Optimum passivation of defects in crystalline silicon solar cells

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The new, modified process for manufacturing monocrystalline solar cells largely eliminates the degradation of Cz silicon solar cells during production. Regeneration is carried out at significantly higher temperatures than before and using hydrogen diffused in from silicon nitride, thereby increasing efficiency and speed considerably. Ideally, this process follows the co-firing step in production.

- Open up the full efficiency potential of solar cells
- Reduced process times during the regeneration process
- Increased efficiency in terms of regeneration
- Cost-effective and easy integration into existing manufacturing processes

Fields of application

Regeneration of Light-Induced-Degradation (LID) in solar cells produced using the Czochralski method

Background

The efficiency of monocrystalline solar cells that are produced using the CZ method (Czochralski method) decreases under sunlight within a few hours. This effect is called Light Induced Degradation (LID). The decreased level of efficiency is mainly due to the boron-oxygen defects in the Cz silicon solar cells. Methods aimed at passivating these defects are of major economic importance as low production costs and high efficiency potentials make the Cz silicon wafers particularly attractive for the mass production of solar cells.

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Development Status

TRL2 - Concept

Patent Situation

DE 11 2013 005 591 B4 granted
DE 20 2020 103 521.5 granted
SG 11201510423Y granted
US 10,892,375 B2 granted
US 11,784,279 granted
KR 10-1807381 granted
CN ZL201380077813.4 granted
EP 3014663 B1 granted,
BE, DE, ES, FR, IT & NL validated
MY PI 2015704636 granted
JP 6 266 768 granted

Reference ID

13/072TLB

Service

Technologie-Lizenz-Büro GmbH has been entrusted with exploiting this technology and assisting companies in obtaining licenses.

Problem

The basic patent of the University of Konstanz on "Regeneration of the LID effect" (Patent number: DE 10 2006 012 920) describes a method which enables the regeneration of Cz silicon solar cells. This method stabilizes the level of efficiency of solar cells during the production process so that it is significantly above the degraded level.

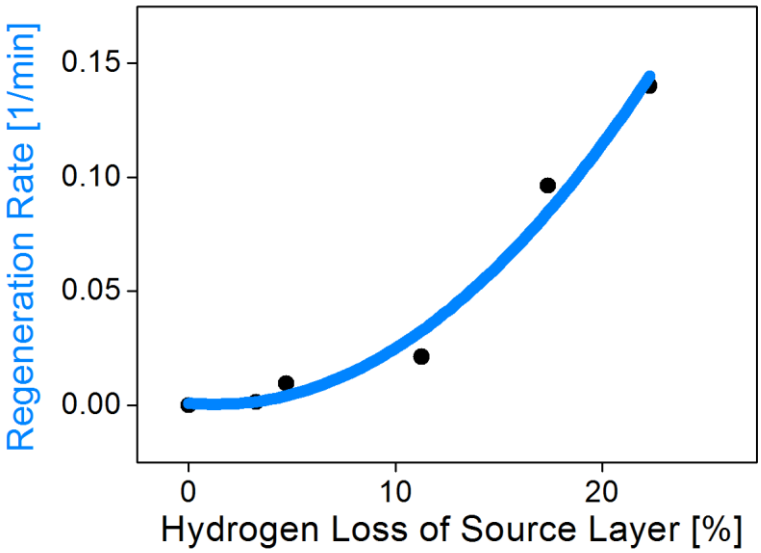
However, process efficiency strongly depends on the achievable regeneration rate or the time needed for defect passivation.

Solution

Scientists at the University of Konstanz succeeded in showing that the patented method can be carried out at higher temperatures. This leads to greater efficiency when there is hydrogen in the silicon substrate during the regeneration step.

There are various ways of adding adequate amounts of hydrogen to the silicon substrate, including a homogeneous distribution during the production process. One way of doing this would be to use a layer of hydrogenated silicon nitride as a source of hydrogen. The silicon nitride will be restructured during the high-temperature process while releasing hydrogen which can then diffuse into the silicon substrate. Appropriate temperature control, which might be combined with the generation of minority charge carriers (e.g. through illumination or external electricity supply), ensures that an sufficient amount of hydrogen can diffuse into the silicon substrate where it is distributed homogeneously.

During the regeneration process, hydrogen can then be attached to the boron-oxygen defects and deactivate them. The regeneration process can now be carried out at much higher temperatures so that the entire process is accelerated. As a result, the method can now be used for industrial mass production. Solar cells that are produced in this manner have regained a high degree of stabilized efficiency. Moreover, they can be produced at low cost.



More hydrogen allows higher Regeneration rates and the use of higher Regeneration temperatures.