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Enhancing Photovoltaic Performance of Solution-Based Si Heterojunction Solar Cells by 1-min Surface Passivation

Solution-based heterojunction is emerging for facile fabrication of Si-based solar cells due to the room temperature manufacturing and solution processing capability [1]. Surface passivation of Si substrate is established well for the photovoltaic (PV) performance enhancement of the conventional bulk Si cells but not of the heterojunction cells. Pristine Si usually has high-concentration, non-saturated dangling bonds at the surface that causes high local carrier recombination rates. Inserting a thin oxide layer between Si and contact materials could provide an intermediate "i" region for the p-i-n device, which greatly suppresses carrier recombination and build an internal electrical field. For the emerging solution-based Si heterojunction solar cells, the surface oxide layer has been introduced by exposure to air or chemical oxidation, which resulted in passivation layer of insufficient quality [2]. Therefore, it is essential to realize a high-quality passivation layer via a simple process.

Here, we report a facile and repeatable method to passivate the Si surface by a simple 1-min annealing process in vacuum, and integrated it into the heterojunction cell with poly(3,4-etyhlenedioxythiophene): poly(styrenesulfonate) (PEDOT:PSS) and that with carbon nanotube (CNT). A 1-nm-thin and dense oxide layer was introduced on the Si surface to provide high-quality hole transport and passivation, which enhanced the power conversion efficiency (PCE) from 9.34% to 12.87% (1.38-times enhancement) for the PEDOT:PSS/n-Si cells (Figure 1) and 6.61% to 8.33% (1.26-times enhancement) for the CNT/n-Si cells. The simple surface passivation will enhance the PV performance of the Si-based heterojunction cells with various materials without losing the easiness of the cell fabrication.

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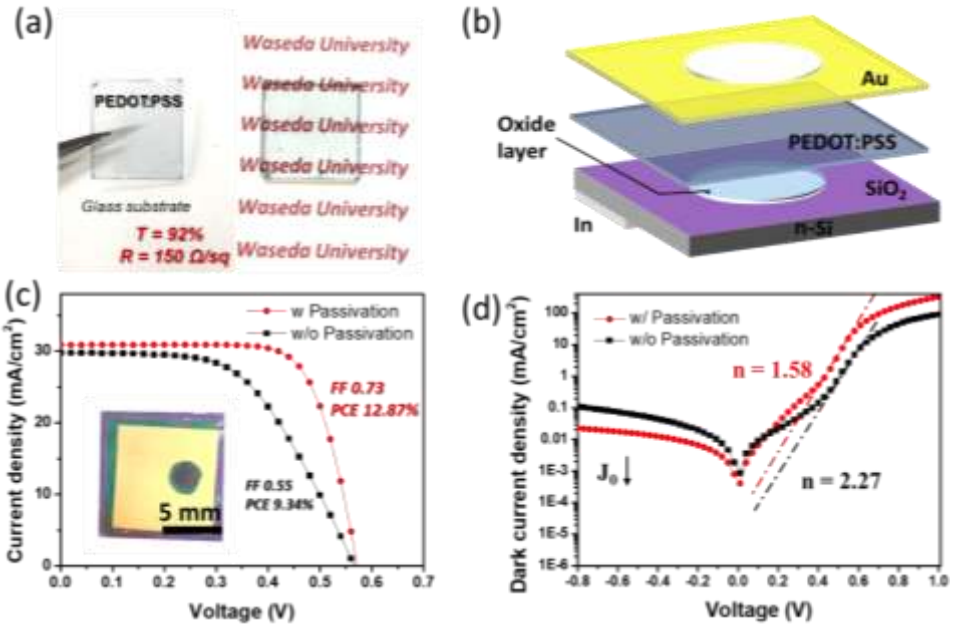

Figure 1: Solution-based PEDOT:PSS-/n-Si heterojunction solar cell with 1-min surface passivation.