Design, Synthesis, and Characterization of New Heteroarene-Based Organic Semiconductors for Thin-Film Transistors

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Recent intensive research efforts at material development and device optimization have realized high performance organic thin-film transistors (OTFTs) with carrier mobility higher than 1.0 cm^2/Vs.[1] However, organic semiconductors having both stability and high performances are still rare, and thus new superior organic semiconductors are still actively pursued. To this end, we have developed a series of new thiophene-containing fused aromatic compounds (often called as heteroarenes) and tested them as an active material for OTFTs.[2] Among these compounds, we found that dinaphtho[2,3-*b*:2',3'-*f*]thieno[3,2-*b*]thiophene (DNTT)[3] and 2,7-dialkyl[1]benzothieno[3,2-*b*][1]benzothiophenes (C_n-BTBTs)[4] are fairly stable and superior organic semiconductors; the former is suitable to vapor-deposited OTFTs and the latter is to solution-processed OTFTs (Figure 1). These devices showed typical p-channel transistor characteristics with mobility up to 3.0 cm^2/Vs with $I_{on/off}$ grater than 10^6. For the further development of this semiconductor class, we have recently synthesized alkylated DNTTs (C_n-DNTTs). The solubility of C_n-DNTTs is, unfortunately, not good enough for the solution processes, but their vapor-processed OTFTs showed excellent transistor characteristics with mobility as high as 8.5 cm^2/Vs, which is the highest mobility so far reported for OTFT devices.

In this contribution, we will present the syntheses, properties, structures, and transistor characteristics of these heteroarene-based organic semiconductors and discuss the structure-properties correlation of the present semiconductor class.

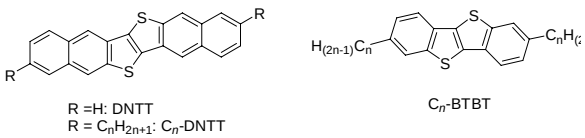

Figure 1. Heteroarene-based organic semiconductors.

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1) For example, Y. Y. Lin *et al.*, *IEEE Electron Device Lett.*, **18**, (1997), 606.
2) K. Takimiya *et al.*, *Chem. Lett.*, **36** (2007), 578.
3) T. Yamamoto *et al.*, *J. Am. Chem. Soc.*, **129** (2007), 2224.
4) H. Ebata *et al.*, *J. Am. Chem. Soc.*, **129** (2007), 15732.