Mobility Qualification from Thin-Films Using Ultra-Low Voltage SEM (B05)

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To obtain a true charge carrier mobility of a semiconductor is of great importance to understand the real structure-performance relationship that is essential for a rational design of novel materials. Large variations are found in published mobility values on identical materials due to external factors such as poor electrodes or film thickness variation. Herein, we present a novel method to evaluate the mobility directly from crystalline thin-films on their several tens of µm large, a few nm thick top surfaces. The model compounds are chosen for a well-studied series of n-type small molecule semiconductors, the TAPP molecules with the substituents of H, Cl, Br and I, respectively. Increasing transfer integrals have been reported, whereas the experimental results obtained from the thin-film transistor device were not in correlation with the theoretical calculations.[1] By using ultra-low voltage scanning electron microscopy (Delta-SEM,[2] performing beam energy 50 eV), we in-situ charge the thin-films with various beam energies and electron doses to observe the response with respect to surface potential. By finding out the very similar surface potential maps between TAPP-H and the other three derivatives (see Figure 1), we are able to calculate the corresponding transient current I_s that flows from each single pixel to the ground during scanning. Hence, the electron mobility ratios of TAPP-H to the other three ones can be estimated. The results agree very well with the trend of the increasing transfer integrals.

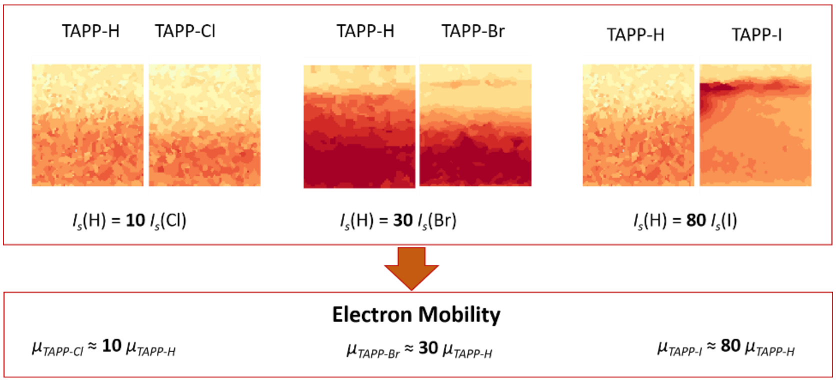

Figure 1. The relative electron mobilities of TAPP-series molecules are evaluated by comparison of similar surface potential map during in-situ charging using ULV-SEM under 50 eV. I_s denotes the transient current flowing through the thin-films to the ground.

References:

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