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Photo-responsive Characteristics in Organic Thin Film Transistors Using Soluble π-Conjugated Molecules

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We fabricated photo-responsive organic thin film transistors (OTFTs) using soluble π-conjugated organic materials such as star-shaped 4(HP3T)-benzene and TIPS-pentacene molecules. The photo-responsive current-voltage characteristics were investigated as a function of gate-bias and light power in the 4(HP3T)-benzene based OTFTs. The gate-field dependence of photosensitivity on light power was analyzed through two photocurrent mechanisms caused by photovoltaic and photoconductive effects. The maximum photosensitivity of OTFTs was found to be approximately 40 times higher in the on-state than in the off-state due to the contribution of photovoltaic effect in the on-state. In TIPS-pentacene-based OTFTs, the photo-responsive hysteresis characteristics were studied with and without an annealing process. Under incident light, the hysteresis and memory effect increased for the annealed devices through photo-induced electron trapping and recombination at the gate-dielectric-semiconductor interface. A comparison of the characteristics under various conditions suggests that deep electron traps might be caused by the appearance of a domain boundary (i.e., cracks) in the annealed TIPS-pentacene film during the annealing process, which showed stable photoresponsive characteristics but relatively lower mobility.