Miniaturized sensors for organic and inorganic contaminants' detection

Sebania Libertino
CNR – IMM headquarter Catania

Progresses in microelectronic industry and in smartphone technology are strongly driving the research of miniaturized sensors for different applications spanning from healthcare to environmental or food analysis. Aim of our research activity is the development of miniaturizable Si-based sensing platforms that can be easily functionalized to detect contaminants (bacteria, heavy metals, pesticides, etc.) in liquid matrixes. To this purpose, we studied both optical and electrical systems, the first by using very sensitive photodetectors, silicon photomultipliers (SiPMs) able to detect down to a single photon, the second by using microelectronic devices such as metal/oxide/semiconductor (MOS) diodes or field effect transistors (MOSFET).

In the first approach, we used chemo luminescence or photoluminescence produced when interaction with a specific contaminant occurs. Bacterial charge was quantified by monitoring the adenosine triphosphate (ATP) presence using an integrated and low-cost disposable microfluidic chamber. The SiPM-based bioluminescence sensing system shows a similar analytical dynamic range for ATP detection to that of a full-size PerkinElmer laboratory luminescence reader.

Heavy metals contamination in water, instead, was detected by using a recombinant Escherichia *coli* bioreporter, expressing a bioluminescent-chemotactic intracellular system. Thanks to a molecular cloning experiment, we modified the bacterial DNA of E. *coli* so that its chemotactic activity is perturbated each time there is an interaction with heavy metals. This perturbation trigs the production of a bioluminescent signal, that is optically detectable and quantifiable.

For electrical systems, we demonstrated the possibility to detect biological contaminants by monitoring DNA pairing with specific probes using electrical detection. This approach can be easily used for any contaminant that will cause a charge variation on the transistor gate. Finally, this technology can be disposable and wearable by using thin film transistors (TFT) fabricated on plastic materials.