Floating film transfer method: an effective method for macroscopically oriented large-area films of conjugated polymers

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Solution processable conjugated polymers (CPs) have made the fabrication of active layer of organic field effect transistors (OFETs) uncomplicated and cost-effective. By orientating the polymer backbone of CPs, improvement in planer charge transport has been well studied in the recent past. However, inevitability of pre-aggregation in solution and difficulty in layer-by-layer film coating by various methods to orient polymer is still a major limitation. This limits their use in large-area fabrication of thin films for high-performance printed electronics with adequate repeatability [1].

Floating film transfer method reported by our group is an efficient film fabrication method to solve the above issue together with various advantages, such as minimum material wastage, high-performance due to uniaxial orientation of polymers, layer-by-layer film fabrication possibility since the films are independently prepared, and then transferred on substrates. We have actively worked and reported on this method. In this technique, one drop of polymer ink is placed on the orthogonal viscous liquid and polymer solution spreads. Viscous drag arising from the liquid substrate continuously acts opposite to the film expansion direction that results in polymer backbone orientation perpendicular to the film expansion direction [2]. At the same time, simultaneous solvent evaporation results in solid oriented thin films of CP floating at the liquid-air interface which can be transferred to any desired substrate.

Recent development in FTM, i.e., controlling the expansion of FTM film through a custom-made slider, we have reported the fabrication of large-area (> 20 cm^2) ribbon-shaped films just from ≈10 μl of the polymer ink [2]. We have also demonstrated the layer-by-layer film coating on the same substrate [3] and reported improved OFET mobility for several p-type CPs. In this work, we will present the recent progress made in this method using p-type/n-type polymers and other basic studies carried out in this method necessary to utilize this method for the facile fabrication of printed electronic circuits.

References:

1. M. Pandey et al. J. Mater. Chem. 7, 13323 (2019)

2. Tripathi et al. Appl. Phys. Lett. 112, 123301 (2018)

3. M. Pandey et al. Synth. Met. 227, 29 (2017).