Liquid crystals as organic transistor materials

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Liquid crystals are very attractive materials for not only displays but also electronic device applications because we can expect not only high mobility in self-organized molecules but also easy control of molecular orientation to the substrates. We have applied polycrystalline thin films of liquid crystalline materials to organic field effect transistors (OFETs) because the specific nature of liquid crystals can be utilized to fabricate them, in addition to their higher mobility than those of liquid crystalline phases. Indeed, we have been able to solve the problems in conventional OFET materials such as uniformity and surface morphology of the crystalline films [1], a trade-off between the solubility in organic solvents and the thermal durability of OFET materials [2] by utilizing the liquid crystallinity. We developed a novel liquid crystalline phenyl-benzothienobenzothiophene derivative of Ph-BTBT-10 as shown in Fig. 1(a) [3], which exhibits highly ordered liquid crystal phase, Smectic E (SmE) phase at a wide temperature range of 142 ^{o}C to 210 ^{o}C. Ph-BTBT-10 showed good solution processability and gave uniform and molecularly-flat crystalline thin films by using liquid crystalline thin films as a precursor, which were prepared by spin-coating its solution at a SmE temperature as shown in Figs. 1(b) and 1(c). Furthermore, the resulting crystalline thin films kept a film form even after heating up to 200 ^{o}C. In addition, thanks to phase transition of the crystalline thin films from mono-layered crystal structure to a bilayered one caused by thermal annealing at 120^{o}C for 5 min, OFET mobility was dramatically increased up to of over 10 cm^2/Vs. In this talk, we demonstrate how the liquid crystals are available in OFET applications and discuss their high potential for practical applications and remaining issues.

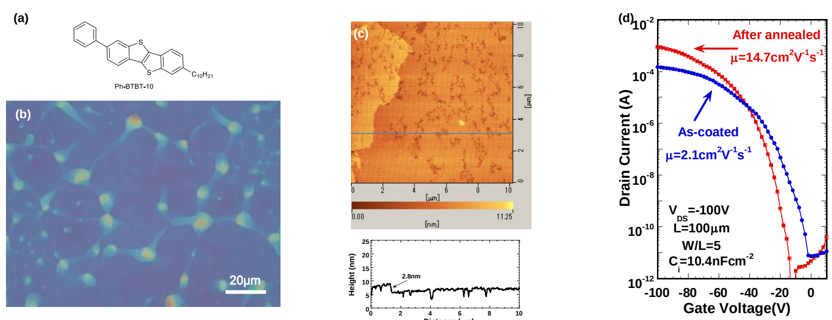

Fig. 1. The characteristics of polycrystalline thin films of Ph-BTBT-10 fabricated by spin-coating in liquid crystal phase. (a) Chemical structure of Ph-BTBT-10, (b) Optical microscopy texture, (c) AFM image, and (d) Transfer characteristics of FET.

References

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Speaker Biography

Hiroaki Iino received B.S. degree in Department of Electronical and Electronic Engineering from Tokyo Institute of Technology in Japan in 2001, and M.S. and Ph.D. degrees in Department of Information processing from the same institute in 2003 and 2006, respectively. He joined Imaging Science and Engineering Laboratory as an assistant professor in 2006, and as an associate professor in the same laboratory in 2012. His research interest are organic devices for imaging applications and their fabrication processes, and are currently focused on device applications of liquid crystals for thin film transistors.