

A Gated Four Probe Technique for Field Effect Measurements on Disordered Organic Semiconductors

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A gated four probe measurement technique to isolate contact resistances in field effect measurements on disordered organic semiconductors was investigated. Organic field effect transistors (OFETs) were prepared with two additional electrodes in the contact geometry protruding into the source-drain channel to monitor the variation in potential across the channel. Two high impedance electrometers were used to determine the potential at the contacts. This technique allows to directly determine the magnitude of the parasitic contact resistances between metal contact and organic semiconductor from the drop in potential at the contact regions. The effects of contact resistances, which can falsify measurements on bulk transport parameters such as the field effect mobility, can be then eliminated during material characterization. Additionally, the temperature and electric field dependence of the contact resistances offers valuable information about the charge injection and extraction processes between metal and organic semiconductor. The effects of the four probe geometry, specifically the effect of the channel electrodes on the current-voltage characteristics, of hole transport in a polythiophene (P3HT) OFET with Au contacts were investigated and found not to influence device performance, except at currents $\ll 1$ nA. The IV characteristics were shown to follow the expected FET behaviour. From the variation in potential along the channel it was found that contact resistances at the source contact (charge injecting contact) are minimal while contact resistances at the drain contact (charge extracting contact) are significant, resulting in a much lower effective source-drain voltage than that applied to the device.

Key words: Contact Resistances; Organic Field Effect Transistor.