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Direct evidence for orientations in the amorphous functional polymer thin films deposited on Si surface

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1 Introduction

Vacuum-deposited organic amorphous thin layers are used for organic light emitting diodes (OLED) which have a feature of flat surface in a nanometer order, flexibility in the choice of the underlying materials, easily controlled thickness, homogeneous structure and a simple high-purity fabrication process. Although the orientation and overlapping of two molecular π plains are important for the electric conductivity, they are usually neglected only because the materials are in the amorphous film.

Recently Yokoyama et al. reported that some of amorphous films had an orientation and the electric conductivities depended strongly on the orientations.[1] In this paper we have investigated that the polarization C and N K-edge NEXAFS.

2 Experiment

The samples were vacuum-deposited on the Si (100) (n-type) with thickness of 100 nm. The samples were following planar tripheyl amines or pyridine/bipyridines linked with biphenyl bonds.

The measurement was carried out in BL7A. The x-ray was monochromatized by the grazing incidence monochromator with varied line spacing grating(VLSG)(300 /mm) and the higher harmonics were rejected by a Si total reflection mirror. The entrance and exit slit sizes were 100 μm. The spectrum was measured in a sample current mode. The current was in the 0.1 nA order. The measurement energy range was 395-440 eV for N K-edge and 270 -320 eV for C K-edge. The energy step in the NEXAFS region was 0.1 eV (upto 292 eV for C and 395 eV for N) and 0.5 eV afterwards. The measurement angles which were defined as angles between the incidence direction and the sample surface were 90º, 60º, 45º and 15º. The 90 º meant the electric vector was parallel to the surface while 15 º meant the vertical component to the surface was the main one. Total time per scan requires less than 10 min for each direction and total exposure time to X-ray was less than 2 hours.

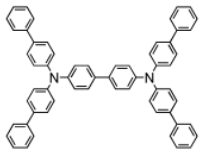

Fig.1 TPD15

3 Results and Discussion

Fig.2 shows the N and C K-edge NEXAFS of TPD15 (see Fig.1). It shows the clear polarization dependence in N K-edge. The strong peak appearing at the edge region can be assigned to 1s to π* transition which directed perpendicular to the molecular plane.

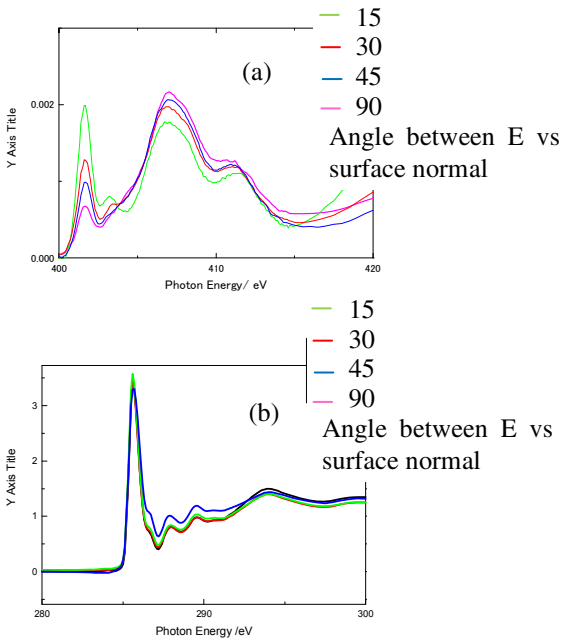

Fig.2 N (a) and C(b) K-edges NEXAFS of TPD15

It suggests that the TPD15 molecule lies parallel to the surface. However, the appearance of 1s to π* transition with the normal incidence indicated the orientation of the molecule was not perfect. No polarization dependence in K-edge indicates that N-C(phenyl group) was rotated and the aromatic planes have no common directions.

The work directly demonstrates that the amorphous layer of organic films can have a horizontal orientation to the surface.

[1] D. Yokoyama, A. Sakaguchi, M. Suzuki, C. Adachi, Organic Electronics 2009, 10, 127 ; D. Yokoyama, A. Sakaguchi, M. Suzuki, C. Adachi, Applied Physics Letters 2009, 95, 243303.

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