Effect of Interfacial Layers on the Performance and Stability of Polymer Solar Cells

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Polymer solar cells have been splotlighted for the last two decades and are still being considered one of the strong candidates for next generation solar cells. The reason can be attributed mainly to the simplified fabrication processes at low temperatures and atmospheric pressure conditions without use of vacuum systems. Additional benefits would be assigned to a variety of semiconducting polymers which can be tailored via organic synthesis strategy. Recently, the power conversion efficiency of devices has been encouragingly improved approaching 11% for single-stack polymer:fullerene solar cells, which might establish a step toward the possibility of achieving >15% efficiency through multi-stacked devices in the near future.

The improved efficiency can be basically ascribed to new semiconducting polymers which have relatively high highest occupied molecular orbital (HOMO) energy levels and suitable lowest unoccupied molecular orbital (LUMO) energy levels. This combination resulted in the increased open circuit voltage in the presence of enhanced short circuit current density thanks to the narrowed band gap. However, the reality is that inorganic materials are still used for both electron-collecting buffer layers and hole-collecting buffer layers, which is a drawback of polymer solar cells when it comes to pursuing 'real plastic' solar cells with high flexibility and bendability.

Unfortunately, the current technology cannot deliver better organic materials for such electron-collecting buffer layers and hole-collecting buffer layers, even though conducting polymers (i.e., PEDOT:PSS) can be applied as hole-collecting buffer layer. Instead, ultrathin organic layers have been applied as an interfacial dipole layer that can modify the conduction band of inorganic electron-collecting buffer layers and also help improve adhesion between polymeric bulk heterojunction layers and inorganic charge-collecting buffer layers. However, the kind of organic interfacial materials is quite limited for applications to polymer solar cells.

Very recently, we have succeeded in achieving high power conversion efficiency with new type of organic interfacial materials. The performance of polymer solar cells with new type of organic interfacial layers is presented together with the stabiliy data. In addition, various measurement results including surface morphology are discussed in order to account for the enhanced device performances.

References

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