Ph.D. Course in Materials Science and Nanotechnology

University of Milano-Bicocca, Department of Materials Science, via Cozzi 55, 20125 Milano

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Building U9 - room 09

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Multipurpose lab on chip – From medical diagnostics to food and environmental monitoring

Recently the development of lab-on-chip devices attracted large interest for detection of specific analytes/markers, cellular studies, drug screening as well as food and environmental monitoring. In this respect, electrochemical impedance spectroscopy is a powerful tool.

Here the development of a multipurpose biochip with integrated microfluidic components is described. Specifically, the layout consists of various sensing areas, each one including an array of transducers (gold interdigited electrodes), while microfluidic channels are used for the delivery of functionalization and sample solutions into the chambers. Such biochips are first demonstrated to be suitable for viability assays, cytotoxicity tests and migration assays on cell populations. Then other applications are discussed concerning the ultrasensitive (pM) detection of biorecognition events in flow immunoassays, such as in the case of cholera toxin in solution or cancer biomarkers in siera.

Our publications demonstrate that these biochips are very suitable for clinical analysis, being faster and more reproducible than traditional techniques. In particular our attention was so far focused mainly on cancer diseases. For example, by means of appositely developed biochips, we assessed the presence of autoantibodies against Ser-419-phosphorylated ENOA in sera originating from patients with pancreatic ductal adenocarcinoma (PDAC). Biochip results are in agreement with those from traditional techniques, such as ELISA and Western Blot, but measurements are much more sensitive and specific increasing the possibility of PDAC diagnosis. Similar chips also allowed to evaluate the free-to-total PSA ratio useful for screening of prostate cancer risk. On a different approach, these biochips were modified to enable automatic tests to quantify the invasive potential of cell lines by detecting the migratory activity of hepatocellular carcinoma (HCC) cells as a function of microenvironment. Moreover, they were also employed for the simultaneous detection of multiple lower genital tract pathogens.

Similar biochips were applied for food and environmental monitoring. For example, we recently reported a portable gliadin-immunochip for contamination control on the food production chain which was validated for both liquid and solid food matrixes by analysing different beers and flours. In a different study, the biochips were employed to detect food pathogens, such as *Lysteria monocytogenes and Staphylococcus aureus*.

Presently, we are also integrating more advanced microfluidic components and monolithic valves for fluid handling using thermo-responsive hydrogels, as well as other read-out approaches for increasing sensitivity in the case of small molecules thanks to magnetoresistive, plasmonic or SAW transducers.