Area: 4 Organic and Dye-Sensitized Solar Cells

INDUCED CRYSTALLIZATION OF ORGANIC SEMICONDUCTOR IN THIN FILM BY SURFACE SEGREGATED MONOLAYERS

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Highly ordered crystalline thin films are required for organic electronics devices such as organic field effect transistors (OFETs) and organic photovoltaics (OPVs) because the high order of the semiconducting molecules improves charge transport exciton diffusion and charge separation. However, separate control of the crystal nucleation and growth processes is difficult for thin films because the crystallization often occurs during evaporation of the solvents during the coating process.

In this work, we report that a self-organized surface segregated monolayers (SSMs) act as a template layer for the crystallization of [6,6]-phenyl-C_{61}-butyric acid methyl ester (PCBM) in the films. Similar to epitaxial growth from the organic film/substrate interface, the surface of the films could be another nucleation site for controlling the crystallization in the bulk of the films.

SSMs can be prepared easily by coating the substrate with a solution of the matrix semiconductors and surface modifiers with low surface energy. Well-ordered SSMs of a fullerene derivative with oligosiloxane chains spontaneously formed monolayers on the surface of PCBM films (Figure 1a). The surface segregation behaviors of the molecules in the films were investigated by X-ray photoelectron spectroscopy (XPS). Two-dimensional grazing incidence wide-angle X-ray scattering (GIWAXS) patterns of surface modified PCBM film after thermal annealing showed a number of sharp Bragg spots, indicating the formation of highly ordered single-crystal domains (Figure 1b). The pattern was completely different from that of the annealed pristine PCBM film. Crystal structure analysis revealed that the new crystal phase of PCBM was induced by the presence of SSMs. Electron mobility measured by conductive AFM in the SSM-induced crystal phase was about 5 times larger than that in the normal crystal phase of PCBM.

Our results demonstrated that SSM induced crystallization is a promising strategy for controlling the crystal structure in thin films for organic electronic devices because it is a solvent-free, substrate-independent, post-deposition crystallization that should be compatible with many solution processes. .

References

S. Izawa, K. Nakano, K. Suzuki,Y. Chen, T. Kikitsu, D. Hashizume, T. Koganezawa, T.-Q. Nguyen. K. Tajima, *submitted*.

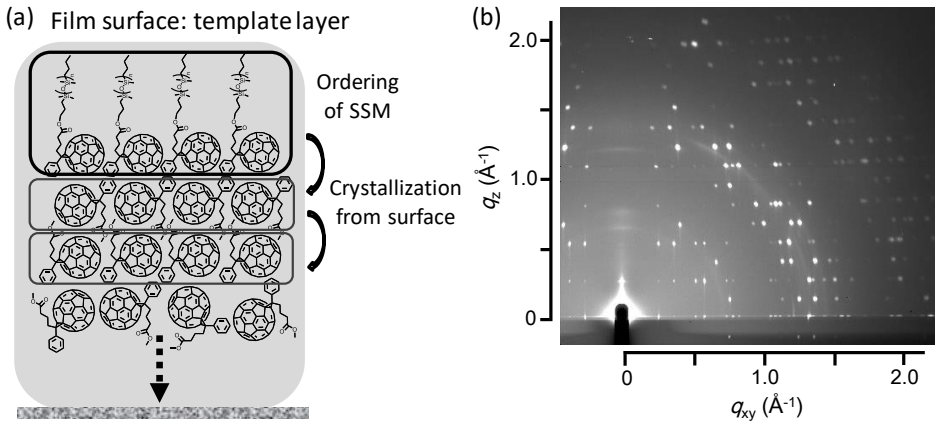

Figure 1 (a) Schematic image of SSM induced crystallization, (b) GIWAXS pattern of surface modified PCBM film.