Title: Tri-compartment chip with microelectrode array and DR1-glass grooves for neuronal cell alignment

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Keywords:
Biomedical engineering, cell and tissue models, microelectrode array, organ-on-chip

Abstract
Many of the central nervous system (CNS) related diseases are characterized by axonal damage and dysfunction. The challenge in studying axons by using microelectrode arrays (MEAs) and advanced organ-on-chips is that the axons tend to grow to random directions. Thus, means to guide the axonal growth to wanted direction, e.g., to grow over the electrodes such that their electrical activity could be measured, are needed.

Here, we report a modular cell-culture chip that combines three modules: custom-designed microelectrode array (MEA) technology, a microfluidic polydimethylsiloxane (PDMS) module with three cell culture compartments separated by microtunnels, and nano-scale grooves made of light-responsive Disperse Red 1 molecular glass (DR1g) to guide neuronal cell growth across the middle compartment over the embedded electrodes.

The functionality of the chip was verified by culturing human-induced pluripotent stem cell (hiPSC) -derived cortical neurons in the chip for 33 days. The chip can be utilized in a large variety of axon biology-related studies, as it offers axonal guidance, possibility to produce controlled axonal damage and to measure axonal activity.