MASTER'S THESIS

# Carrier transport characterization and thin film transistor applications of amorphous organic electronic materials

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*Date of Award:*
2013

# Carrier Transport Characterization and Thin Film Transistor Applications of Amorphous Organic Electronic Materials

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A thesis submitted in partial fulfillment of the requirements
for the degree of
Master of Philosophy

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Hong Kong Baptist University

September 2012

# Abstract

This thesis presents the charge injection and transport properties of p-doped organic hole transporters using transition metal oxides (TMOs) dopants. Three techniques are used to investigate the injection and the transport of phenylamine-based compounds in a sandwich configuration including current-voltage (JV), dark injection space-charge-limited current (DI-SCLC)， and admittance spectroscopy (AS). In-plane transport properties of p-doped organics are measured by organic thin film transistor (OTFT) technique.

For charge injection, $MoO_3$ and NiO are used as the hole injection materials. The hole transporting materials under study are NPB and TPD which are popular hole transporting materials. Generally, $MoO_3$ and NiO form quasi-Ohmic contacts to NPB and TPD. Clear DI-SCLC transient peaks can be observed.

Besides pure organic materials, we also study transport properties of p-doped organic hole transporters. First, we employ time-of-flight (TOF) technique. NPB is p-doped by $MoO_3$, $V_2O_5$ and $WO_3$. After doping, the TOF signals become quite dispersive. Also a background current is present. Besides TOF，OTFT is used to study the effects of $MoO_3$ dopants on eight amorphous organic hole transporters (HTs). Doping $MoO_3$ into organic HTs can produce a leakage current, but the field effect current still can be observed. From the output characteristics, the mobilities $\mu$, threshold voltage $V_T$ and energetic disorder $\sigma$ can be extracted. After doping, mobilities $\mu$ and the energetic disorder $\sigma$ of these doped films generally become smaller and the $V_T$ becomes more positive. The free carrier concentration can be extracted from the mobility and the conductivity data. For 5% (vol) of $MoO_3$, hole

concentration of about $10^{16}$- $10^{18}cm^{-3}$ can be achieved whereas undoped samples have negligible hole concentrations. The increase of free carrier concentration, rather than the change in carrier mobilities, is the deciding factor in the conductivity enhancement in doped organic HTs.

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