Injectable synthetic building blocks to regenerate soft anisotropic tissues

Laura De Laporte

DWI – Leibniz Institute for Interactive Materials, Aachen, Germany
Polymeric Biomaterials, Institute of Technical and Macromolecular Chemistry, RWTH University Aachen, Germany
Advanced Materials for Biomedicine, Institute for Applied Medical Engineering, University Hospital RWTH Aachen, Germany

We apply polymeric molecular and nano- to micron-scale building blocks to assemble soft 3D biomaterials with anisotropic and dynamic properties. Microgels and fibers are produced by technologies based on fiber spinning, microfluidics, and in-mold polymerization. To arrange the building blocks in a spatially controlled manner, self-assembly mechanisms and assembly by external magnetic fields are employed. For example, the Anisogel technology offers a solution to regenerate sensitive tissues with an oriented architecture, which requires a low invasive therapy. It can be injected as a liquid and structured *in situ* in a controlled manner with defined biochemical, mechanical, and structural parameters. Magnetoceptive, anisometric microgels or short fibers are incorporated to create a unidirectional structure. Cells and nerves grow in a linear manner and the fibronectin produced by fibroblasts is aligned. Regenerated nerves are functional with spontaneous activity and electrical signals propagating along the anisotropy axis of the material. Another developed platform is a thermoresponsive hydrogel system, encapsulated with plasmonic gold-nanorods, which actuates by oscillating light. This system elucidates how rapid hydrogel beating leads to a reduction in cell migration, while enhancing focal adhesions, native production of extracellular matrix, and nuclear translocation of mechanosensitive proteins, depending on the amplitude and frequency of actuation.