Smart Multi-Well Plate: Industrializable open technology platform for tubeless, autonomous OoC applications

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ALTEX Proceedings

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Presentation: Poster

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Smart Multi-Well Plate: Industrializable open technology platform for tubeless, autonomous OoC applications

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Introduction: Organs-on-Chip (OoC) have been a promise of microfluidics since their early days, leading to a widespread use in research. OoC adoption by industry conversely has so far been slow, resulting in a big gap between what is developed by elite pioneers and what can be offered to a broad audience. A way to bridge this gap is the consolidation of standards for design, manufacturing and qualification of OoC, making it easier for experts in different fields to combine their expertise and creating integrated systems with higher value than the sum of the parts. To this end, here we present the Smart Multi-Well Plate (SMWP), a device based on an open technology platform and the standardized 96-well plate format. Within this format, the SMWP integrates 16 OoC devices and piezoelectric micropumps, connected by a microfluidic network and controlled by integrated electronics.

Results and discussion: The SMWP allows for high modularity, with design and interfacing rules according to guidelines defined by experts from industry and academia [1]. With the SMWP, OoC devices, sensors and piezoelectric micropumps can be integrated using industrial workflows exploiting automated pick-and-placing and wire-bonding machines. The modules are fluidically connected by means of a polymeric fluidic circuit board and electrically connected by reusable and disposable printed circuits boards. These take care of both control of micropumps and sensors and transfer of power and data to the outside world. Fluidic and electric performance of the plate, including piezoelectric micropumps from Fraunhofer EMFT, were tested in combination with barrier model OoC devices from BEOnChip and Bi/ond and multi electrode array chips from MultiChannel Systems. Preliminary results of the biological validation of the three embodiments of the SMWP will also be presented.

Conclusions: An autonomous standardized OoC platform based on an open technology was realized by leveraging industrially upscalable processes and integrating OoC devices.

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Presentation: Oral

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Investigating the crosstalk between cardiomyocytes, fibroblasts, endothelial cells and resident macrophage within vascularized cardiac organ-on-a-chip platforms

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The advances in human stem cell technology and biofabrication techniques have generated a synergetic influence to accelerate research in the field of heart-on-a-chip. Functional cardiac tissues with microvascular plexus remain the challenge due to the highly condensed and organized tissue architecture and the complex multi-cell interactions. In the heart, fibroblasts, endothelial cells, and circulating and resident macrophages (Macs) play an important role in matrix deposition, vascularization, and paracrine signaling. Cardiac resident macrophages, which originate from the yolk sac, were shown to facilitate angiogenesis [1], cardiomyocytes (CMs) proliferation, improve electrical conduction [2], and promote scarless repair post-MI [3]. Thus, the incorporation of Macs along with other cells is critical to achieving an adult-like, functional, vascularized engineered cardiac tissue.

Here, we first evaluated vessel network formation within a cardiac tissue using a fibrin plug method and identified that when culturing ECs with CMs, vessel networks formed but degraded over time, whereas the control cultures, without CMs, remained stable for weeks. Moreover, pro-inflammatory and endothelial activation cytokines secretion were increased in the presence of CMs. When adding Macs to the culture, vessel stabilization occurred along with a decrease in pro-inflammatory and endothelial activation cytokines secretion.