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Smart-integration of organic light-emitting transistors in a multifunctional system for plasmonic sensing

M. Prosa[1]*, E. Benvenuti[1], D. Kallweit[2], P. Pellacani[3], M. Toerker[4], M. Bolognesi[1], L. Lopez-Sanchez[3], F. Marabelli[4], S. Toffanin[1] *

[1] Institute of Nanostructured Materials (ISMN), National Research Council (CNR), Via P. Gobetti 101, 40129 Bologna, Italy.
[2] CSEM Center Muttenz, Tramstrasse 99, CH-4132 Muttenz, Switzerland.
[3] Plasmore s.r.l., Viale Vittorio Emanuele II 4, 27100 Pavia, Italy.
[4] Fraunhofer FEP, Winterbergstraße 28, 01277, Dresden, Germany.
[5] Physics Department, University of Pavia, Via A. Bassi 6, 27100 Pavia, Italy.

The integration of multiple devices in a single functional unit is boosting the advent of a series of compact optical sensors for rapid and on-site analysis. In this context, the huge potential of plasmonic-based sensors has been affected by the strict constraints of the detection scheme. Therefore, the resulting need for laboratory equipment, such as laser sources and expensive prism-based optics, ends up in not-portable systems.

Here, an ultra-compact plasmonic sensor is demonstrated through the smart-integration of an organic light-emitting transistor (OLET), an organic photodiode (OPD), and a nanostructured plasmonic grating (NPG). The direct integration of the OPD onto the planar structure of the OLET enabled unprecedented proximity of the light-source and light detecting areas, which allowed the exploitation of the angle-dependent sensing characteristics of the NPG.

The most effective 3D layout of integration, including the optimal size and relative positioning of the three elements (i.e. OLET, OPD, and NPG), was unraveled by an advanced simulation tool, which also predicted the signal variation of the sensor under different conditions. Accordingly, the effectiveness of the new plasmonic-based detection scheme was demonstrated by the dependence of the OPD photocurrent on the surrounding environment of the NPG. In particular, a variation of the OPD photocurrent of about 10^{-9} A was recorded when exposing the NPG from water to alcoholic solutions at different concentrations.

A miniaturized plasmonic sensor with a total size of 0.1 cm^3 was therefore obtained through the smart integration of nanometer-thick optoelectronic and plasmonic components.

Corresponding Author e-mail: mario.prosa@cnr.it, stefano.toffanin@cnr.it
*lead presenter: e-mail: mario.prosa@cnr.it