Organic light-emitting transistor as nanoscale light source for optical sensing

Stefano Toffanin

1 Italian National Research Council, Institute for the Study of Nanostructured Materials (CNR-ISMN), Via Gobetti 101, 40129 Bologna
**stefano.toffanin@cnr.it*

We report on the definition and engineering of a new detection scheme to be use in optical biosensing by the unprecedented exploitation of inherent features of the organic optoelectronics and nanoplasmonics technologies building the overall system.

Keywords: organic photonics, nanoplasmonics, food security, optical biosensor, smart-system integration

Abstract

Organic light-emitting transistors (OLETs) show, in a single device, the fascinating combination of electrical switching characteristics and light generation capability. Thus, the OLET development is prompted by the possibility to exploit a transport geometry to suppress deleterious photon losses and exciton quenching mechanisms[1] inherent in the OLED architecture, and ultimately enable new light source technologies at the nanoscale[2].
The key advantages of the planar structure coupled to the possibility to easily incorporate photonic structures[3] for light guiding, confinement and extraction, position favourably the field-effect transistor approach to achieve efficient and bright electroluminescence form organic semiconducting materials. Based on these characteristics organic light-emitting transistors are of immediate use in sensing platforms, optical communication and integrated optoelectronic systems, which incorporate OLETs as a key active element.
In particular, the feasibility of optical instruments for sensing depends not only on recognition or transduction principles but on the entire sensor system where cost and portability are of primary concern for effective point-of-care or in-the-field applications. The lack of an integrated, versatile detection scheme - one which is miniaturized, integrated, wavelength-selective and able to monitor multiple locations on the chip - is a major obstacle to the deployment of diagnostic devices in the real-setting applications and has prevented the development of more complex tests where rapid, kinetic or multipoint analysis is required.
In this scenario, we report the preliminary results of the EU H2020-ICT-2017 granted MOLOKO project that aims at the manufacturing, implementation and validation of miniaturized organic photonic sensor for low-cost standardized screening of interest analytes for sustainable food safety. In particular, the multiplexed and (semi)quantitative detection is expected to be of up to 10 analytes among which food safety parameters e.g. antibiotics (i.e. penicillin, cephalonium) and toxins (i.e. mycotoxins) and food quality parameters e.g. lactoferrin and caseins. In particular, we will report on the unprecedented integration of 3 technology-enabling building blocks which allows for the realization of high-added value optical biosensor:

- ☐ An organic light source as organic light-emitting transistor enables an optics-less light-coupling in a high-sensitive detection scheme
- ☐ A non-conventional nanostructured plasmonic surfaces which allow to detect refractive index modulation at the grating surface opposite to where the probing excitation light is impinging
- ☐ An organic photodetector that is monolithically integrated in the OLET structure by multistack side-by-side fabrication in order to enhance sensor miniaturization.

Acknowledgements

This work has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 780839 (MOLOKO Project).

References

1. Koopman, W.W.A. et al. *ACS Appl. Mater. Interfaces* **10**, 35411-35419, (2018).
2. Prosa, M. et al. *ACS Appl. Mater. Interfaces*, **10**, 25580–25588 (2018)
3. Natali, M. et al. *Adv. Funct. Mater.*, **27**, 1605164, (2017)