

NEXAFS characterization of a sulfur-containing p-type organic semiconductor deposited on various surfaces

Toshihiro SHIMADA^{1*}, Manabu OHTOMO¹, Tetsuya HASEGAWA¹, Keiji UENO³,
Koichiro SAIKI² and Susumu IKEDA²

¹Department of Chemistry, The University of Tokyo, Tokyo 113-0033, Japan

²Department of Complexity Science and Engineering, The University of Tokyo,
Chiba 277-8561, Japan

³Department of Chemistry, Saitama University, Saitama 338-8570, Japan

Introduction

Organic semiconductors are studied in various aspects, but the conduction mechanism is not understood precisely. We have studied this issue by electron spectroscopy of device structures.^{1,2} Our goal of the present study is to detect the field-induced holes by using NEXAFS of a FET structure to understand the conduction mechanism of organic semiconductors. In this report, we describe the NEXAFS characterization of a recently synthesized sulfur-containing molecule (DPh-BTBT³) which has large amplitude of HOMO at sulfur atoms. This molecule shows high mobility in thin film form and it is also important to study the interaction of this molecule with materials consisting of electrodes and gate insulators. In this report, we describe the NEXAFS characterization of a high mobility organic semiconductor DPh-BTBT as a first step to the NEXAFS characterization of organic FETs.

Experiments

DPh-BTBT was deposited on the surface of polyimide film and Ag in a high vacuum chamber adjacent to the NEXAFS chamber located at BL-11B. The substrate was kept at room temperature. The thickness of DPh-BTBT was monitored by a quartz crystal microbalance placed near the substrate. Ag was freshly deposited on a Si wafer. The sample was transferred via ambient condition. A fluorescence proportional counter was used as a detector.

Results and Discussions

Figure 1 shows NEXAFS of 5 nm thick DPh-BTBT film. It shows a large intensity of σ^* with grazing incidence (GI, 15°) whereas π^* is strongly observed with normal incidence (NI, 90°). It clearly indicates the planar molecule is standing upright from the very first stage of the deposition. This orientation was maintained at larger thickness. On the other hand, S-NEXAFS of the film grown on Ag shows strong π signal with GI incidence and strong s signal with NI incidence as shown in Fig. 2. It shows the molecule is lying on the surface. Atomic S and SO_x components were found in the sample deposited on Ag. It shows the decomposition of the DPh-BTBT due to the reaction with Ag. The orientation difference of the molecule might be related with this reactivity.

Conclusions

We found the orientation of DPh-BTBT was dependent on the substrate material. The molecule stood upright on polyimide from the early stage of the deposition, whereas it was lying flat on polycrystalline Ag. It was found that the molecule is decomposed when deposited on Ag substrate or deposition of Ag on the molecule. The orientation of the molecule might be related with this reactivity.

Acknowledgment

The authors would like to thank Prof. Kazuo Takimiya (Hiroshima University) for supplying DPh-BTBT and valuable discussions.

References

- [1] T. Shimada, T. Suetsugu, T. Miyadera, Y. Yamamoto, A. Koma, K. Saiki, K. Kudo, Appl. Phys. Lett. 84, 2439 (2004).
- [2] T. Shimada, K. Saiki, J. Elec. Spec. Rel. Phen. 154, 119 (2007).
- [3] K. Takimiya, H. Ebata, K. Sakamoto, T. Izawa, T. Otsubo, Y. Kunugi, J. Am. Chem. Soc. 128, 12604 (2006).
* shimada@chem.s.u-tokyo.ac.jp

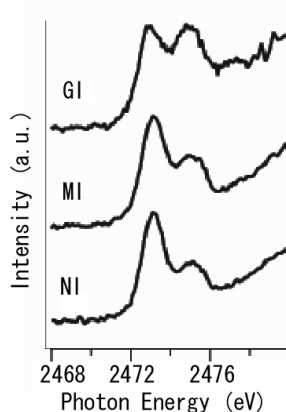


Fig.1 S-NEXAFS of DPh-BTBT/polyimide

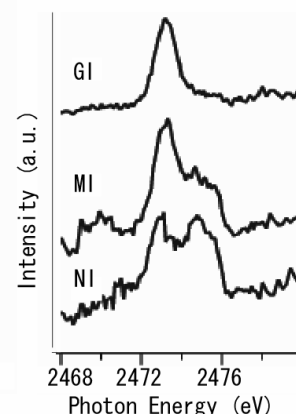


Fig.2 S-NEXAFS of DPh-BTBT/Ag