Poly(3-alkylthiothiophenes) (P3ATTs) Semiconductor for Organic Field Effect Transistors:The Effect of Alkylthio Side Chain on Their Properties

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Abstract

Poly(3-alkylthiophenes) (P3ATs) have been used broadly in organic electronic application by virtue of its solution processability, tunable chemical structure and high hole mobility. Among these polythiophene derivatives, poly(3-hexylthiophene) (P3HT) is most representative and well-studied, and many studies revealed polymer regioregularity (R.R.) and molecular weight have an influence on molecular packing and ordering of polymers, which is important to charge transfer. However, there is less research about the effects of regioregularity or molecular weight on other P3ATs with functionalized sidechain, and the systematic research is needed.

Furthermore, alkyl sidechain substituent with a sulfur atom has been proven to enable fine tuning of the solid-state organization of the corresponding regioregular P3HT analogues. In this paper, we present the synthesis and characterization of a series of poly(3-alkylthiothiophene) (P3ATT)-based polymer semiconductors including poly(3-hexylthiothiophene) (P3HTT) 、 poly(3-decyl-thiothiophene) (P3DTT) and poly(3-(2-ethyl)hexylthiothiophene) (P3EHTT). P3HTT with various R.R. and molecular weights were also discussed. In this case, the π-π stacking distance successfully decreased from 3.88 Å to 3.76 Å by substituting hexyl sidechain by thiohexyl sidechain. Since both π-π interaction and backbone alignment are significant factors affecting charge transport behavior, unidirectional solution shearing method was applied to fabricate oriented polymer thin film for organic field effect transistor, reaching the mobility to 1.48×10^{-2} cm^2 V^{-1} s^{-1} and 7.67×10^{-3} cm^2 V^{-1} s^{-1} for P3HTT and P3DTT, respectively.

Keywords - Polymer Semiconductor, Organic Field Effect Transistor, Side Chain Engineering, Solution-Shearing method