Abstract

Towards up-scaling of organic photovoltaic (OPV), cathode-side interface layer (CIL) engineering faces the problems of processing compatibility and stability, both of which have posted challenges on the device performance and reproducibility. Therefore, it is an essential task to engineer low-efficiency-loss CIL for large-scale device printing. In this talk, I will introduce my works on the CIL materials development, interfacial engineering and investigation on the mechanism for material degradation.

In the first part, I will introduce our investigation of a ultra-thin poly (ethylene imine) PEI, a popular CIL, with the most promising transparent conducting electrode PEDOT:PSS using slot die coating. We find that PEI react with both the PSS and PEDOT backbone, causing an interface de-doping. This interface reaction also results in a pinning effect to stabilize the surface morphology of PEDOT:PSS. This interaction is identified to be the origin of work function reduction, beside the dipole effect. We propose that the oxygen that exists in the ambient conditions can effectively re-dope the de-doped PEDOT:PSS. The re-doping is detrimental to the low-work-function electrodes. Consequently, it causes the low-reproducibility in process.

Next, by considering the tolerance of thickness variations of the interface layer can ease the technological difficulty in processing, a new CIL is developed and successfully used. This CIL consists of a metallic conjugated polyelectrolyte, PEDOT-S, and surfactant-functionalized deoxyribonucleic acid (DNA). We show that a dipole effect induced by using the surfactant, CTMA, is responsible for lowering the electrode work function. The DNA: CTMA complex works as an diluting component in blend to improve the optical transmission, while PEDOT-S provides the conducting pathway for electron transport and allows thicker layer to be used in the large-scale printing. If time permits, I will also introduce a mature self-assembly method of CIL for OPV in solution processing.