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Microfluidic Chambers with Fluid Walls for Cell Biology

Authors : Cristian Soitu, Alexander Feuerborn, Cyril Deroy, Alfonso Castrejon-Pita, Peter R. Cook, Edmond J. Walsh

Abstract : Microfluidics now stands as an academically mature technology after a quarter of a century research activities have delivered a vast array of proof of concepts for many biological workflows. However, translation to industry remains poor, with only a handful of notable exceptions – e.g. digital PCR, DNA sequencing – mainly because of biocompatibility issues, limited range of readouts supported or complex operation required. This technology exploits the domination of interfacial forces over gravitational ones at the microscale, replacing solid walls with fluid ones as building blocks for cell micro-environments. By employing only materials used by biologists for decades, the system is shown to be biocompatible, and easy to manufacture and operate. The method consists in displacing a continuous fluid layer into a pattern of isolated chambers overlaid with an immiscible liquid to prevent evaporation. The resulting fluid arrangements can be arrays of micro-chambers with rectangular footprint, which use the maximum surface area available, or structures with irregular patterns. Pliant, self-healing fluid walls confine volumes as small as 1 nl. Such fluidic structures can be reconfigured during the assays, giving the platform an unprecedented level of flexibility. Common workflows in cell biology are demonstrated – e.g. cell growth and retrieval, cloning, cryopreservation, fixation and immunolabeling, CRISPR-Cas9 gene editing, and proof-of-concept drug tests. This fluid-shaping technology is shown to have potential for high-throughput cell- and organism-based assays. The ability to make and reconfigure on-demand microfluidic circuits on standard Petri dishes should find many applications in biology, and yield more relevant phenotypic and genotypic responses when compared to standard microfluidic assays.

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