MIS-CELIV 法による n 型有機半導体の電子移動度評価

Evaluation of electron mobilities in n-type organic semiconductors via the MIS-CELIV method

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Introduction: Charge carrier mobility is an important parameter, and the reliable measurement method of mobility is necessary for the improvement in performance of organic semiconductor devices. Injection-CELIV in metal-insulator-semiconductor structure (MIS-CELIV) has gained attention for its ability to measure carrier mobilities within thin organic films, and to distinguish carrier types.[1] In MIS-CELIV, single-type carriers are first accumulated at the semiconductor-insulator interface (**Fig. 1a**), and then extracted by a linearly increasing voltage, giving a transient current in response to the movement of the carriers (**Fig. 1b**). Thus far, MIS-CELIV measurements have been performed on bulk-heterojunction (BHJ) and p-type organic films,[1,2] but rarely on n-type organic materials; presumably due to the inability in producing transients as a result of electron traps at the SiO_2 surface. In this study, we employed a passivation layer on top of the insulator to gain sound signals and estimate the electron mobility in n-type organic semiconductors.

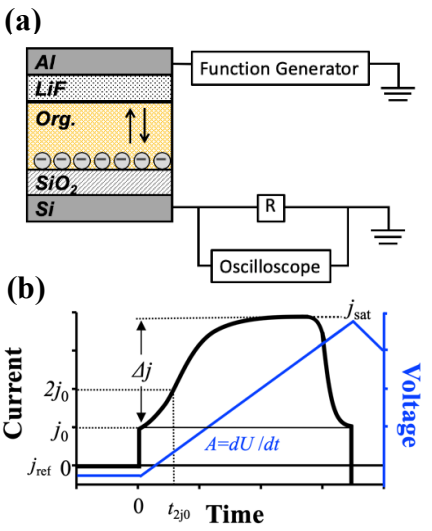

Fig. 1 (a) Schematic device structure and measurement setup. (b) Typical transient signal of MIS-CELIV.

Experimental: MIS devices were prepared on top of heavily n-doped silicon wafers with a 30 nm-thick SiO_2 insulator surface. Tetratetracontane (TTC), $C_{44}H_{90}$, was employed as the passivation layer. An n-type material and a LiF/Al cathode were subsequently deposited via vacuum evaporation.

Results: **Figure 2** portrays the MIS-CELIV transient signal obtained for a perylene bisimide derivative (Me-PTC), with various forward (charging) voltages. The characteristic value of j_0 (discharging current from the electrode) was in close proximity with the theoretical value—an indication of a sound transient current. The electron mobility was estimated to be 8.46×10^{-2} cm^2/Vs. These results indicate that the MIS-CELIV method can be employed for measuring electron mobilities in pure n-type films by eliminating the interfacial traps.

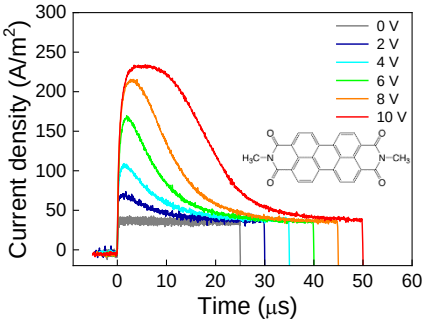

Fig. 2 Transient current for the MIS device using Me-PTC, and its chemical structure (inset).

[1] A. Armin et al., *Adv. Energy Mater.*, **4**, 1300954 (2014),

[2] C. Katagiri et al., *AIP Adv.*, **8**, 105001 (2018).