Press Release

18 Dezember 2020

Biodegradable, osteochondral and tailor-made:

3D lithography (2PP) enables production of monolithic, biodegradable 3D scaffolds of one cubic centimeter for the first time in under 1.5 hours

Würzburg/Heiligenstadt. - Using its core technology 3D lithography via two-photon polymerization (2PP), Multiphoton Optics has succeeded for the first time in producing a biodegradable, osteochondral 3D scaffold (3D support structure) of approximately one cubic centimeter in less than one and a half hours in just one single process step. Due to the time-saving production of monolithic biphasic implants for applications in regenerative medicine, implants can be adapted to requirements in the future and, for example, manufactured immediately before surgery. Another major advantage of using biodegradable, tailor-made bone-cartilage implants is that, in the event of a disease-related defect, only a single surgery for the patient is required, thus making a significant contribution to minimizing healthcare costs.

The basis for the technological implementation is a prototype of the Multiphoton Optics' 3D printing platform LithoProf3D®, which has been optimized specifically for the fabrication of scaffolds through further automation of process steps within the system and the control software developed by Multiphoton Optics. The development is part of the 'Poly-IMPLANT-Druck' project funded by the German Federal Ministry of Education and Research (BMBF). The aim of the project is the fabrication, analysis and field tests of monolithic biphasic implants to stimulate tissue regeneration of bone-cartilage defects. The fabricated 3D scaffolds serve as mechanical support structure as well as bioactive carrier which provides an optimal culture medium for cell growth. The scaffold, based on a biomimetic design by iba Heiligenstadt e.V., features a height of 10 and a diameter of 7 millimeters and is divided by a separation layer into a 3 millimeter tall cartilage phase and a 7 mm tall bone phase (see Figure 1). Due to complete freedom of design, the mechanical properties such as porosity and Young's modulus of the respective phases can be adjusted to closely resemble real examples of bone and cartilage. The newly developed prototype enables the fabrication of the approximately 1 cm^3 scaffolds within 1.5 hours, which is a first important step towards scalability. The biodegradable material used was poly-((D, L)-lactide-co-ε-caprolactone)-dimethacrylate (LCM3) developed by iba Heiligenstadt e.V., which will later be replaced by poly(amide-co-ε-caprolactone)-dimethacrylate (ACM), as the latter can be better degraded by the body. Cell and filling tests of the scaffolds are currently being carried out at iba Heiligenstadt e.V. and other project partners, after which an animal study is to follow over the next few years.

A further increase in the degree of automation of the printing platform should further increase the production throughput in the future and enable series production, also in other application areas. In addition, individually designed 3D scaffolds will open up new therapeutic options for personalized medicine in the future.

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About Multiphoton Optics GmbH:

Multiphoton Optics GmbH, founded in 2013 as a spin-off from Fraunhofer ISC and based in Würzburg, is a global solution provider for 3D lithography via two-photon polymerization (2PP). This disruptive technology enables the fabrication of complex functional structures in micro-optics and microsystems technology, optical interconnects, micromechanics and biomedical engineering. The modular LithoProf3D®-GSII 3D printing platform enables high-precision manufacturing of complex structures in a single process step with very high throughput. The realization of completely new designs, further miniaturization and streamlining of manufacturing processes significantly accelerate the time-to-market of products, thereby unlocking substantial cost savings for customers.

About iba e.V. Heiligenstadt:

The Institute for Bioprocess Technology and Analytical Measurement e.V. (iba) is a non-university research institute in the Free State of Thuringia and since 2013 an affiliated institute at the TU Ilmenau. iba Heiligenstadt e.V. has proven expertise in the field of biointerface engineering and focuses its research in particular on 3D cell culture techniques and their application in the field of diagnostic (disease modeling) and therapeutic tissue engineering (tissue regeneration). The spectrum of services ranges from numerical modeling to the establishment of corresponding in vitro test and cultivation procedures to the development of clinical therapy options. For the matrix engineering relevant here, highly innovative 3D printing processes such as 2PP are used, among others.

Financial support for the corresponding joint project is provided by the BMBF as part of the "ProMatLeben-Polymere" initiative (FKZ's: 13XP5089A-F).

Further information: https://promatleben.de/de/projekte/projekte-alphabetisch/poly-implant-druck/

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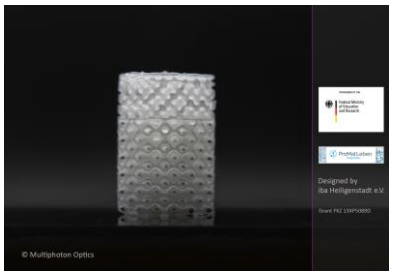

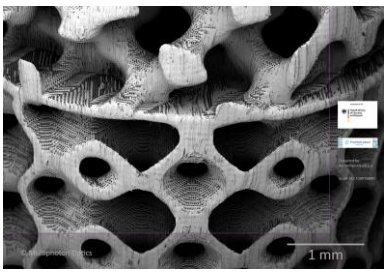

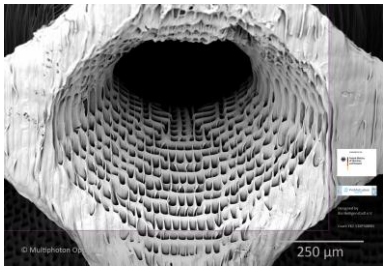

Abb.1 *Abb. 2* *Abb. 3*

The structure was produced with an optimized prototype version of the Multiphoton Optics 3D printing platform LithoProf3D® and consists of a biodegradable material developed by iba (Institut für Bioprozess- und Analysenmesstechnik e.V.). Figure 1. the left photo shows a 10 mm high scaffold structure: at the top the 3 mm high cartilage phase is separated from the 7 mm tall bone phase by a separation layer. Figure 2 shows a magnified view of the structure in the area of the separation layer. Figure 3 shows a single macroscopic pore of the bone phase. It is clearly visible that the scaffold still has a microstructure internally with a pore size of approx. 20 µm. Figure 2 and 3 were taken using an electron microscope. Image source: Multiphoton Optics.