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Blends of small molecule semiconductors with insulating polymers to fabricate OFETs for sensing

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Printing organic small molecule semiconductors by solution shearing for the fabrication of highly performing organic field-effect transistors (OFETs) and electrolyte-gated field-effect transistors (EGOFETs) is currently of major technological interest. However, a current challenging that remains unsolved in order to implement these devices in real applications is their stability. The blending of the organic semiconducting molecules (OSC) with insulating binding polymers has proved to be an efficient route to ensure the formation of homogenous films over large areas with high device-to-device reproducibility.
Recently, we have shown that the use of blends of OSCs with polymers by Bar-Assisted Meniscus Shearing (BAMS) gives rise to highly crystalline films exhibiting an enhanced device performance.[1] The performance of the devices both in OFET and EGOFET configuration is significantly improved when the polymer blending agent is included. Further, these devices also exhibit an improved stability in air and in aqueous media.[2]
The devices fabricated with this methodology have been applied for the development of X-ray detectors [3]. In particular, we fabricated films of bis-(triisopropylsilylethynyl)-pentacene (TIPS-Pen) with polystyrene (PS) by BAMS. By modifying the ink formulation and the deposition parameters the device sensitivity was optimized, reaching a record sensitivity of $1.3 \cdot 10^4$ μC/Gy·cm^2, the highest value reported for organic-based direct X-ray detectors, and a very low minimum detectable dose rate of 35 μGy/s.
Additionally, our devices have also been investigated as EGOFETs for biosensing. A sensing platform based on a dual gate coplanar EGOFET in a microfluidic chamber was demonstrated to detect α-synuclein, a hallmark of neurodegeneration in important pathologies like Parkinson's and Alzheimer's, down to 0.25 pM. [4] Further, we demonstrated that our devices can stably record the extracellular potential of human pluripotent stem cell derived cardiomyocyte cells for several weeks.[5]

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