Fiscal Year 2016, Tokyo Institute of Technology ASPIRE League Research Grant

Selected Research Project for Type 1 in FY2016

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Subject of the research project		Organic thin film devices based on narrow band gap semiconducting polymers
Summary of the research project		Narrow band gap semiconducting polymers are important materials for the future electronic devices, which are implemented in mobile displays, radio frequency identification tags, electronic papers and skins due to their designable synthesis, solution-processability, high thermal stability, and mechanical flexibility. In the past decade, remarkable achievements have been made in polymer thin film transistors (TFTs) with high carrier mobilities over 10 cm^2 V^{-1} s^{-1}, which are competitive with or even surpassing the benchmark mobility of amorphous silicon semiconductors. In order to further increase the carrier mobilities of polymer TFTs, three important polymer design principles

Summary of the research project	are proposed. First, conjugated coplanar backbones with a low conformational disorder must be developed. This enables the formation of short π–πstacking and strong intermolecular interactions in the thin film states. Second, side chain engineering is a powerful tool in increasing the polymer solubility into organic solvents and crystallinity in the thin film states. Third, the introduction of heteroatoms into the π–conjugated backbones results in fine-tuning of energy levels and intermolecular interactions. With these design guidelines in mind, novel semiconducting polymers with high carrier mobilities will be developed. We have already reported a series of benzobisthiadiazole (BBT)-based semiconducting polymers. It was shown that comonomer structures and heteroatom substitution of the BBT moiety strongly affect the nature of charge polarity (p-type or n-type). Also, polymer orientation on the substrate could be controlled by these chemical modifications, as revealed by grazing-incidence wide-angle X-ray scattering (GIWAXS) measurements. In this research project, we will synthesize novel BBT-based semiconducting polymers that show very high hole mobilities and/or electron mobilities (both unipolar and ambipolar semiconductors). In collaboration with device experts, these polymers will be subjected to high-performance transistors, solar cells, nonvolatile memories, or thermoelectric devices. Furthermore, flexibility and mechanical toughness or self-healing properties might be given to these devices.