Silicon Nanowire Solar Cells: Surface Passivation and Interface Analysis

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Introduction

Silicon nanowire (SiNW) solar cells provide potential advantages over planar wafer-based or thin-film cells such as high light absorption and enlarged forbidden energy gap [1][2]. However, due to a large surface-to-volume ratio, nanowires typically suffer from a high surface recombination rate. This work focuses on reducing surface states and developing passivation technique for SiNWs.

Experimental Procedures

Charge pumping (CP) method is adopted to horizontally synthesized SiNW with varying nanowire size in order to measure interface state density D_{it}. We prepared p-i-n SiNW diode to measure the recombination current along the nanowires which is schematically illustrated in **Fig. 1**.

Results and Discussion

Measured D_{it} for various nanowire sizes are shown in **Fig. 2**. D_{it} increases with narrower width, meaning that the effect of localized high D_{it} is becoming more apparent. Assuming discrete D_{it} for each surface, top, side, and corner surface, localized D_{it} are extracted as shown in **Fig. 3**.

Conclusions

CP measurement is performed to p-i-n SiNW diode. D_{it} at the corner is one order higher than other surfaces and that effect is more apparent in narrower width. This result implies that adopting rectangular cross-sectional shape provide advantage for reducing surface recombination, and precise surface passivation technique is indispensable for achieving high efficiency.

Acknowledgement

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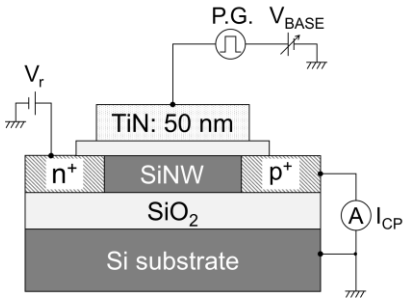

Fig. 1 Schematic illustration of device structure.

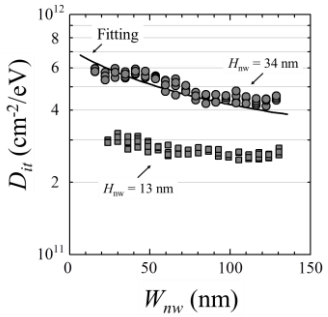

Fig. 2 D_{it} for various nanowire sizes.

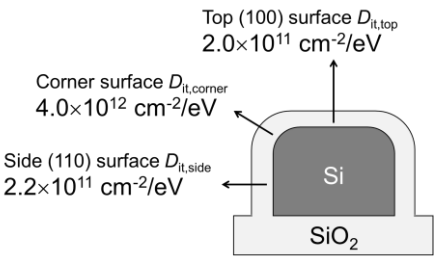

Fig. 3 D_{it} extraction for top, side, and corner surface

References

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