Optical immunosensors: Analytical tools with many applications

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Optical transducers are widely used as biosensing tools due to their high detection sensitivity, immunity to parasitic electronic noise, multi-analyte capabilities and, in many cases, ability for label-free detection. Most label-free optical biosensors rely either on refractrometric or reflectrometric detection principles. In the first category fall all sensors based on surface plasmon resonance and interferometry, including Mach-Zehnder and Young interferometers, while the second category includes mainly sensors based on reflectance spectroscopy. Aiming to develop optical biosensors that could offer high analytical sensitivity but also ease-of-use at the point-of-need, in the last 15 years, we have focused our research efforts to the development of silicon-based Mach-Zehnder interferometers (MZIs) as well as to a system based on white light reflectance spectroscopy [1, 2]. The integrated MZIs consist of silicon nitride waveguides fabricated on a silicon chip along with broadband light-emitting diodes and photodetectors. The implementation of a broadband light source resulted to a new detection approach that benefiting from the information gained by processing the whole transmission spectrum provided high detection sensitivity. Over the years, several chip layouts have been realized seeking the most suitable for implementation to portable devices that could perform at the point-of-need. Thus, chip formats that included along with the MZIs, light sources, spectral analysers and photodiodes were fabricated leading to the ultimate level of integration. On the other hand, chips with only the MZIs and external light source and spectrometer have been exploited as "dipstick" sensors in order to abolish the need for microfluidics and pumps. Regarding the biosensors based on white light reflectance spectroscopy (WLRS), in addition to optimization of their analytical performance, the main targets were to minimize the size of the whole system and built-up an instrument that could automatically perform all the assay steps and process the data for presentation to the user. Both systems have been applied to the immunochemical detection or either single or multiple analytes related to food and environmental safety in different matrices as well as of disease biomarkers in biological fluids.

References

[1] D. Tsounidi, P.S. Petrou, I. Raptis, IEEE Sensor J. 21 (2021) 12840-12855.

[2] M. Angelopoulou, P. Petrou, S. Kakabakos, Trends Anal. Chem. 175 (2024) 117714.