Nanoimprinted Polymer Solar Cell

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Among the various organic photovoltaics (OPVs), the conjugated polymer/fullerene approach draws the most research interest. The performance of these types of solar cells is greatly determined by the nanoscale morphology of the two components (donor/acceptor) and the molecular orientation/crystallinity in the photoactive layer. A vertically bicontinuous and interdigitized heterojunction between donor and acceptor has been regarded as one of the ideal structures to enable both efficient charge separation and transport. In recent years, nanoimprint lithography has emerged as a new approach to realize this architecture and simultaneously control both the heterojunction morphology and polymer chain alignment in organic photovoltaics. Preferred polymer chain orientations and improved efficiencies have been reported by many different groups. However, it is worth noting that there are large variations of specific fabrication methods, materials used, imprinted feature sizes and processing details for imprinted polymer photovoltaics in literature, which make it difficult to compare one work with another to validate the methods and underlying science.

To develop a comprehensive understanding of nanoimprinted OPVs, it is important to review recent work on this type of solar cell. Therefore we will first review and compare different nanoimprint lithographic techniques employed to fabricate nanoimprinted polymer solar cells in literature. Then the nanoimprint induced chain alignment in the well studied OPV material poly(3-hexylthiophene) (P3HT) and its impacts on charge transport will be introduced. By fabricating P3HT with different geometries, we will study the effects of imprinted polymer feature sizes and interface enhancement factors (IEF) on chain alignment and solar cell performance which can provide geometric guideline for imprinted OPVs. Besides active layer patterning, we will also review the progress on electrode patterning in literatures such as poly(3,4-ethylenedioxythiophene) poly(styrenesulfonate) (PEDOT:PSS), transparent conductive oxides and metals for polymer solar cells. Finally the current challenges and future tasks for nanoimprinted polymer solar cells will be previewed.