Distribution of Charge-Carrier States Due to Oriented Dipoles in Ordered Alignment of Smectic-Liquid Crystals

Akira Ohno[a,b] Tsukasa Nakamura[a,b] and Jun-ichi Hanna[a,b]

a Imaging Science and Engineering Lab. Tokyo Institute of Technolology, 4259 Ngatsuta-cho Midori-ku, Yokohama, Kanagawa 226-8503 JAPAN
b JST-CREST, 4-1-8 Honcho, Kawaguchi, Saitama 332-0012 JAPAN

We have theoretically and experimentally investigated the effect of dipole moments on the layer structure of molecular alignment of smectic liquid crystal.

Basic understandings of "carrier" in liquid crystal (LC) are dramatically changed in this decade. The electronic conduction, now, can be measured. It provides us a new insight into the application of liquid crystalline materials to semi-conductive devices. The mechanism of electronic conduction in the liquid crystal can be explained by the disorder model, which is a well-used hopping model in amorphous-organic semiconductors,[1)] by improving the model to be two-dimensional system.[2)]

To understand the origin of the energetic disorder of the disorder model in liquid crystal, we doped guest molecules of biphenyl derivatives with large dipole moments for host liquid crystalline materials of phenyl-naphthalene derivatives and measure the concentration dependence of the mobility. On the other hand, we calculate energetic disorder limited to director orientation and layer alignment of smectic-LC structure and compared with the experimental results. We found that energetic disorder is proportional to square root of the concentration: $\sim c^{1/2}$ for liquid crystal. The experimental results are agreement with the result of calculation.

This study gives us an insight into the effect of dipole moments in ordered molecular systems and the molecular design for getting quality oriented organic semiconductors using organic liquid crystalline phase.

References
(1) H. Bassler *Phys. Stat. Sol (b)* **1993***, 175* 15
(2) A. Ohno, J. Hanna, *Appl. Phys. Lett.* **2003***, 82*, 751