



## Interactive and Anisometric Colloidal Building Blocks for Regenerative Medicine and Tissue Engineering

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**Abstract:** We apply polymeric molecular and micron-scale building blocks to assemble into soft 3D biomaterials with anisotropic and dynamic properties. We focus on injectable materials that can be pipetted using automated systems, bioprinted or delivered *in vivo* in a low invasive manner. Spherical and rod-shaped microgels and fibers are produced by microfluidics, in-mold polymerization, and fiber spinning. To arrange the building blocks in a spatially controlled manner, self-assembly mechanisms and alignment by magnetic fields are employed. Reactive and/or bioactive spherical and rod-shaped microgels interlink and form macroporous constructs facilitating 3D cell growth and cell-cell interactions or cells are able to use microgels as bricks to build their own house. Chemically defined poly(ethylene glycol)-based microgels, produced via parallelized step-emulsification microfluidics, self-organize with induced pluripotent stem cells (iPSCs) into 3D constructs by robust cell-material interactions. The iPSCs expand and retain their pluripotency, after which they can be differentiated into the three germ layers, providing a suitable platform for organoid differentiation, which was exemplary demonstrated for cardiac organoids. This new organoid production technology enables iPSC expansion and differentiation in the same construct in a reproducible and scalable manner, compatible with high-throughput automation. On the other hand, magneto-responsive rod-shaped microgels form the core of the patented Anisogel technology, which offers a low-invasive therapy to regenerate sensitive tissues with an oriented architecture. It can be injected and structured *in situ* to guide cells in a linear manner. Finally, a thermoresponsive hydrogel system, encapsulated with plasmonic gold-nanorods, actuates by oscillating light and elucidates how rapid hydrogel beating affects cell migration, focal adhesions, extracellular matrix production, and nuclear translocation of mechanosensitive proteins, depending on the amplitude and frequency of actuation. The time spent in the *in vitro* gym seems to affect myoblast differentiation and fibrosis, while actuation seems to induce mesenchymal stem cell differentiation into bone cells.

**Bio: Laura De Laporte** combines engineering, chemistry and biology to design biomaterials that control and direct the interaction with cells. She is a Chemical Engineer from Ghent, where she got the tissue engineering microbe. To follow her dream, she did her PhD with Lonnie Shea at Northwestern University and engineered guiding implants for nerve regeneration. At EPFL, she learned about hydrogels in Jeffrey Hubbell's group during her post-doctoral research. Since 2018, she is a Leibniz Professor at the RWTH University in Aachen, Germany, where she works on Macromolecular Materials for Medicine at the DWI-

Leibniz Institute for Interactive Materials. Her team designs injectable polymeric hydrogel precursors, consisting of nano –and micron-scale building blocks that interlink to form macroporous 3D cell scaffolds and organoids, orient after injection to grow anisotropic tissues, and actuate to include movement into the growing tissues.

***Hosted by:*** Prof. Szu-Wen Wang, Prof. Michelle Digman