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Multi-photon lithography on hydrogels for organ-on-chip applications

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Multi-photon lithography (MPL) exploits the ability of femtosecond lasers to penetrate transparent materials, and trigger non-linear absorption phenomena only in the focal volume of a microscope objective. Applying its 3D patterning capabilities to hydrogels allows researchers to recreate the microenvironment surrounding cells, providing high-resolution building blocks for organ-on-chips. Cells can invade the hydrogel structure once it has been produced, or be already encapsulated into it (or both), since most MPL processes can be biocompatible if the appropriate photochemistry is chosen. Different effects can be achieved depending on the materials, such as polymerization of the hydrogel, cleaving of an already crosslinked network, or grafting additional molecules to the polymer backbone to modify the local environment. We demonstrated several applications, including semi-permeable barriers for signals, nutrients, and drugs exchange, microchannel networks for cell invasion and microvessel formation, and guided cell migration.