Study on interface recombination characteristics of crystalline-silicon/organic heterojunction solar cells

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1. Introduction: We have investigated the effect of interface recombination characteristics at the front- and rear-Si interface by reverse recovery study of PEDOT:PSS/n-Si/SnO_2(TiO_2) junction solar cells to understand the recombination velocity. We have found that, for PEDOT:PSS/n-Si junction solar cells the reverse charge storage time (~5.5μs) for the minority carrier is almost independent of the reverse recovery current. This can help to understand the effect of front-electron and rear-hole blocking layers on surface recombination velocity.

2. Experimental: The solar cell devices are fabricated on n-Si (250μm thick 0.1~0.5 Ω-cm resistivity 2×2 cm^2) substrate. After the organic cleaning of the substrates, a ~ 90-nm-thick PEDOT:PSS is coated over the top surface of the Si by spin coating and heat treated at 140°C for 30 mins. After that, the Ag grid is screen printed on top of PEDOT:PSS followed by 180°C annealing for 30 mins to remove the residual solvent. Finally, Al is evaporated at the back side as a cathode.

3. Results and discussion: Figure 1(a) shows the equivalent circuit of p-n hetero-junction solar cells (dotted area) with reverse recovery experimental circuit. In which ***Vs*** is the programmable wave source, ***Rs*** and ***Rsh*** are corresponding to the equivalent series and shunt resistance respectively. Figure 1(b) depicted the experimental result of the reverse recovery study for different load resistance (***R_L***). It was observed that, a nearly constant reverse current was flowing for a time ($T_{storage}$), when the steady state forward current is quickly switched to reverse current by applying a reverse voltage. So, this current is due to the minority carrier at the PEDOT:PSS/n-Si interface. When these minority carriers begin to deplete significantly the current rate drops and eventually reduce to reverse saturation current. The effect of carrier blocking layer on surface recombination properties for the device can be extracted by this study. We will present the effects of resistivity of Si substrate and hole-blocking layer on the transient current response.

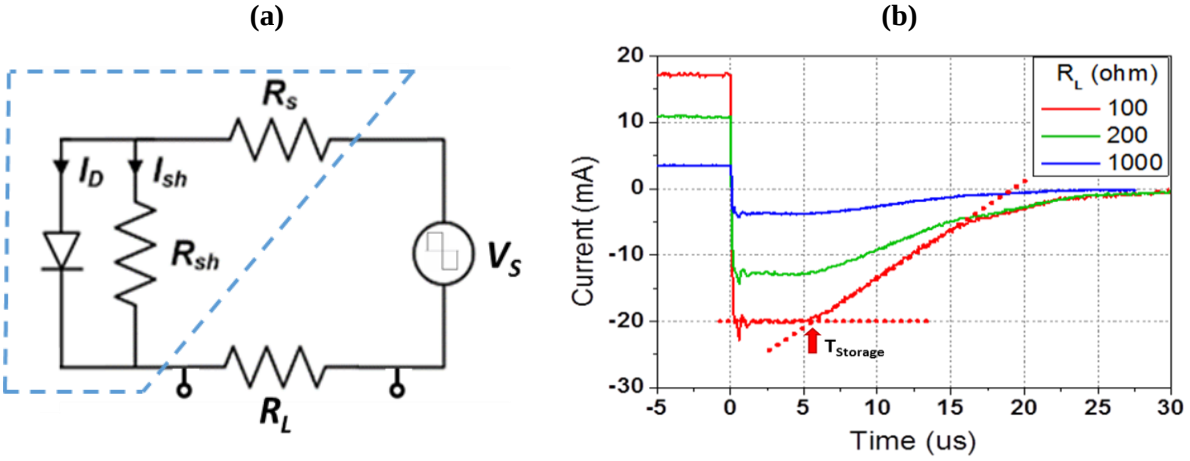

Fig.1: (a) Equivalent circuit for PEDOT:PSS/n-Si junction solar cells for reverse recovery experiment (b) Transient current response of the corresponding device.