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Effect of dopants and gate dielectrics on charge transport and performance of organic thin film transistor

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Abstract

We employed organic thin film transistors (OTFTs) for carrier transport measurement and material characterization of amorphous organic semiconducting materials. In the first part of this work, p-doped organic hole transporters were studied by TFTs in three aspects. First, we used three different transition metal oxides as p-dopants. They were MoO_3, WO_3 and V_2O_5. The TMOs were doped into N,N'-diphenyl-N,N'-bis (1-naphthyl) (1,1'-biphenyl)-4,4'diamine (NPB) and the changes in conductivities and carrier transport were examined by TFT experiments. Second, the relationship between the level of doping and the host-dopant energy level difference was examined by doping a molecular p-dopant (HAT-CN) into five organic hole transporters (HTs) of different HOMO levels. Third, the effects of doping concentration of MoO_3 on NPB are investigated. By temperature dependent TFT measurements, important parameters, such as the changes in conductivity, carrier mobility, free carrier concentration, and the activation energy can be extracted.

In the second part of this work, we examined in details the effect of gate dielectric layers on TFT mobilities. TFTs of six organic HTs were fabricated on SiO_2 gate dielectric and the carrier mobilities of the TFTs were extracted. Deviations of about 1-2 orders of magnitude were observed between the carrier mobilities obtained from the TFT and the time-of-flight experiments. In order to investigate the how the discrepancy arises, temperature dependent TFT measurements were performed. It is found that dipolar disorders between the organic/dielectric interface impede hole transport. We demonstrate that bulk-like mobility can be achieved on TFT configuration by a non-polar polymer, polystyrene.

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