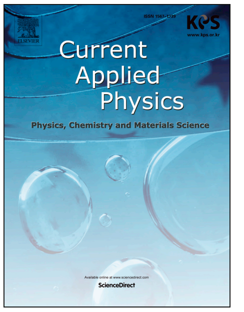

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Interfacial Engineering for Highly Efficient Organic Solar Cells

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ABSTRACT

Interfacial engineering using metal oxides, organic surface modifiers and other materials can effectively enhance the performance of conventional and inverted organic solar cells by reducing energy barriers for charge transport, while improving compatibility between organic active layer and inorganic metal oxides or transparent conducting electrode. This short review introduces several important classes of interfacial materials which have been widely successful in improving the efficiency of organic solar cells, and covers some of the recent advances in this field.

1. Introduction

Polymer solar cells (PSCs) may be regarded as next-generation solar cells due to their advantages such as printability, low-cost, light weight and mechanical flexibility.[1-4] One of the important advantages of PSCs is their solution-processability, which enables their mass production via economical and large scale processing techniques like roll-to-roll manufacturing.[5,6] In spite of their compatibility with low-cost fabrication techniques, their power conversion efficiencies (PCEs) must be comparable to those of other commercially available solar cells, such as silicon solar cells, in order for them to be commercially successful or widely adopted in any practical applications.

Extensive research relating to the synthesis of donor polymers and acceptor fullerene derivatives,[7-11] device architectures,[12-14] morphology control and processing additives,[15,16] have recently improved PCEs up to 12%. These increased efficiencies have largely stemmed from the development of novel active layer materials with improved physical characteristics such as extended light absorbtion, increased charge carrier mobilities and desirable self-assembly properties when processed from organic solvents. Although new active layer materials have been instrumental in pushing the upper boundaries of PCEs which can be achieved in OPVs ever higher, the highest efficiency PSC devices are almost always achieved when the device architecture is optimized by engineering some aspect of the device structure in addition to the active layer. Thus, the continued research of new and innovative device architectures constitutes an important endeavor which develops in tandem with new active layer materials.

One of the most effective strategies for device optimization involves introducing various interfacial materials in order to engineer device properties so that an optimal amount of electrical energy can be extracted from a given active layer. These interfacial materials can be divided into several general classes based on their function, such as electron transport layers (ETLs), hole transport layers (HTLs), interfacial