Multi-layer coating of oriented conjugated polymer films via FTM method

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1. Introduction

Conjugated polymers are one of the potential candidates owing to their the application in low cost organic devices such as Organic Field Transistors, Organic Light Emitting Diodes, Solar Cells, Actuators and Sensors. Unique structural feature of conjugated polymers lies in its highly one-dimensional distribution of π-conjugation, which promises to provide anisotropic functionality to optoelectronic-characteristics. In this respect, the orientation methodology of conjugated polymer has been developed by many researchers in the recent past [1]. Reported methods, such as mechanical rubbing, friction transfer and flow-coating with post-annealing, prepare an oriented thin-film directly on the device substrate. These methods essentially require some chemical, mechanical or thermal actions for promoting the orientation. These actions, at the same time, affect the coated surface leading to mechanical or chemical damages, in particular, if the surface is consisted of soluble organic materials. This makes it difficult to build up organic multi-layered structure while maintaining the orientation.

Our group has developed a facile casting method to obtain oriented conjugated polymer film named as Floating-film Transfer Method (FTM) [2][3]. The oriented floating-film can be skimmed easily with a hydrophobic solid-surface, by which we can coat the oriented film without the impact on the substrate surface. This enables us to prepare oriented multi-layer films of conjugated polymers. In this study, non-regiocontrolled poly (3-hexylthiophene) (NR-P3HT) has been utilized to demonstrate this multi-layer coating.

2. Experimental

Chemically synthesized NR-P3HT was dissolved in chloroform to prepare 1% (v/v) solution. Single drop of this solution was put on to the hydrophobic liquid-substrate consisted of a mixture of water/ethylene glycol or ethylene glycol/glycerol. After putting the droplet, solution quickly spreads leading to a floating-film immediately cast on the liquid-substrate because of the rapid evaporation of chloroform. The dynamically obtained floating-film, thus, forms an oriented thin-film, after which was transferred on a suitable substrate. This coated film was washed with methanol and dried prior to the next coating step. Parallel- and perpendicular-coatings of oriented conjugated polymer film has been carried out repeatedly with the same procedure.

2. Results and Discussion

Polarized analyses have been carried out for the multi-layered films. Figure 1 (a) shows the comparison of polarized absorption spectra of the single and the double layers on glass substrate. It can be seen that both of the polarized spectra have a similar spectral profile. Orientation characteristics in both the 1st and the 2nd layers were well-conserved even after over-coated. This result indicates that the over-coating method prepared with FTM does not alter the film morphology in both of the upper and under layers. Figure 1 (b) shows the surface images of oriented NR-P3HT film. It is obvious that uniaxially aligned structure was found in the AFM image. The observed alignment direction is matched to the optical parallel direction, indicating that the morphological alignment represents the origin of the optical orientation. FET measurements also conserved the anisotropic characteristics in the double-layered NR-P3HT film.

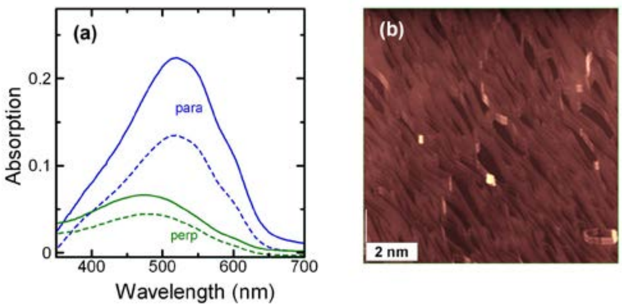

Figure 1: (a) Polarized spectra of oriented single layer (dashed line) and double layer (solid line) NR-P3HT films prepared by FTM. (b) AFM images of oriented NR-P3HT film.

4. Conclusions

It is concluded that the over-coating method via FTM proves to be useful for fabricating multi-layer architecture of oriented conjugated polymers suitable for anisotropic-device fabrication.

References

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