

Openbaar eindrapport TKI Urban Energy project

New Application for ALD Al₂O₃: Interface Hydrogenation for Passivating Contacts in Silicon Solar Cells (AAA)

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Targets of the project and project partners

In the last decade atomic-layer-deposition (ALD) has become a key technology for the deposition of Al₂O₃ nanolayers that provide an outstanding level of surface passivation for crystalline silicon (c-Si) solar cells. Consequently it has been implemented at a large scale in manufacturing lines of PERC cells. Recently the photovoltaic (PV) community has also started to progress towards more efficient c-Si solar cell architectures which can be considered as follow-up of PERC technology. These comprise passivating contacts such as polycrystalline silicon (poly-Si). The goal of this project was to pave the way for application of ALD Al₂O₃ as (sacrificial) capping layers in the c-Si PV industry as it was found that ALD Al₂O₃ capping layers can significantly improve the passivating contact properties. The project was carried out by the Eindhoven University of Technology (TU/e), Delft University of Technology (TUD), ECN part of TNO and Levitech B.V.

Project results

The AAA project has clearly demonstrated the potential of ALD Al₂O₃ as hydrogenation layer for passivating contact materials. This has been done by revealing the fundamental working principles of the hydrogenation on polycrystalline silicon contacts using isotope labeling of the hydrogen and secondary ion mass spectroscopy. Moreover, the effects of hydrogenation by ALD Al₂O₃ on the passivating contact properties have been monitored under a wide variety of processing conditions and contact properties for both *n*- and *p*-type poly-Si. The potential for ALD Al₂O₃ as capping layer in PV industry has also been mapped in various solar cell configurations and process flows. The results have been and will be disseminated in peer-reviewed journal articles and at PV conferences.

Contribution to targets of TKI Urban Energy

The project results can be considered as a showcase for the introduction of (sacrificial) ALD Al₂O₃ capping layers in PV industry which is important for the market position of Dutch ALD equipment manufacturers. Moreover, the project result will enable the improvement of the quality of passivating contacts, and in this way will contribute to the increase of the energy yield of high-efficiency commercial c-Si PV modules.

Publications related to the project

1. M. Schnabel, B. van de Loo, *et al.* Hydrogen passivation of poly-Si/SiO_x contacts for Si solar cells using Al₂O₃ studied with deuterium, *Appl. Phys. Lett.* 112, 203901 (2018).
2. G. Yang *et al.* Poly-crystalline silicon-oxide films as carrier-selective passivating contacts for c-Si solar cells, *Applied Physics Letters*, 112, 193904 (2018).
3. L. E. Black *et al.*, *Solar Energy Materials and Solar Cells*, 188, 182 (2018).

4. Stodolny *et al.*, Proceedings of the 35th European Photovoltaic Solar Energy Conference and Exhibition (2018).
5. Van de Loo *et al.*, accepted for publication in J. Appl. Phys. (2019).
6. Two other publications by Van de Loo *et al.* and Yang *et al.* are currently under preparation

Contact person for more information

Prof.dr.ir. W.M.M. (Erwin) Kessels
Faculteit Technische Natuurkunde
Technische Universiteit Eindhoven
P.O. Box 513
5600 MB Eindhoven
Tel: 040 247 3477

Meer exemplaren van dit rapport zijn verkrijgbaar via de Technische Universiteit Eindhoven (secretariaat.pmp@tno.nl).

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