Room Temperature, Dip Coating Organic Passivation for *c*-Si Surfaces

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Introduction

- Effective surface passivation of crystalline Si is crucial to obtain high-efficiency *c*-Si solar cells.
- Conventional passivation layers (SiO_x, SiN_x, Al_2O_3) require high processing temperatures that are undesirable for bulk degradation study.
- Nafion has been explored as a solution-based, organic, room-T passivation technique[1], but exact mechanisms are not completely understood.

1. W. Ji *et al.*, *ACS Nano,* vol. 13, no. 3, pp. 3723-3729, 2019.

Aim

To determine the passivation quality of Nafion on bare and *poly*-Si/SiO_x passivating contacts, and to explore Nafion passivation and signatures under electron paramagnetic resonance at cryo T (6K).

Methods

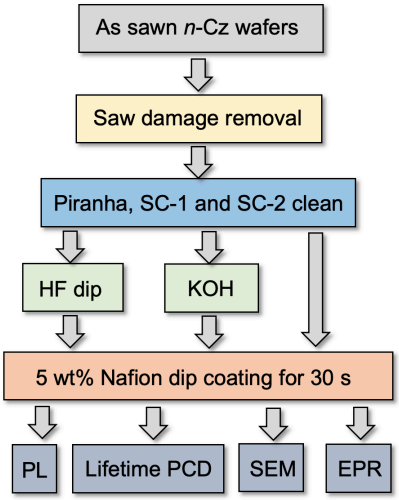
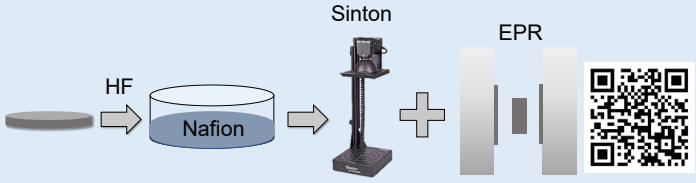


Fig. 1. Experimental process flow.

Passivating contact samples were fabricated by growing a ~1.5 nm thermal oxide layer before depositing P- and B- doped *a*-Si:H layers.

Conclusion

Room T solution-based Nafion passivation can effectively reduce the surface recombination rate of crystalline silicon for low-T bulk degradation study by EPR



Results

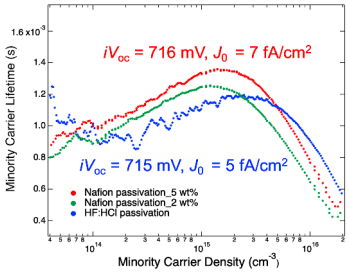


Fig. 2. Minority carrier lifetime plot for Nafion and HF:HCl liquid passivation for comparison.

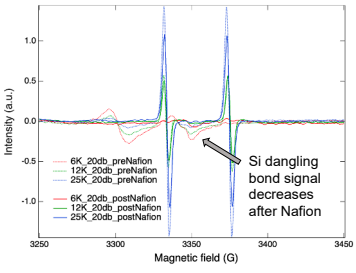


Fig. 3. EPR spectrum for *n*-Cz sample pre (dashed line) and post (solid line) Nafion treatment at 6, 12, and 25K.

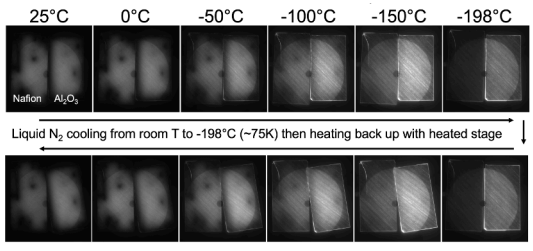


Fig. 4. PL images of Nafion (left) and Al_2O_3 (right) treated samples subjected under different temperatures on a T-controlled stage. The process was reversed when heating back up.

Discussion

- Nafion treatment is a room-T, simple procedure that provides good passivation quality of *c*-Si surfaces.
- Compatible under cryogenic temperature (6K) with electron paramagnetic resonance.
- Maintains good passivation down to -150°C, and the process is reversible.
- Ideal passivation technique to treat laser-scribed edges for bulk degradation characterization, but effective edge damage removal is needed.
- Nafion on *poly*-Si/SiO_x passivating contacts does not passivation, which indicates Nafion is passivated via field effect passivation.
- Effective Nafion passivation lifetime lasts ~1 day, but the process is reversible, thus can be used for LID and process-induced degradation study.

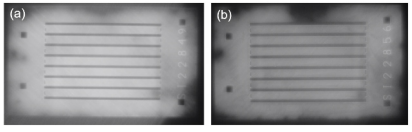


Fig. 5. Photoluminescence images for (a) EPR sample coated with Al_2O_3 and activated via FGA; (b) EPR sample after 5 wt% Nafion passivation.

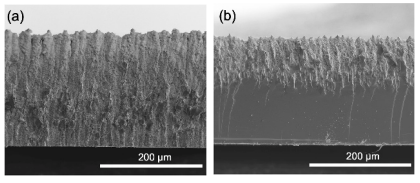


Fig. 6. Laser-scribed edge damage of *n*-Cz sample (a) without any pretreatment; (b) post 22.5 wt% KOH saw damage etch at 50°C for 1 hr.

Acknowledgement

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