Femtosecond Laser Written Polymer Micro-Scaffolds for Tissue Engineering

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Natural regeneration of neuronal and periosteum tissues is extremely slow or non-existent and hence human interference is necessary for their repair when damaged. Implantation of tissue grown externally is one possibility. Biocompatible polymer scaffolds are suitable media to grow tissue with structure and form like the damaged area. Scaffolds provide texture and the physical support needed for cell growth by acting as extracellular matrices to the cells. The cells can then grow as if it is inside the body by reproducing the shape and form.

Additive Manufacturing (AM) or 3D printing, has been applied in Tissue Engineering [1]. In this method, 3D microstructures are produced layer-by-layer using Computer Aided Design (CAD). Direct Laser Writing (DLW) aided by Two Photon Polymerization (TPP) is used to fabricate complex sub-micron structures [2]. A mixture of a monomer and photoinitiator is irradiated by a tightly focused laser beam. The monomer and the photoinitiator should be biocompatible and non-cytotoxic. The scaffold should be porous and hydrophilic for efficient cell proliferation and nutrient transfer. Ideally, the scaffold should degrade after a period post-implantation. Moreover, the mechanical strength should be comparable with that of the area of transplant.

In this work, we discuss TPP 2D structures made from a combination of the prepolymer poly (ethylene glycol) diacrylate [3] and the photoinitiator Michler's Ketone [4] using Ti: Sapphire laser operated at 1 kHz repetition frequency. We have studied voxel (polymerized volume) dimensions as a function of laser pulse energy and exposure time (number of pulses). Additionally, we discuss other important parameters like biocompatibility, biodegradation rate, tensile strength and hydrophilicity.

Acknowledgements: The authors thank Chancellor's Award – 2019 for the financial support. The authors wish to acknowledge CUSAT for the SMNRI fund. Meenu M S acknowledges the Kerala State Council for Science Technology and Environment, Government of Kerala for the research fellowship. Rahul acknowledges the Council for Scientific and Industrial Research, Government of India for the research fellowship.

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