Highlights

Advanced materials and techniques for organic electronics, biomedical and sensing applications - 2019

Perylene-Diimide Molecules with Cyano Functionalization for Electron-Transporting Transistors

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Core-cyanated perylene diimide (PDI_CY) derivatives are conjugated molecules exhibiting an uncommon combination of appealing properties, including remarkable oxidative stability, high electron affinities and excellent self-assembling properties. Such features made these compounds the subject of an intense research activity aimed at developing electron-transporting (n-type) devices with superior charge transport performances. In this report, the authors reviewed their extensive experimental work, performed during the last 10 years, on the fabrication and characterization of transistors based on PDI8-CN_2 and PDIF-CN_2 molecules, the most renowned compounds of the PDI_CY family. The main efforts were devoted to correlating the deposition conditions, relying on evaporation processes using both effusive sources and supersonic beams, and the charge transport properties of PDI8-CN_2 and PDIF-CN_2 (Fig.1) thin films for transistor applications (Fig,1). Electrical instabilities and non-idealities, such as the bias stress effect and the contact resistance phenomenon (Fig.2), were widely investigated, highlighting the role of charge trapping mechanisms associated to the film morphological disorder and/or to the absorption of chemical species (i.e. water molecules) at the dielectric/semiconducting interface. The possibility to use these compounds for the development of nanoscale devices or sensors to be applied in liquid environment was also discussed.

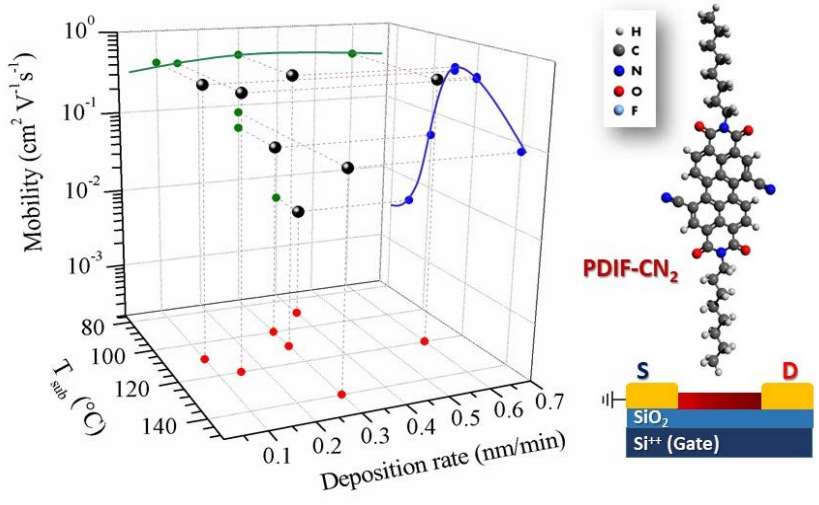

Fig.1: Mobility values (black symbols), estimated for evaporated PDIF-CN_2 films on HMDS (Hexamethyldisilazane) -treated SiO_2, as a function of the substrate temperature (T_{SUB}) and of the deposition rate. The projections of the black symbols along the three axes are the colored plots. On the right, the molecular structure of PDIF-CN_2 and the transistor layout are also shown.

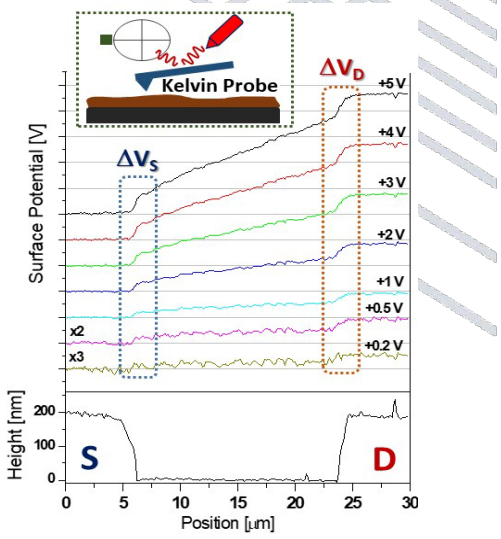

Fig.2: Scanning Kelvin Probe Force microscopy profiles acquired for a PDIF-CN_2 transistor by applying different V_{DS} voltages; Voltage drops associated to the contact resistance phenomenon are visible on both Drain (D) and Source (S) contacts.