Solvent-vapor surface treatment induced performance improvement of organic solar cells

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Abstract: Improvement of the photovoltaic efficiency via exposure of organic solar cells to solvent-vapor at room temperature is reported. Carbon disulfide (CS_2) vapor treatment can induce Poly(3-hexylthiophene) (P3HT) self-organization into ordered structure leading to enhanced hole transport and light absorption. The power conversion efficiency (PCE) of the organic solar cells can be increased from 0.89 to 1.67% by solvent-vapor treatment.

1. Introduction

Organic solar cells (OSC) are potential candidates for harvesting solar energy. These devices offer a renewable, sustainable source including low-cost fabrication and mechanical flexibility.[1,2] Thermal annealing of the bulk heterojunction organic solar cells is a critical step for improving the efficiency.[3] However, thermal annealing is normally processed relatively high temperatures from 120℃ to 180℃ are often used, which requires care for devices fabricated on cheap flexible plastic substrate. In this report, the improvement in the organic solar cell efficiency and structural changes occurring during solvent-vapor treatment of P3HT:PCBM solar cells in CS_2 vapor at room temperature are described.

2. Results

Figure 1 shows the dark and light J-V curves under 100mW/cm^2 white light illumination for the organic solar cells with different treatments. The solar cell without vapor annealing has an open-circuit voltage (Voc) of 0.61 V, a short-circuit current (Jsc) of 3.89mA/cm^2, and a calculated fill factor (FF) of 0.37. The overall PCE for this cell is therefor 0.89%. When the P3HT:PCBM active layer is subjected to the CS_2 vapor treatment, the Jsc of the resulted organic solar cells increase over 6.48mA/cm^2, almost twofold of the no annealed solar cells. A PCE over 1.67% is achieved for the organic solar cells with CS_2 vapor treatment. This improvement is attributed to the enhanced optical absorption and charge transport after solvent-vapor treatment.

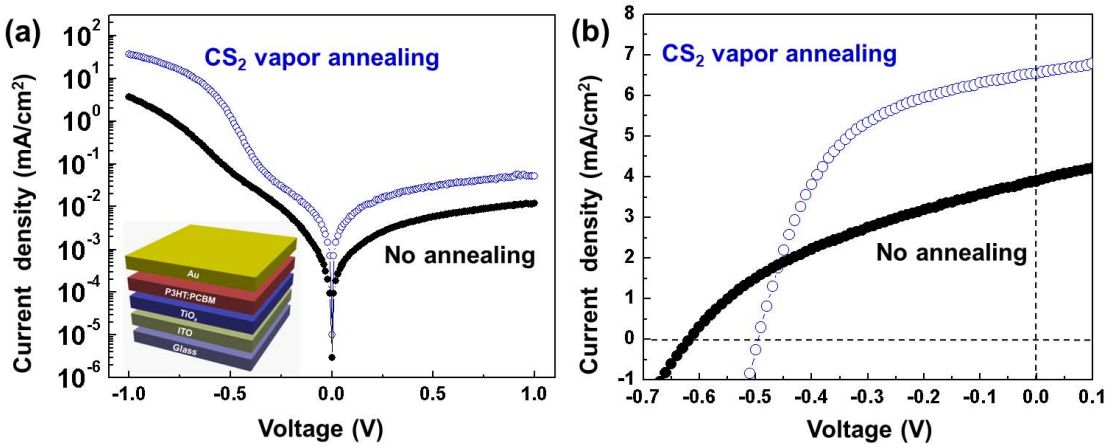

Fig. 1. The dark and light J-V curves of the organic solar cells solvent-vapor treated with CS_2

3. Conclusion

Efficient organic solar cells based on P3HT:PCBM are realized by a solvent-vapor treatment. It is found that the P3HT chains can self-organize into the ordered structure under the CS_2 vapor treatment, and the optical absorption and the hole transport are enhanced. Our report indicate that the proper solvent-vapor treatment is a more effective approach than thermal annealing for the flexible organic solar cells.

References

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