High-Quality Oxide Interfacial Layer for Silicon-Organic Hybrid Solar Cell Applications

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Introduction: Research around inexpensive and renewable energy sources is increasingly becoming one of the most important challenges of our time due to the alarming rate and effects of global warming. Recently, hybrid solar cell architectures which use *n*-type Si as the absorber and PEDOT:PSS as the carrier-selective contact have been able to achieve device efficiencies exceeding 20%. Despite showing great potential, these devices suffer from poor reliability and rapid performance degradation. Several factors for this have been suggested, among which the quality of the silicon-PEDOT:PSS interface plays a key role. It has been shown that silicon deposited with PEDOT:PSS will form an interfacial oxide layer[1], which will degrade the performance of the cell as it grows. Attempts to grow a native oxide passivating tunneling layer under ambient conditions before deposition are inadequate due to the large number of defects and reaction sites still present on the substrate. This research reports that a high-quality silicon oxide interfacial layer grown using Neutral Beam Oxidation (NBO)[2] can form a stable passivating tunneling layer for future solar cell applications.

Experimental: Samples of silicon substrate were treated with different durations of neutral beam oxygen plasma. The samples were then spin-coated with PEDOT:PSS and 5% dimethyl-sulphoxide (DMSO) and annealed at 130°C under Argon gas. These samples were then stored in a temperature-controlled desiccator for 7 days at 25°C and 22% humidity. After this the PEDOT:PSS layer was removed by rinsing in acetone and DI water and dried with a nitrogen gun. The thickness and composition of the oxide layer were measured using an ellipsometer and XPS both before the deposition and after removing the PEDOT:PSS layer.

Results and Discussion: Studies have already shown that both the quality and thickness of the passivating layer significantly affects the performance of the solar cell [3,4] , with layers above 2 nm showing poor performance. It has also been suggested that HF-etched silicon, kept in ambient conditions forms a thin enough tunneling layer. NBO provides a more controllable method to form a defect free SiO_2 interfacial layer. Under NBO, the SiO_2 layer saturates around 400 s at 4.88 nm with a substrate temperature of 300°C. An exposure time of 30 s produces a 2 nm layer which is thin enough to facilitate tunneling while being a good passivating layer. This layer remains stable even after 7 days with a coating of PEDOT:PSS [Fig 1]. This may have the potential to address the performance challenges facing the durability of hybrid solar cells due to the silicon-PEDOT:PSS interface. More information will be shared in the presentation.

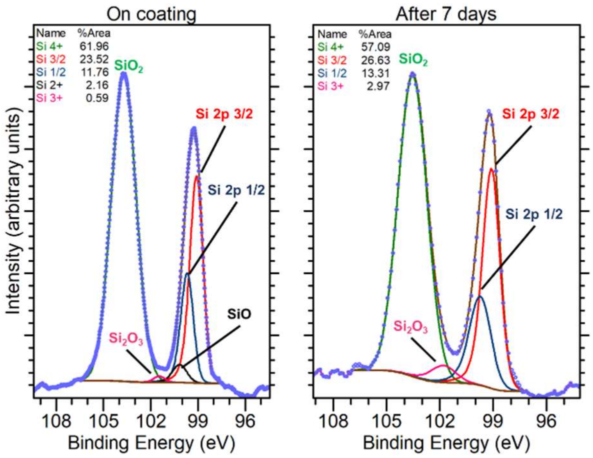

Fig. 1: Effect of PEDOT:PSS on NBO SiO_2 layer after 7 days.

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[4] L. He et al. *Appl. Phys. Lett.,* **100**, 1–4 (2012).