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3D ENGINEERING PEG-DIACRYLATE HYDROGELS FOR MIMICKING HUMAN MECHANICAL MICROENVIRONMENTS

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Abstract

Poly(ethylene glycol)-diacrylate (PEGDA) hydrogels are widely used to mimic the microenvironment of human organ cells due to their tunable mechanical properties, ease of fabrication by radical polymerization, and low cytotoxicity. This gives the opportunity to develop PEGDA hydrogels in different sizes and shapes that can be used as a construct substrate for culturing of human stem cells to use in drug screening and disease models on human mini-organs.

The manufacture of micrometer scale PEGDA hydrogels requires stable mechanical properties in the material that can be controlled within a narrow range. Previously fabrication of PEGDA hydrogels has been done with photolithography by using scaffold masks to control the crosslinking pattern in multiple layers. However, this method is labor-intensive and not scalable to production scale. 3D printing by micro-stereolithography enables faster and reproducible manufacture, and we demonstrate that structures with feature sizes down to 40 µm can routinely be produced using this method.

In order to permit long time culturing of human mini-organs the 3D printed PEGDA constructs should be able to withstand up to 1 million cyclic mechanical actuations, thus exhibiting both a high degree of flexibility and robustness.

Cyclic actuation of the PEGDA construct is done by using a voltage controlled piezo actuator that has been adapted to work in an aqueous environment and is coupled to an optical readout system with the possibility to connect to a force read-out system as well.

Shaping the PEGDA constructs using 3D stereolithography printing makes it possible to produce them in a fast and efficient manner and gives the opportunity to produce multiple constructs at a time thus making it industrially suitable.