FUN
Sputtered and otherwise deposited a-Si for Fabricating passivated screen- printed contacts for an indUstrially feasible productioN

Project duration: from 09.2019 to 08.2022
Report submitted: 11.2022

Publishable Summary

The overall aim of the project is to provide highly performing photovoltaics and reduce the cost of solar technology. Therefore, we selected the EpiWafer process (epitaxially grown Si wafers) to produce highly cost-effective Si wafers and combine them with a high efficiency silicon solar cell process based on the approach of passivated contacts and screen-printing metallization. Therefore, this project develops and characterizes on the one hand a specific gettering process and on the other hand screen-printing metal pastes for contacting doped polycrystalline or amorphous Si layers.

Innovations within this project are reached by a successful development of a gettering process for NXW's innovative EpiWafers, that allow for a significantly reduced Si amount and energy consumption per wafer and thus per kWh of electricity to achieve cell efficiencies above 24%. In addition, a metal paste that allows for a less than 20% enhanced recombination current of passivated contacts, an application of the passivating contact scheme to the solar cell front side while not using a transparent conductive oxide (TCO). A successful project will lead to a high acceptance of NXW EpiWafers in the market since the most promising next step in silicon solar cell design the passivated contact approach is fully compatible with the new Si wafer material. The successful development of a cost effectively produced screen-printing paste that forms a contact with low contact resistance and almost no increase in recombination in the contact area will help the approach of passivated contacts to a breakthrough.

The main results of the FUN project are: Firstly, the successful development of a screen-printed Ag paste that contacts n-type and p-type polySi with low, required contact resistivity and at least in case of n-type polySi with an only low increase in saturation current density.

Secondly the development of polySi deposition for gettering and passivating contacts in the inline APCVD tool.

Thirdly the development of gettering processes for EpiWafers and CZ-Si wafers based on polySi.

Fourthly the development of laser crystallization processes in combination with electron beam evaporated Si for passivating contacts leading to an iVOC value of 730 mV and 703 mV for n- and p-type poly Si respectively.

Fifthly demonstrating the integration of the new solar cell features as polySi in combination with the newly developed Ag paste leading to 20% solar cell efficiency that is not limited by the passivating contact.

FENZI AGT results and results in collaboration in particular with UKON generated knowledge about how the specific conductive pastes react with different thin film coating at certain application

and processing conditions, this knowledge will be transferred to other business areas such as conductive pastes for electronic and automotive industry.

Leibniz-IPHT results and results with Leibniz-IPHT participation were published in two peer-reviewed articles, at a national and international conference, and in the Leibniz-IPHT annual report. In the project, technologies for laser crystallization of thin films on interfacial oxides without their destruction as well as on sensitive polycrystalline substrates such as EpiWafers with fracture tendency were developed. The experience and knowledge gained are to be used to acquire new projects and new industrial partnerships (submitted IraSME proposal).

UKON results are published in 2 peer-reviewed articles (one already published the second in preparation) as well as 2 conference contributions (one published, one handed in for review) and a separate talk at a workshop. In addition, the knowledge gained could have been used for a national project proposal handed in.

The investigations and results on poly Si growth in the epitaxy tool have shown Nexwafe the possibility to improve the epi-quality. An implementation of poly-Si for product optimization in the process chain can thus be considered.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Germany	3	928 992	840 479
The Netherlands	1	165 000	82 500
Total	*4*	***1 093 992***	***922 979***

Funding agencies involved and contracts

Funding Agency	Contract N° and Title
Federal Ministry for Economic Affairs and Energy	• 03EE1022A: “Integration of screen-printing based metallisation and gettering processes of EpiWafers in a solar cell process with passivated contacts” • 03EE1022B: Advanced industrial PV technologies • 03EE1022C: „Electron beam evaporation and laser crystallization of silicon for passivated screen printed contacts“
RIjksdienst voor Ondernemend Nederland	SOL18004: Sputtered and otherwise deposited a-Si for fabricating passivated screen-printed contacts for an industrially feasible production