MASTER'S THESIS

Carrier transport characterization and divice applications of amorphous organic semiconductors

Choi, Wing Hong

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Carrier Transport Characterization and Device Applications of Amorphous Organic Semiconductors

CHOI Wing Hong

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Abstract

This thesis presents charge transport measurements of organic materials by a few experimental techniques. They include time-of-flight (TOF), dark-injection space-charge-limited current (DI-SCLC), admittance spectroscopy (AS), current voltage (*JV*) characteristic and thin film transistor (TFT). A phenylamine compound, namely, *N*,*N*'-Bis(3-methylphenyl)-*N*,*N*'-bis(phenyl)-9,9-spirobifluorene (spiro-TPD), was investigated. Among these techniques, AS and TFT appear to the most useful. The goal of investigation is to check which technique is the best for transport characterization of thin films of organic semiconductors. The TFT technique is the most appealing because it requires the least amount of materials for measurements. We could obtain reasonable and reliable results. However, the transport parameters from TFT deviate from the other techniques. Its hole mobility is generally smaller than the others by one order of magnitude due to the increase of the energetic disorder arising from the gate dielectric.

In addition, a light-emitting dye molecule, *fac*-tris(2-phenylpyridine)iridium [Ir(ppy)$_3$], was studied by TFT. Hole mobility was found to be $1.6\times10^{-5} cm^2V^{-1}s^{-1}$, which is comparable to a widely used hole transport material *N*,*N*'-diphenyl-*N*,*N*'-bis(1-naphthyl)(1,1'-biphenyl)-4,4'diamine (NPB). The charge transport capability is quite significant because it can simplify the OLED device structure. To demonstrate the application of the charge transport properties, a light-emitting dye, *p*-bis(*p*-*N*,*N*-diphenyl-amino-styryl)benzene (DSA-Ph), was doped in a bilayer spiro-TPD based OLED. The current density increased by one order of magnitude. Moreover, the overall performance of the OLED was significantly improved. The luminance and current efficiency were 1062 cd/m^2 and 5.3cd/A at the current density 20mA/cm^2, respectively. The improvement can be explained by the charge transport capability of the light-emitting dye in the OLED.

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