

Exploiting biosensors to investigate tumors through lab-on-chip and organ-on-chip systems

Giuseppe MARUCCIO - University of Salento, CNR-Institute of Nanotechnology, INFN Sezione di Lecce

Lab-on-chip devices attracted large interest for medical diagnostics and drug screening. In this respect, electrochemical impedance spectroscopy allows the development of multipurpose biochips with integrated microfluidic components. Such biochips were demonstrated to be suitable for ultrasensitive detection of biomarkers in flow immunoassays providing tools useful to achieve a diagnosis of tumours (or other diseases) and monitor their evolution by liquid biopsy approaches. On the other hand, the same impedance sensors with few modifications can enable viability, cytotoxicity, migration and proliferation assays on cell populations providing a suitable platform for gaining further insight on the disease and perform drug research. For exploiting the full advantages of a lab on a chip approach, microfluidic components for fluid handling and cell separation/isolation can be integrated with the transducers. For increasing sensitivity, advanced read-out approaches can be employed when needed (e.g. in the case of small molecules) exploiting magnetoresistive, plasmonic, SAW and SRR transducers while advances in gas sensing can enable diagnostic approaches based on volatilomics.

More recently, microphysiological systems, organ-on-chip and multiorgans microdevices attracted considerable attention as novel tools for high-throughput and high-content research to achieve an improved understanding of diseases and to accelerate the drug development process towards more precise and eventually personalized standards. To take full advantage of their capabilities and accelerate research, they should be combined with efficient analytical methods. A recent trend consists in the on chip integration of in-line miniaturized sensors to replace off chip assays on manually extracted samples. This approach offers great opportunities for enabling continuous and automated data collection and in-situ monitoring of functional indicators and biological responses. It also facilitates real-time decision making. The range of monitorable parameters include barrier integrity, oxygen concentration and inflammation response (e.g., cytokines production) as well as electrical and mechanical signal.