Study of carrier transport mechanism of organic devices by charge modulation spectroscopy and electric-field induced optical second harmonic generation measurement

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Organic semiconductors have been investigated for use along with an effort to achieve low cost, easy fabrication, and lots of application since the discovery of conducting materials. We can see typical examples in studies on organic field effect transistors, organic light emitting diodes, organic solar cells, and so forth, where many theoretical and experimental studies on carrier mechanisms have been carried out. However, these studies are still not sufficient for the use of organic semiconductors in actual organic devices. We therefore present a method for studying carrier motions in organic devices by using time-domain measurement and energetic measurement in combination. The measurement is based on charge modulation spectroscopy (CMS) in energetic measurement and time-resolved electric field induced optical second harmonic generation (TR-EFISHG) measurement. The TR-EFISHG measurement is very effective to directly measure electric field distributions and potential distributions in organic devices under operational conditions, and available for analyzing carrier motions on the basis of a Maxwell-Wagner model. The CMS is capable of probing energy states of carriers in organic materials.

By using these methods, we studied the carrier transport mechanism in ITO/PI/TIPS-pentacene/Au diodes, in terms of the current-voltage and capacitance-voltage characteristics. Results give an insightful picture on the carrier injection, and the succeeding carrier accumulation and carrier transport, which cannot be obtained by the use of conventional I-V and C-V measurements.