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Development of High-Efficient Organic Solar Cell With TiO_2/NiO Hole-Collecting Layers Using Atomic Layer Deposition

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Organic solar cell was fabricated using one-pot deposition of a mixture of NiO nanoparticles, P3HT and PCBM. In the presence of NiO, the photovoltaic performance was slightly increased comparing to that of the device without NiO. When TiO_2 thin films with a thickness of 2～3 nm was prepared on NiO nanoparticles using atomic layer deposition, the power conversion efficiency was increased by a factor 2.5 with respect to that with bare NiO. Moreover, breakdown voltage of the film consisting of NiO, P3HT, and PCBM on indium tin oxide was increased by more than 1 V in the presence of TiO_2-shell on NiO nanoparticles. It is evidenced that S atoms of P3HT can be oxidized on NiO surfaces, and TiO_2-shell on NiO nanoparticles. It is evidenced that S atoms of P3HT can be oxidzed on NiO surfaces, and TiO_2 shell heavily reduced oxidation of S at oxide/P3HT interfaces. Oxidized S atoms can most likely act as carrier generation sites and recombination centers within the depletion region, decreasing breakdown voltage and performance of organic solar cells. Our result shows that fabrication of various core-shell nanostruecutres of oxides by atomic layer deposition with controlled film thickness can be of potential importance for fabricating highly efficient organic solar cells.

Keywords: Organic solar cell, Buffer oxide layer, NiO, TiO_2, Ultra-thin films, ALD

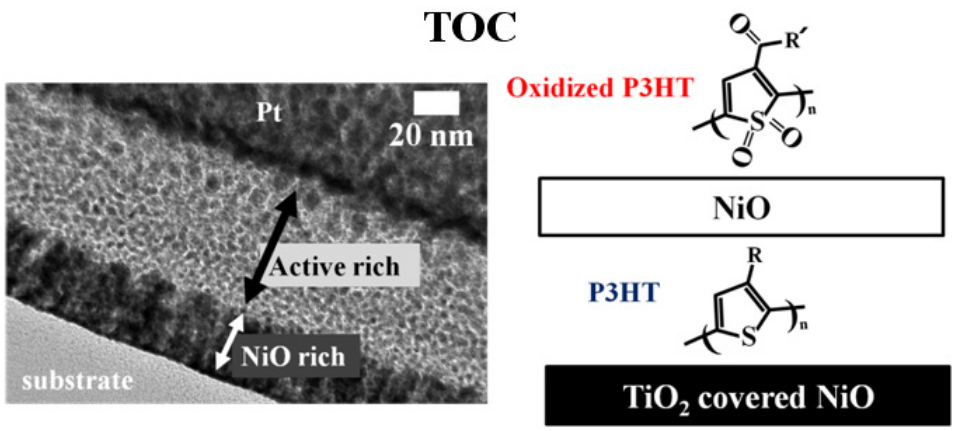
TOC
Pt
20 nm
Active rich
NiO rich
substrate
Oxidized P3HT
NiO
P3HT
TiO2 covered NiO

Fig. 1.