Deliverable 1.1 – 3D Polymer Matrix Design (Summary)

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Materials for culturing of living cells must provide a cell environment like that of native tissues. They should be produced by a method that enables control over the scaffold architecture and chemical composition to influence cellular behaviour in a desired manner. Depending on the tissue engineering (TE) application, scaffold structures must exhibit certain geometrical properties to permit 3-D cell infiltration and growth. Therefore, precise methods for the fabrication of TE scaffolds with well-defined pore sizes and predictable interconnectivities are highly desired. With the rapid advancement of nanotechnology and particularly contact-free computer-aided microfabrication methods, it has become possible to produce biomimetic synthetic scaffolds with high precision and reproducibility. These abilities can be found in laser-based microfabrication technologies which are known for high resolution spatial control of the generated structures. Two-photon polymerization (2PP) fulfils the above requirements and enables the fabrication of 3D microstructures with complex architectures and precise dimensions. 2PP is compatible with several classes of photosensitive materials, which have been already successfully used for the fabrication of 3d tissue engineering scaffolds.

The aim of the 3D polymer matrix design is to identify optimal materials and patterns for neural cell culture.

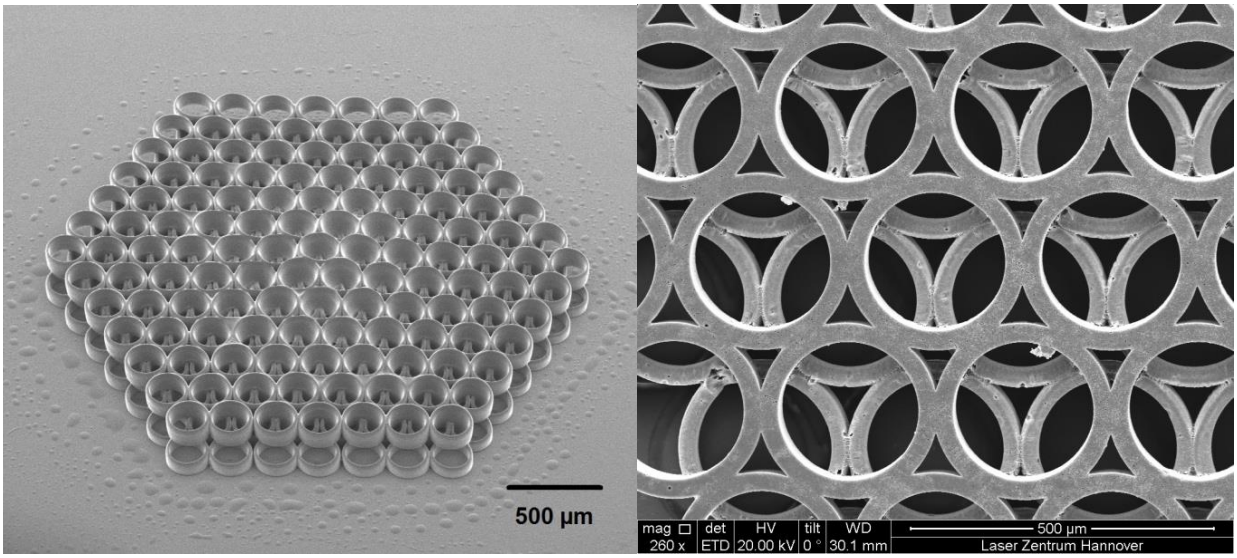

Figure 1 *Hexagonal scaffolds from biomaterials with cylindrical 3D architecture, which allows mass transport (delivery of nutrients and oxygen and remove of wastes) for growing cells.*

In the early stage of the MESO-BRAIN project, several relevant polymers or the initial cell studies were identified and different polymer samples were fabricated by 2PP for conducting cell tests. After first tests with iPSCs for biocompatibility and suitability for long term culture, one material

has been observed to have good compatibility with neural precursor cells (NPCs) and differentiated neurons, as well as, supporting long term culture.

Based on this result, further investigations were focused on this promising Material, with the aim of achieving the best scaffold design through the variation of 2D and 3D structural parameters and by using different surface topographies and coatings, to improve cell grows, differentiation and the ability to control and to guide cells selectively along well-defined paths in 2D and 3D.

In the next period of the MESO-BRAIN project, different designs and surface topographies from the selected material will be tested in long term culture to identify the best 2D and 3D structures for guiding cells. The results of this period will give an answer to the question of the best design that should be used to fabricate the final 2D and 3D network scaffolds.

This will be one of the key steps to develop technologies and know-how to create a "MESO_BRAIN", which will be a 3D functional neuronal network unit based on the structure of a cortical column module involving a designed scaffold that can be reproducibly manufactured, with defined neuronal cell placement and connectivity resulting in a functional human neuronal network that displays in vivo activity patterns.