Fraunhofer ISE

Press Release

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Fraunhofer ISE develops new photovoltaic technologies

New concepts for n-type silicon solar cells with great efficiencies

Researchers at the Fraunhofer Institute for Solar Energy Systems ISE have developed new methods and cell concepts for the manufacture of n-type silicon solar cells. As a result, higher efficiencies and power production levels are also possible for commercial solar cells. The prototype exceeded an efficiency of 23 %.

"Most commercial silicon solar cells are currently p-types," Fraunhofer ISE's group manager Dr. Martin Hermle explains the difference between the new technology and current products. "But the new n-type silicon used for the novel solar cell structures developed at ISE has better properties for photovoltaic electricity production, such as greater tolerance for most impurities. In practice, there are two options: either greater efficiency, or lower manufacturing costs because you can use less expensive silicon." In addition, p-type Czrochalski (Cz) silicon suffers from light-induced degradation, which does not occur with n-type silicon.

Silicon solar cells consist of two areas with different thicknesses for different conduction: n stands for negative, p for positive. The thicker layer, the substrate material, is considered the base and determines the cell's type – such as p-type for conventional solar cells. Such cells have a p-type base and a thin n-conductive layer – the emitter, or the charge carrier. In n-type solar cells, the emitter is p-doped, either through boron diffusion or the addition of aluminum.

For some time, experiments have been conducted on n-type silicon as a base material, but production technology was very complicated. For instance, the main problem in using n-type

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solar cells, in which the emitter is on the side facing the sun, was the passivation of the emitter, which was usually doped with boron. Such surfaces cannot be optimally passivated with conventional layers, such as silicon oxide SiO_2 or silicon nitride SiN_x. In collaboration with the Technical University of Eindhoven, the problem of front passivation was solved through the use of aluminum oxide Al_2O_3.

Jan Benick, who is working on his doctorate in the group for high- efficiency silicon solar cells, managed to develop a highly efficient cell process especially for n-type cells that uses boron diffusion to make the emitter; the efficiency is 23.4 % on 2x2 cm² – the highest efficiency ever reached for this cell type.

Christian Schmiga, project leader in the group for high-efficiency silicon solar cells, has also reached 18.2 % efficiency on 12.5x12.5 cm² by using much simpler process stages close to industry practice, including a screen printing process to apply the aluminum alloy emitter.

Fraunhofer ISE continues to further develop process technology for n-type solar cells so that industrially manufactured silicon solar cells can reach efficiency rates exceeding 20 % quickly.

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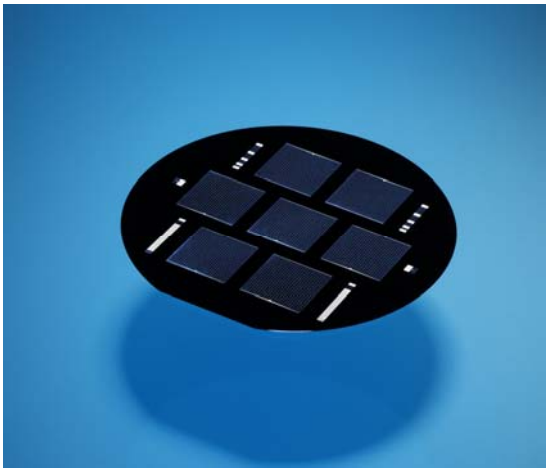

Four-inch wafers with seven highly efficient 4 cm² n-type silicon solar cells that reach efficiencies of up to 23.4%. Source: Fraunhofer ISE

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