

# Synthesis of organic semiconductors containing heterocycles and applications to devices

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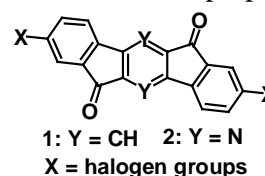
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In our laboratory, various kinds of heterocyclic compounds have been prepared to apply to electronic devices such as organic field-effect transistors (OFET). Here we will introduce some examples of our recent results.

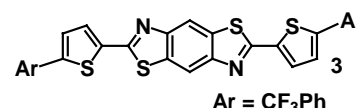
## (1) Indenopyrazinediones and diindenopyrazinediones

We have found indenofluorenedione derivatives **1** having two halogen groups at the terminal positions work as high performance n-type semiconductors for OFETs. We have also prepared diindenopyrazinedione derivatives **2**. Replacement of the benzene ring with the pyrazine one decreased the LUMO level. The FET device based on **2** showed a lower threshold voltage of +17 V (mobility: 0.17 cm<sup>2</sup>/Vs) than that based on compound **1**.<sup>1)</sup>



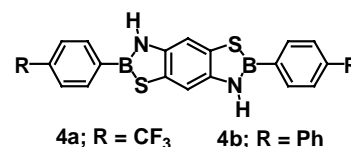
## (2) Benzobisthiazole derivatives with trifluoromethylphenyl groups

We have found  $\pi$ -conjugated compounds with trifluoromethylphenyl groups are interesting candidates for high performance n-type semiconductors. Introduction of nitrogen heterocycles such as a thiazolothiazole to  $\pi$ -electron cores has increased mobilities and decreased threshold voltages.<sup>2)</sup> We have also prepared benzobisthiazole derivatives **3** possessing a fused benzene ring. The FET devices on compound **3** showed high mobilities and low threshold voltages (0.24 cm<sup>2</sup>/Vs and +24 V).<sup>3)</sup>



## (3) Boronate derivatives as transparent semiconductors

Recently,  $\pi$ -conjugated compounds containing boron atoms have attracted much attention because of their unique physical properties. Although boronate derivatives take planar geometries, the electronic devices based on them have not been developed. We have designed new planar boronate derivatives **4**. Compound **4b** showed clear p-type FET characteristics (mobility: 1.8 x 10<sup>-3</sup> cm<sup>2</sup>/Vs).<sup>4)</sup> The colorless film of **4b** is expected to apply to transparent electronics.



[1] T. Nakagawa et al., *Chem. Mater.*, **20**, 2615-2617 (2008). [2] S. Ando et al., *J. Am. Chem. Soc.*, **127**, 5336-5337 (2005). [3] M. Mamada et al., *Chem. Lett.*, **37**, 766-767 (2008). [4] T. Kojima et al., *Chem. Lett.*, **37**, 1122-1123 (2008).