Fabrication of planarly-oriented polycrystalline thin films of smectic liquid crystalline organic semiconductors

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Organic FETs can be well fabricated with organic crystalline thin films prepared by various techniques including vacuum evaporation and spin-coating techniques, which require vertical orientation of organic semiconductor molecules that favors lateral carrier transport at the channel. On the other hand, planarly-oriented thin films are required in order to fabricate vertical devices such as solar cells and OLEDs with crystalline thin films. However, few techniques have not been established to fabricate well planarly-oriented thin films yet.

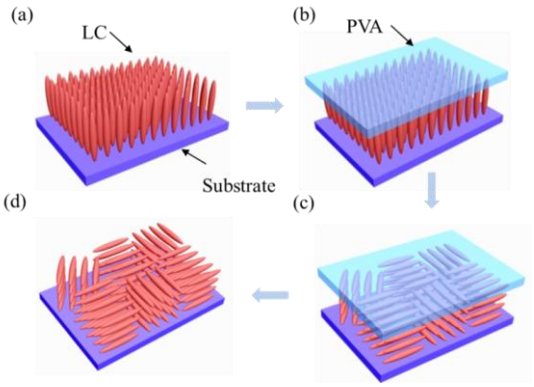

Fig. 1 Schematic illustration of the the fabrication procedure of planarly-oriented polycrystalline thin films.

In this work, liquid crystal was studied as a tool to control molecules orientation in organic polycrystalline thin films. A general method to fabricate planarly oriented polycrystalline thin film was developed. By using an over-coated film of water-soluble polymer, e.g., PVA as orientation layer and annealing at low ordered liquid crystal phases, the molecules in spin-coated liquid crystal thin films were successfully re-oriented from “homeotropic” to “planar” orientation. Planarly-oriented polycrystalline thin film as thin as ~100nm could be easily processed while maintained good morphology. We investigated 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 and liquid crystals. The present procedure for the fabrication of planarly-oriented crystalline thin films will promote their applications in vertical devices such as OLEDs and OPVs in the future.

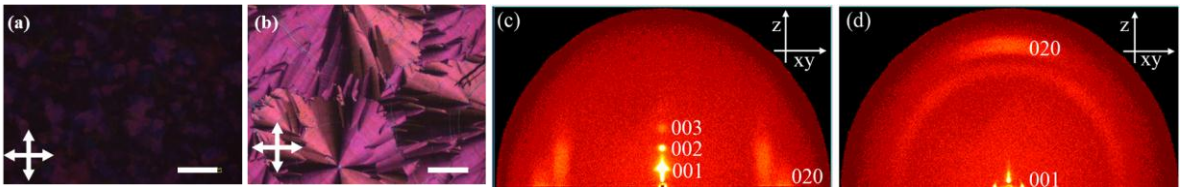

Fig. 2 (a-b) POM textures of polycrystalline thin films as spin-coated (a) and after re-orientation (b); (c-d) 2D-XRD patterns of polycrystalline thin films as spin-coated (c) and after re-orientation (d).

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[2] H. Iino and J. Hanna, Adv. Mater, 2011, 23, 1748.

[3] YF. Wang H. Iino and J. Hanna, Soft Matter, 2017, 13, 6499.