**Phenanthro[1,2-*b*:8,7-*b’*]dithiophene (PDT):**

**Application to organic field-effect transistors and photovoltaics**

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Transition metal-catalyzed cross-coupling and cyclization reactions have been utilized to synthesize picene, a compound consisting of five fused benzene ring with an armchair structure and its derivatives. We further designed to replace two terminal benzene rings with thiophene rings to yield phenanthro[1,2-*b*:8,7-*b'*]dithiophene (PDT). Moreover, we synthesized the low-band gap semiconducting polymers containing a PDT core in the polymer backbone. These PDT-based polymers have some superior features, including strong intermolecular interaction, high thermal stability, deep HOMO energy levels, and dense packing structure in their solid state. The solar cell devices using PDT-isoindigo (IID) copolymer or PDT-benzothiadiazole (BT) exhibited high power conversion efficiency (PCE) with 5.28% and 6.56%, respectively. In particular, PDT-BT copolymers formed a desirable face-on orientation, which can promote the efficient carrier transport in solar cells, reading to high PCE. We measured DSC (differential scanning calorimetry) and TG-DTA (thermogravimetry-differential thermal analysis) in order to investigate the thermal stability of the solid states of several PDT polymers, which were copolymerized with IID (isoindigo), DPP (diketopyrrolopyrrole) and BZT (benzothiadiazole) units. From DSC measurements, P3HT, which has been widely studied for various electronics devices, showed phase transition peak around 200 ºC in heating and cooling processes. On the other hand, these polymers showed no peak ascribed to a phase transition in the range of 50-250 ºC. The thermal decomposition temperatures estimated by TG/DTA was higher than 300 ºC, which is inferior to that of P3HT. These results show that the devices composed of these polymers maintain the solid state, and thus the device performances. Furthermore, these polymers are stable than P3HT. The HOMO level measured by PYS (photoelectron yield spectroscopy) shifted to a more negative side upon storage in air, but the degree of a change was smaller than that of P3HT. This indicates that the device composed of these polymers may keep the good performance longer than that composed of P3HT.

