

Integrated sensing in microphysiological systems: the key role of microelectrode arrays

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The technology of microphysiological systems (MPS) is establishing a plausible alternative to animal-based models for the study of human physiology under *in vitro* conditions [1]. MPS aim to recapitulate synthetically the main traits of cellular microenvironments for the growth and maturation of tissues under controlled conditions. Compared to established cell culture methods, MPS afford higher physiological relevance through the inclusion of mechanical, electrical and chemical cues that closely mimic *in vivo* conditions.

Continuous monitoring of the MPS microenvironment and of the status of cells and tissues across the duration of the assays is crucial for assessing health and metabolism of the biological constructs [2]. Among several available types, electrical sensing is particularly suitable for integration within the confined geometries of MPS and to complement optical inspection. Microelectrodes, which represent the interfacing elements between the tissues and the external readout, play thereby a crucial role. Geometry and material composition are particularly important parameters for the functionality of microelectrodes, and both are constrained by the fabrication methods.

In this contribution, I will showcase the opportunities offered by wafer-level microfabrication of MPS through the design, fabrication and characterization of a microfluidic tissue barrier sensor module (Fig. 1, left) [3-4] and of three-dimensional arrays of microelectrodes (Fig. 1, right) [7-8]. I will emphasize the reproducible fabrication of pre-defined geometries for microelectrodes as a step toward standardization of tissue impedance measurements in MPS, and conclude with the concept of modular platforms embedding multiple standardized modules as viable perspective for MPS advancement.

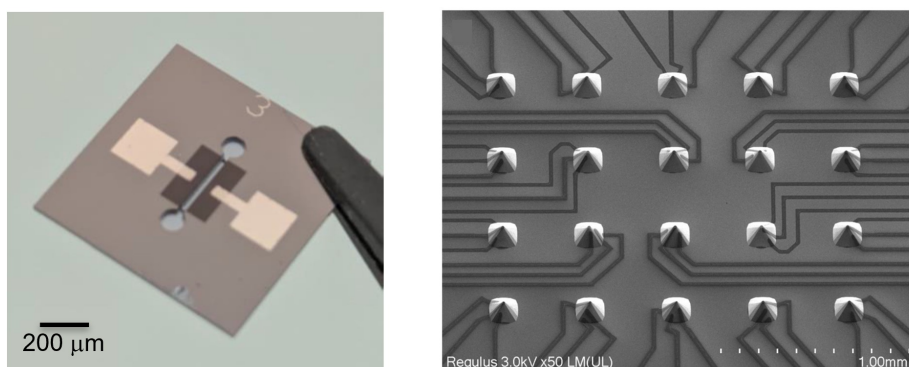


Figure 1. Tissue barrier sensor chip [3] (left), and 3D silicon-based microelectrode array [5] (right).

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