Synthesis and characterization of liquid crystalline organic semiconductor materials with benzothiophene skeleton

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【Introduction】 Organic thin-film transistors are made with organic compounds with semiconductor characteristics and can be fabricated in a large area on thin substrates at low temperatures. However, the field-effect mobility indicative of transistor performance is low. One of the factors related to the low field-effect mobility is the crystal grain boundaries created during the fabrication of thin films for semiconductor devices. It has been reported that the self-organization of liquid crystal (LC) molecules can be used to improve this problem by suppressing the crystal grain boundaries[1]. In this study, we focused on benzodithiophene (BDT) which has a planar conjugated structure expected to show high field-effect mobility[2]. The objective of this study is to synthesize LC organic semiconducting polymers with high field-effect mobility at low temperatures by introducing polymerizable parts into organic semiconducting molecules with BDT cores and polymerizing them while retaining an LC order.

【Experiment】 The target compound, 6-(6-(thiophen-3-yl-ethynyl)benzo[1,2-b:4,5-*b*']dithiophen-2-yl)hexa-5-yn-1-yl acrylate (PE-BDT-AA), was synthesized through the synthetic routes as shown in Figure 1 and was subjected to ^{1}H NMR (JEOL ECS-400) measurements to identify its structure.

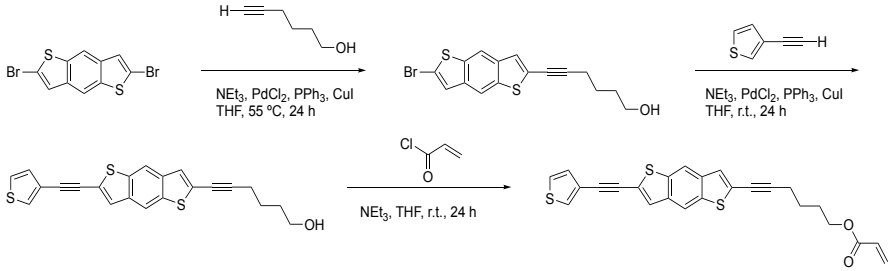

Figure 1 Synthetic pathway of PE-BDT-AA.

【Results and Discussion】 The results of differential scanning calorimetry (DSC) and powder X-ray diffraction (XRD) measurements of the obtained PE-BDT-AA are shown in Figures 2 and 3, respectively. As shown in Figure 2, an endothermic peak was observed at around 170 °C in the heating process. A fan-shaped texture was observed under a polarizing optical microscope around this temperature, suggesting the presence of the LC phase. Based on the results of XRD measurement at 160 °C as shown in Figure 3, this phase was determined to be a smectic E phase which is a higher-order LC phase.

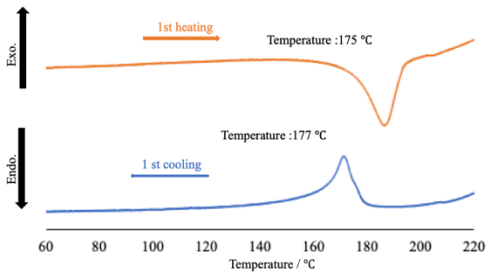

Figure 2 DSC curves of PE-BDT-AA.

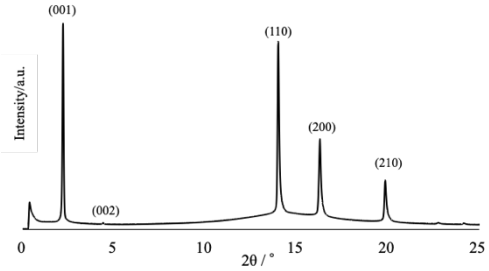

Figure 3 XRD pattern of PE-BDT-AA (160 ℃).

【Reference】

1) W. Pisula, M. Zorn, and J. Y. Chang, *Macromol. Rapid Commun*., **2009**, *30*, 1179.
2) H. Wu, H. Iino, and J. Hanna, *Chem. Lett*., **2018**, *47*, 510.