2008
첨단과학기술전문가회의

Korea Conference on Innovative Science and Technology 2008

Electronic Properties of Carbon Based Materials

October 18(Sat) – 21(Tue), 2008
Phoenix Park, Pyungchang, Korea

KOFST
THE KOREAN FEDERATION OF SCIENCE AND TECHNOLOGY SOCIETIES

Photo-controlled Organic Thin Film Transistors Using Soluble π-Conjugated Molecules

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We fabricated highly photo-sensitive organic thin film transistors using soluble star-shaped molecules with four-armed π-conjugation paths, such as 4(HPBT)-benzene, 4(HP3T)-benzene, and 4(HPDTT)-benzene molecules having a relatively high quantum yield. The 4(HPBT)-benzene based organic photo-transistors (OPTs) exhibited high photo-sensitivity (2500 ~ 4300 A/W) even with low optical powers (6.8 ~ 30 $\mu W/cm^2$) at zero gate bias. The measured photo-sensitivity of the devices was much higher than that of inorganic single crystal Si based photo-transistors, as well as that of other OPTs reported earlier. With the highly photo-sensitive characteristics of the 4(HPBT)-benzene based OPTs, we observed the high ratio of on and off current switching as $\sim 4\times10^4$ with low optical power and low gate bias. The slow relaxation of the photo-induced charges and charge trapping phenomena at the interface could lead to a reproducible memory operation for 4(HPBT)-benzene based OPTs. We also present the photo-enhanced memory effect using soluble TIPS-pentacene based OTFTs.