ABSTRACT

Organic Optoelectronics as a Key-Enabling Technology for a New Class of Miniaturized Optical Sensors

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Optical sensors are powerful tools for numerous analytical applications, ranging from healthcare to food safety monitoring. In the detection scheme of the sensor, a light-emitting source and a light-detector are respectively needed to excite and to detect the signal from an element sensitive to the analyte of interest. Although conventional systems are robust and sensitive, they typically comprise bulky and expensive optical components such as lasers and photomultiplier tubes. As a result, this class of sensors is mostly confined to analytical labs. The smart exploitation of nanotechnology is here proposed as a new approach to bring sensing methods to the point-of-need. For instance, the monolithic integration nanometer-thick organic optoelectronic devices, such as organic light-emitting diodes (OLEDs) and organic photodiodes (OPDs), provides a miniaturized platform of optical excitation and detection.

A designed combination of OLEDs and OPDs with a band-pass polymeric optical filter is demonstrated to obtain an all-organic and miniaturized fluorescence sensor that is capable to detect signals for a wide range of fluorophore concentrations, ranging from 10-3 M to 10-6 M. The three integrated elements work cooperatively in a reflection-type configuration, in which the OLED is directly fabricated onto polymeric stack of the filter, that is laminated onto the OPD.

This application-driven approach is pushed further to obtain a plasmonic sensor with a total size of 0.1 cm3.[1] The new concept involves the identification, the

development, and the accurate design of the 3D layout of integration of optoelectronic and plasmonic elements. Specifically, the selection of organic light emitting transistors, as planar devices with micrometer-wide emission areas, offers the pioneer incorporation of an OPD to obtain a photonic module endowed with light-emitting and light-detection characteristics at unprecedented lateral proximity of them. This approach allows for the exploitation of the angle-dependent sensing of a nanostructured plasmonic grating (NPG) in a miniaturized system based on low-cost components, in which a reflective detection is enabled by the elegant fabrication of the NPG on top of the photonic module. The plasmonic detection scheme is validated by the rational variation of the OPD photocurrent upon exposing the NPG from water to alcoholic solutions at different concentrations. The concept of having miniaturized architectures through a smart-system integration approach may enable the full expression of the potential of cost-effective sensing systems in real-settings in terms of fast-response, high sensitivity and ease of portability.[2]

References

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