Area: 1 Crystalline and thin film silicon PV

CRYSTALLINE-SI HTEROJUNCTION WITH ORGANIC THIN-LAYER (HOT) SOLAR CELLS

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The promising combination of organic and inorganic materials, often termed hybrids, has led to the emerging research field of hybrid optoelectronic devices. Especially, hybrid solar cells combining the highly conductive polymer with well-studied inorganic semiconductor materials such as crystalline-silicon (c-Si) have triggered intensive research. Among several conjugated polymers, poly(3,4-ethylene dioxythiphene):poly(styrene sulfonate)(PEDOT:PSS) has recently proved to be one of the most promising candidates for transparent hole-transporting layer, which has been applied for organic thin-film solar cells and electroluminescence devices. The power conversion efficiency (PCE) increased to 13.5% by adjusting a type of solvent, solvent concentration, film thickness of PEDOT:PSS, and a resistivity of c-Si substrate without using p-n junction and TCO. These findings originate from the uniaxial optical anisotropy, i.e., metallic character in-plane, whereas a dielectric property in out-of-plane, although it's degree depend on the solvent and deposition method. Thus, we named this type of solar cell as a Si Heterojunction with Organic Thin layer (HOT) solar cells. Among several parameters, an open-circuit-voltage V_{oc} increased from 0.55 to 0.61V by adjusting a resistivity of 0.1-0.3 Ω·cm. PCE further increased to 15.9% using an AR coating layer.

In this paper, I demonstrate the effect of hole blocking layer and organic barrier film coating on the photovoltaic (PV) performance and PEDOT:PSS/n-Si front-junction solar cell module.

Figure 1 shows I-V curves and the 2-dimensional map of J_{sc} and EQE at 1050 nm of the devices with and without a 2-nm thick $Ba(OH)_2$ interlayer. The J_{sc} increased without deteriorating *FF* and V_{oc}, which is due to the lowering of wok function (WF) of Al. To improve the stability of PEDOT:PSS for air storage and light soaking, we also coated several organic and inorganic acid and base such as Nafion, PTSA, and Di-[4-(N,N-ditolyl-amino)-phenyl]cyclohexane (TAPC) as a protection layer on top of PEDOT:PSS. Among them, the stability of PV performance for air storage was improved by TAPC coating.

We also fabricated solar cell module using these component technologies on $2\times2 cm^2$ and four-inch size N-type c-Si wafers. Figure 2 shows the I-V curve of solar cell module of a $2\times2\ cm^2$ size cells connected in series 10 units. The PCE was still 12.6% with a J_{sc} of 0.08330A, a V_{oc} of 6.16V, a *FF* of 0.712. The P_m of 0.368W was obtained despite of no use of light harvesting techniques.

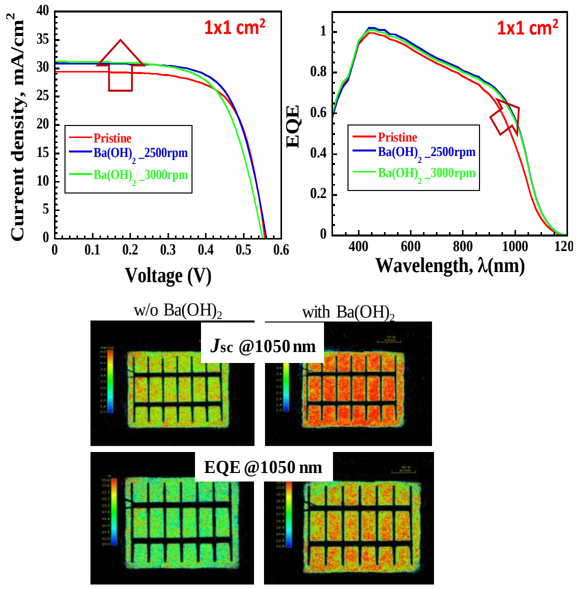

Fig. 1 I-V and EQE spectra of PEDOT:PSS/c-Si solar cells with and without a 2-nm-thick $Ba(OH)_2$ interlayer at rear Si/Al interface. The 2D map of J_{sc} and EQE at 1050 nm for corresponding devices.

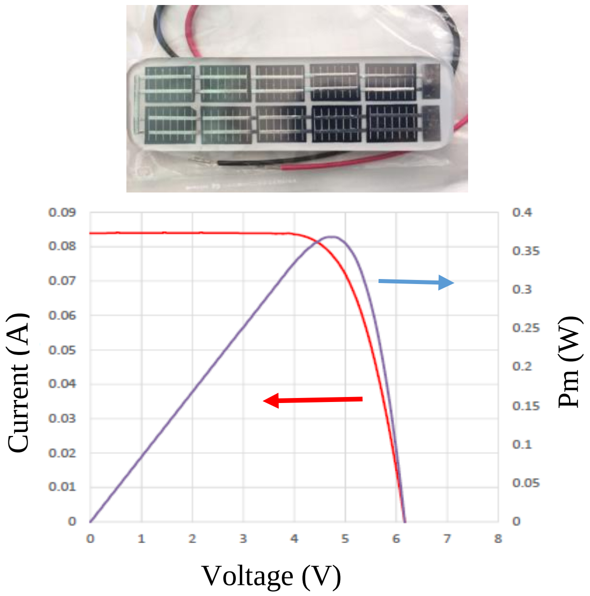

Fig. 2 Solar cell module and I-V and P-V curves of corresponding solar cell module.