Development of fully Copper-metallized c-Si heterojunction Solar cell and Module

Publieke samenvatting / Public summary

Aanleiding

The IEA world energy supply scenarios show about 800 GWp annual PV capacity additions. For the current Ag usage in solar cell metallization, this requires more than 40% of annual Ag mining, and, until 2050, half the world's Ag reserves. Ag availability and cost will therefore have a strong impact on the PV value chain. Currently, the crystalline silicon heterojunction (c-Si HjT) solar cell is the mainstream technology of European PV industry. To mitigate the challenges of Ag availability and cost fluctuation, replacing Ag by more abundant materials is an urgent, important and innovative necessity. Although replacing Ag by electroplated Cu contacts has been applied in the past, due to its process complexity, extra equipment investment, less environmentally friendly process and other challenges, it is still a research topic instead of being adopted in PV production, at least in Europe. Recently, screen-printed Cu metallization has opened another route for Ag reduction, particularly for the HjT cell thanks to its low-temperature process. Promising results were obtained at TNO showing a high potentiality to fully replace Ag contacts by Cu in this way.

Doelstelling

This project aims to establish a much more sustainable solar cell manufacturing process for c-Si HjT technology by replacing Ag fully by Cu for screen-printed cell metallization. Importantly, this project will cover development from cell metallization up to interconnection, module

Projectinformatie / Project information

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Algemene informatie / General information

Penvoerder / Secretariat
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lamination and reliability tests, to demonstrate that Cu metallization is not only an innovative metallization step at cell level, but can also be used to produce high performance and reliable PV modules, comparable to the conventional Ag-metallized counterpart. Thus, the risk of reliance on scarce Ag in the HjT solar cell manufacturing will be mitigated. This project aligns well with the MMIP2 (renewable electricity generation on land and in the built environment) and its sub-theme 1, (technology development of solar power). The success of this project can provide a solution for manufacturing HjT solar cells with a sustainable process, and reduce process cost due to the cost difference between Cu and Ag raw materials. The innovation will be highly beneficial to MCpv, TCC, and other Dutch PV manufacturers and potentially PV material suppliers to enhance their product competitiveness.

Korte omschrijving

WP1 will start with benchmarking Cu pastes for metallization (TNO). The most promising Cu paste will be applied for a stable Cu metallization process development, which will be integrated in HjT solar cell manufacturing, validated at cell level (TNO, MCPV). In WP2, both low temperature soldering and electrically conductive adhesive will be investigated for Cu contact interconnection (MCPV). A well-developed material and process shall be applied to tab single cells and short strings for lamination development and reliability testing in WP3 (TCC, TNO). Subsequently, stringing up to full module size will be demonstrated with an industrial tabber stringer (MCPV). Encapsulant materials and lamination process with high compatibility to the Cu-metallized solar cells will be developed and tested at minimodule level (TCC, TNO). The best material and process will be applied in full-size Ag-free and reference HjT solar modules (MCpv) for reliability tests (MCPV) and outdoor tests (TNO). In WP4, all will conduct cost calculation and life cycle assessment to evaluate the economic benefits and environmental impact of applying fully Cu-metallized cells instead of conventional Ag-based HjT cells

Resultaat

•A stable Cu metallization process in ambient. Demonstrated Cu fine line printing. A metallization design with low optical shading without significantly increasing series resistance. •Cu metallization process integrated in HjT cell manufacturing to validate minimum performance loss compared to a Ag-metallized reference. At least 1000 Cu-metallized HjT solar cells manufactured. •A stable Cu contact interconnection process with proper materials. The FF loss from cell to module minimized. Interconnection process and material transferred to and scaled up with industrial stringer, and used for full size module manufacturing. Proper encapsulant materials and lamination process for Cu-metallized HjT cells selected and developed. Initially demonstrated at minimodule level, then transferred and scaled up to full-size Ag-free HjT modules. •Outdoor performance of full-size Ag-free HjT modules assessed relative to Ag reference. Performance monitoring over 1 year to cover all different seasons. •Cost calculation and environmental impact assessment for Ag-free HjT solar cells and modules compared to conventional Ag-metallized HjT solar cells and modules.

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.
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