Highlights

ACTIVITY E Advanced materials and techniques for organic electronics, biomedical and sensing applications 2020

Suppression of the morphology mismatch at graphene/n-type organic semiconductor interfaces: a scanning Kelvin probe force microscopy investigation

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The close affinity between organic semiconductors and graphene has stimulated a new research interest on Graphene- Organic Hybrid Electronics (GOHE) with a potentially high technological impact on the next generation of flexible and light-weight electronics. In this framework, we fabricated and analyzed the response of n-type bottom-contact bottom-gate Organic Field Effect Transistors (OFETs) based on thermally-evaporated PDI8-CN_2 thin films and CVD-Graphene as source/drain electrodes. Our efforts were mainly aimed to a quantitative analysis of contact resistance (R_C) through the direct evaluation of parasitic voltage drops at PDI8-CN_2/Graphene contact regions via Scanning Kelvin Probe Force Microscopy (SKPFM). The contact effect contribution of both source and drain interfaces was separately analyzed as a function of the applied voltages (gate–source V_{GS} and drain–source V_{DS}) and in the temperature range of 300 K < T < 360 K. The SKPFM analysis demonstrates unambiguously that the physical mechanisms driving the charge injection and extraction phenomena are distinctively based on the electrode material. While for OFETs with gold electrodes, the R_C effect is mainly ascribable to the degraded quality of the charge transport in the semiconducting film regions close to the electrodes, for graphene-based devices, it is related to the presence of a Schottky-like barrier at the injecting electrode. Ultimate proof of the totally different behaviors occurring at the graphene/organic and gold/ organic interfaces was achieved by the fabrication of a hybrid gold–graphene device. These results could address future strategies aimed at optimizing the response of organic field-effect transistors equipped with transparent monolayer graphene electrodes.

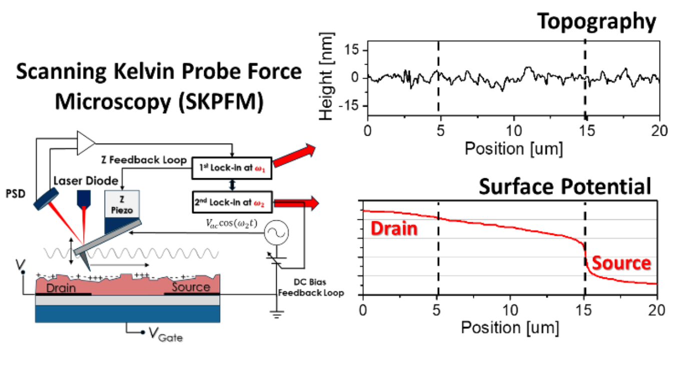

Fig. 1: Graphical abstract depicting the SKPFM technique applied to our bottom contacts/bottom gate OFETs with CVD graphene as Source-Drain electrodes. SKPFM allows to simultaneously acquire the topography and surface potential of the surface under investigation

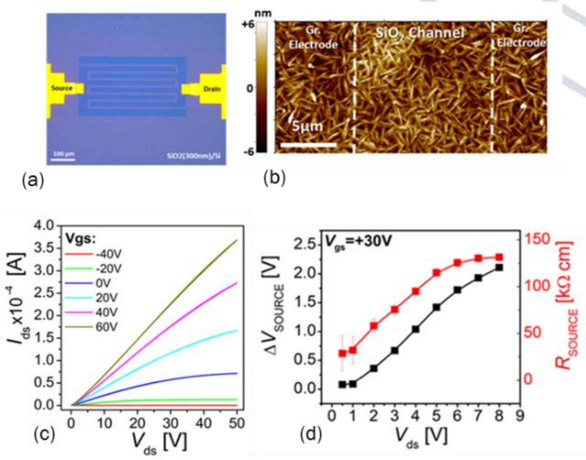

Fig. 2: (a) Optical micrographs of interdigitated micrometric layouts. (b) AFM image of a PDI8-CN2 thin film. The white dashed lines mark the edges of the graphene electrodes. (c) Output curve acquired in vacuum (d) Voltage drops at the source electrodes (black symbols) and width-normalized contact resistance values (red symbols).