterogeneous environment, which is essential for cell and tissue development. One basic approach in the field of biofabrication is to seed viable cells onto a 3D scaffold that provides adhesion sites for further cell cultivation and tissue maturation. Since cells are capable of sensing this environment with submicron resolution, and are highly influenced by the 2D and 3D morphology of the substrate, a scaffold fabrication technique with corresponding submicron resolution is needed.



High-definition 3D cell scaffolds composed of welded and loosely intertwined rings with a diameter of 5 µm.

Two-Photon Polymerization

Within additive manufacturing, the direct laser writing technology based on two-photon polymerization (2PP) offers the highest lateral resolution reaching values below 100 nm. At the same time, 2PP is applicable to a broad selection of material classes, e.g. hydrogels, diverse polymers, or multifunctional composites. Along with the 3D architectural freedom and the possibility of tailoring different material properties like crosslinking density or Young's modulus by optimizing the processing parameters, make the 2PP a perfect candidate for the complex design of cellular scaffolds with submicron sized structural elements.

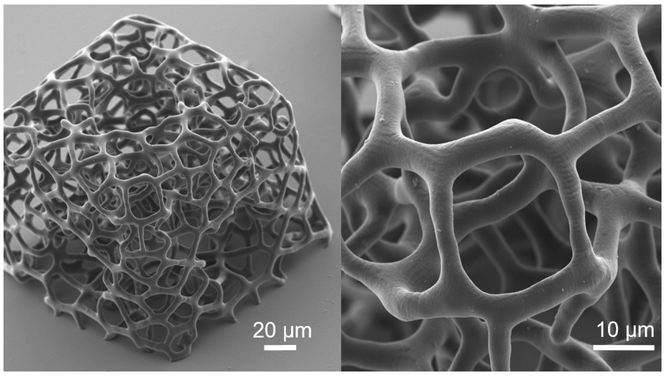
Furthermore, 2PP is not bound to the standard hatching and slicing procedure of conventional 3D printing technologies and makes it therefore possible to produce extraordinary structures that are impossible with manufacture with other methods. These include, for example, loosely intertwined elements or anisotropic mechanical connections.

Development of advanced materials

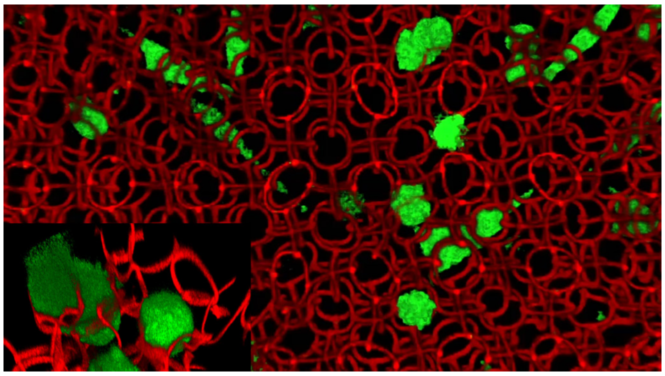
Fraunhofer ISC offers a unique infrastructure for multidisciplinary research and has years of experience in the development of highly tailored materials for different applications. For this purpose, we have access to a broad portfolio ranging from glasses to hybrid polymers and hydrogels. In order to optimize the cell-material interaction we are able to tailor many parameters such as the chemical composition, Young´s modulus and surface roughness. By using, for example, surface functionalization and composites, additional material properties can be introduced to realize additional cell responses.

We offer

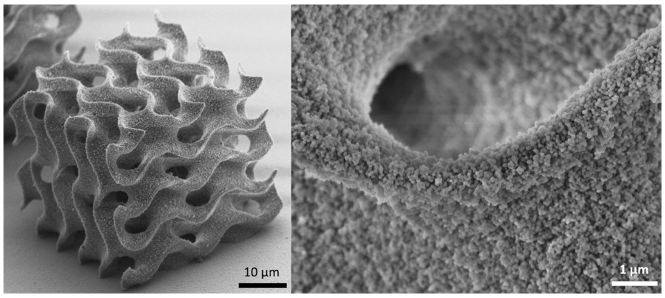
- Development and fabrication of (customer-designed) cell scaffolds and pharmaceutical assays
- Printing of 3D 2PP structures into your assay or microfluidic platform
- Development of novel materials for your cell specific needs
- Enhancing your material of choice and tailoring diverse material properties
- Designing and printing of arbitrary 3D structures via 2PP



Example of highly porous cell scaffold made of biocompatible hybrid-polymer.



Fluorescently labeled fibroblast cells migrating inside a 4 layered chainmail structure of image 3b. Due to the low Young´s modulus of the hydrogel, cells are easily capable of distorting the scaffold. (Ringdiameter: 20 µm)



3D gyroid scaffold made of a nanoparticle / hybrid polymer composite with tailored surface roughness.

Contact

Marie Richard-Lacroix
Optics and Electronics
Phone +49 931 4100-515
marie.richard-lacroix@
isc.fraunhofer.de

Fraunhofer ISC
Neuerplatz 2
97082 Würzburg | Germany
www.isc.fraunhofer.de