ORGANIC SOLAR CELLS WITH INTERFACIAL LAYER FORMED BY SPONTANEOUS PHASE SEPARATION

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Bulk heterojunction organic solar cells have attracted attention as future photovoltaic devices since they can be manufactured on large area via low-cost solution processing. One way to both improve the efficiency and simplify the process is to use the phase separation of two polymers during spin coating. This paper presents the improvement of organic solar cells by spontaneous phase separation of active layer (P3HT and PCBM) and interfacial layer of PEG (Polyethylene glycol) during spin coating.

PEDOT-PSS was spin-coated on ITO coated glass substrate. On the top of PEDOT-PSS layer, P3HT(15mg):PCBM(15mg):PEG with different PEG weight were spin-coated and dried. The molecular weight of PEG is 300 (PEG300), 1540 (PEG 1540) and 6000. Al electrode was thermally evaporated onto the active layer using vacuum evaporation, followed by the different annealing temperature from 80°C to 140°C for 10 min. The I-V characteristics were measured under AM 1.5 illumination.

The weight of PEG was varied with keeping the annealing temperature fixed to 80°C, and it was found that short circuit current density and FF (fill factor) were improved with increasing the amount of PEG and have maximum at around 2 mg, then degraded in the case of PEG 300. Figure 1 shows I-V characteristics of solar cells with PEG 300 (the weight of 2 mg) and annealing temperature of 80°C. The I-V characteristic without PEG is also shown. This figure shows that the short circuit current and FF were improved by adding PEG 300. On the other hand, the open circuit voltage becomes worse in the case of PEG 1540 as shown in Figure 1.

The cross-section of organic solar cell was characterized by FE-SEM (field emission scanning electron microscopy). The thin PEG layer was clearly observed at the interface between active layer and PEDOT-PSS layer in the case of PEG 300. The absorption spectrum shows no change with and without PEG. It suggests that the improvement of solar cell is due to the PEG layer formed by the spontaneous phase separation of active layer and PEG layer during spin coating. In order to prove the effectiveness of PEG layer, the PEG layer was separately introduced between PEDOT-PSS layer and P3HT:PCBM active layer, and it was found that insertion of PEG layer improves the solar cell performance. It indicates that the PEG layer acts as suitable hole transport layer for P3HT:PCBM based organic solar cell.

The degradation of solar cell performance using PEG 1540 is that the PEG layer was not formed during these processes because of the difficulty in the formation of PEG thin layer. On the other hand, the improvement was confirmed with increasing the annealing temperature up to 140°C. It was also confirmed that the long term stability of organic solar cell was also improved by introducing PEG.

The detailed properties of organic solar cells with PEG with various conditions will be presented at the conference.

![Graph showing I-V characteristics](image_url)

Figure 1: I-V characteristics of organic solar cell with and without PEG.