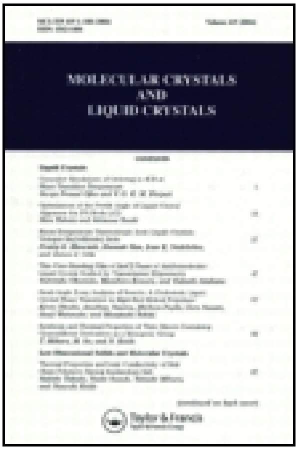

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Novel Organic Semiconductors

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NOVEL ORGANIC SEMICONDUCTORS

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ABSTRACT A new type of single-component organic compounds, BTQBT (Bis[1, 2, 5]-thiadiazolo-*p*-quinobis (1, 3-dithiole)), has been synthesized. The conductivities of the single crystals are remarkably high and anisotropic. The observation of the Hall effect is quite unusual in familiar organic semiconductors including the charge transfer complexes.

INTRODUCTION

Two major categories of organic solids are known to offer the prospect of high electrical conduction. The first group consists of charge-transfer complexes such as $(BEDT\text{-}TTF)_2Cu(NCS)_2$, one of the organic superconductor. The other group is single component materials; typical and historical examples are polycyclic aromatic compounds and also phthalocyanines.

A large number of studies on charge-transfer complexes, included C_{60} complexes, have been carried out and their conductivity ranges from semiconductivity to superconductivity. On the other hand, the progress to find high conductive single component organic semiconductors is rather slow, but is desirable to enable us to analyze their conduction mechanism. Recently, we have discovered three new types of single component organic semiconductors having fairly good electrical conduction. One of them is "molecular fastener" series[1], the second is quasi-covalent bonding molecular compound[2] and the third is "BTQBT" series[3], which is reported in this talk.

RESULTS AND DISCUSSION

The molecular structure and packing in a crystal of BTQBT [(Bis[1, 2, 5]-thiadiazolo-*p*-quinobis (1, 3-dithiole)] are illustrated in a figure.

As shown in the figure, BTQBT molecules are stacked to form columns along the c-axis with a uniform spacing of 3.46 Å. It is noteworthy that we have observed short intercolumnar S···S contacts of 3.26 Å; this is a quite short distance as comparison with that of their van der Waals radii.

The electrical resistivities of BTQBT single crystals, recrystallized from a nitrobenzene solution and sublimed in nitrogen atmosphere are $1.2\times10^3\Omega$cm having the activation energy (E_a) E_a=0.21eV and also $2.7\times10^5\Omega$cm with E_a=0.24eV.

We also find a large anisotropy value of resistivity $\rho_x:\rho_y:\rho_z$=1:2:100, where ρ_x is resistivity measured in the direction parallel to the long axis x of a needle-like crystal, and ρ_y and ρ_z are those perpendicular to the x-axis. This result supports the existence of strong two-dimensional intermolecular interaction which are inherent in the crystal structure.

Further, we could observe a Hall voltage as described in the following table.

TABLE I. Result of a Hall effect of BTQBT[4]

Magnetic field	(H_z)	1.3 T
Applied voltage	(V_x)	10 V
Current	(I_x)	3.6 μA
Hall voltage	(V_H)	0.25 mV
Sign of carriers		positive
Hall coefficient	(R_H)	$4\times10^3 cm^3C^{-1}$
Hall mobility	(μ_H)	4 cm^2/v.sec.

The research to find good conductors among single component organic solids is typical example of the study of molecular systems.

The works on BTQBT have been carried out with Y. Yamashita, K. Imaeda, S. Tanaka and M. Sano.

REFERENCES

1. H. Inokuchi, G. Saito, P. Wu, K. Seki, T. B. Tang, T. Mori, K. Imaeda, T. Enoki, Y. Higuchi, K. Inaka, and N. Yasuoka, Chem. Lett., 1986, 1263.
2. H. Inokuchi, K. Imaeda, T. Enoki, T. Mori, Y. Maruyama, G. Saito, N. Okada, H. Yamochi, K. Seki, Y. Higuchi, and N. Yasuoka, Nature, 329, 39 (1987).
3. Y. Yamashita, S. Tanaka, K. Imaeda, and H. Inokuchi, Chem. Lett., 1991, 1213.
4. K. Imaeda, Y. Yamashita, Y. Li, T. Mori, H. Inokuchi, and M. Sano, J. Mater. Chem. (1992) in press.