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Outline of Thesis

Title: Control of molecular orientation in organic polycrystalline thin film by liquid crystal and its application in organic electronic devices

By Wang Yi-Fei, supervised by Prof. Hiroaki Iino

This thesis consists of the following six Chapters:

Chapter 1 is the introduction part of this thesis. The organic electronics and organic semiconductors, mesophases and orientation of liquid crystals, advantages of liquid crystal semiconductors are introduced in this part, which form the background of this study. The motivation and research objective of this thesis are also described.

Chapter 2 is the experimental section of this thesis. The materials used in this study, purification methods, fabrication and characterization techniques are introduced in this part.

In chapter 3, I developed a general method to fabricate planarly-oriented polycrystalline thin films. With the aid of self-organization of liquid crystalline molecules and an over coated orientation layer, tens of nm spin-coated thin films can be re-oriented from ‘‘hemeotropic’’ to ‘‘planar’’ to achieve polycrystalline thin films planarly oriented after removing the over-coated orientation layer. The key factors to affect re-orientation of the films and uniformity and surface morphology of the resulting films, including conditions required for the re-orientation and properties of the orientation layer materials were investigated.

In chapter 4, I developed an efficiency thermal-imprinting method to fabricate planarly-oriented polycrystalline thin film. By using a low-cost micro-stamp obtained from a CD-R mold, molecular orientation of the spin-coated polycrystalline thin film can be easily re-oriented to planar after thermal imprinted at isotropic phase of liquid crystal materials and cooling to room temperature. The stamp can be directly peeled off after imprinting, which resulting a planarly-oriented polycrystalline thin film with micro-patterned surface morphology.

In chapter 5, I developed a co-planar nanogap organic diode and investigated the orientation of liquid crystal in nanogap structures. Due to the self-assembly of liquid crystal and surface anchoring from electrode sidewall, molecules orientation of polycrystalline thin film can be controlled to enable a superior charge transport in nano-channel. A solution processed organic diode with high performance was realized and advantages of liquid crystal materials for nanogap device were demonstrated.

In chapter 6, I summarize the research results achieved from each of the above chapters and described the future perspective of this study.