Abstract of Presentation

Presentation Title:

Supra-hierarchical Nano-structured Organic Thin Film Solar Cells

Abstract :

The power conversion efficiency of the bulk hetero-junction (BHJ) polymer solar cell has been increased markedly in the last few years and achieved up to 4～6% efficiency. For much higher performance of organic solar cells with an efficiency over 10 % and much higher durability for practical use, there are two key issues to be solved: 1) low efficient charge separation from exciton with very short diffusion length and 2) low efficient transport of electron and hole due to the charge trapping and charge-recoupling in the bulk layer.

Using a simple calculation that assumes 100% EQE for all photon energies above the 1.9 eV band gap of P3HT, the best possible P3HT/PCBM PV cell would produce roughly 17 mA/cm^2 of photocurrent under AM1.5G illumination. Combined with the open-circuit voltage (550 mV) and fill factor (0.6) that has been reported for this bulk heterojunction, the resultant power efficiency would be only 5.6%. Thus, it is clear that, for the P3HT/PCBM PV cell to reach 10% efficiency, significant improvements in the device fill factor and open-circuit voltage will be necessary, requiring new device architectures. that give reduced recombination.

We proposed “Supra-hierarchical nano-structured organic solar cells” as a possible candidate for this requirement. Metal oxides 1D nano-array of ZnO or TiO2 have been developed as feasible electron transport path (ETL), while for hole transport path (HTL), polymer brush of PEDOT:PSS complex has been developed successfully. Donor and Acceptor complex have been also prepared with highly ordered structure. We believe there is no theoretical reason that prevent conjugated polymer PV cells that are competitive with commercially produced crystalline silicon PV cells. For that, it will also require the synthesis of new conjugated molecules with smaller band gap, wider bandwidth, optimized energy level, and higher carrier mobilities. These innovations will be the key to allowing plastic solar cells to become a viable energy source for the 21st century.