Investigating the Influence of Molecular Orientation on the Performance of Planer and Sandwich Type Organic Electronic Devices

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Conjugated Polymers (CP) have gained a huge scientific interest owing to their excellent electronic, optical and material properties, which make them a potential candidate in the field of Organic Electronics. The overall nature of the CPs is controlled by the backbone planarity and the extended π-conjugation and this provides them the inherent tendency of molecular self-assembly. The nature of the macromolecular crystallite orientation on the substrate dictates the charge transport, and controls overall performance of the devices under investigation. A face-on orientation supports the vertical charge transport and is suitable for sandwich type devices, while Edge-on orientation exhibits facile in-plane charge transport demonstrating its suitability for the planer devices.

In this work, thin films of regioregular (RR) and non-regiocontrolled (NR) Poly (3-hexylthiophene) (P3HT) were utilized for the thin film fabrication from the chloroform solutions by spin-coating and Floating Film Transfer method (FTM). These thin films were used to make two types of devices Organic Schottky Diode (OSD) and Organic Field Effect Transistor (OFET) as a representative of sandwich and planer devices. Thin film of the CPs thus fabricated were then subjected to characterizations by polarized electronic absorption spectroscopy, atomic force microscopy along with the *out-of-plane* and *in-plane* XRD before the device fabrication and characterizations in order to investigate the influence of the molecular orientation on differential charge transport and respective device performances.

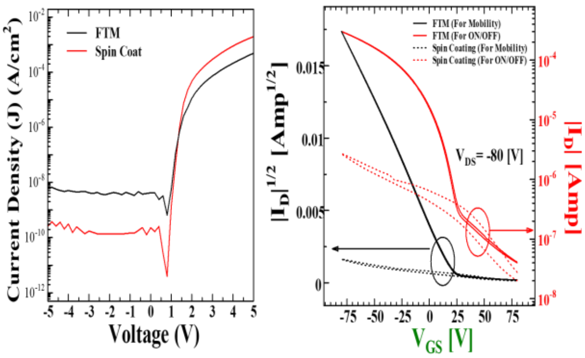

Fig. 1: Transfer characteristics of OFETs (left) and I-V characteristics of the OSDs (right) using RR-P3HT thin films fabricated by the Spin-coating and FTM.

Results of the thin film characterizations revealed that thin films fabricated by spin-coating are not only isotropic but also exhibited mixed edge-on/face-on orientations. On the other hand, FTM processed thin films were not only anisotropic but also exhibited purely edge-on crystallite orientations. It can be seen from the Fig. 1 that device performance of OSDs fabricated using RR-P3HT exhibited well-defined diode characteristics having rectification ratios of 7.5×10^6 and 7.6×10^4 for thin films fabricated by spin-coating and FTM, respectively. On the other hand, method of thin film fabrications has rather very clear and opposite trend in the device performances for the OFETs, where FTM processed thin films exhibited nearly two orders of magnitude higher mobility as compared that of spin-coated thin films.

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