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20 percent efficiency in sight for silicon solar cells processed at near-industry conditions

A team of researchers at the Fraunhofer Institute for Solar Energy Systems ISE has succeeded in reaching new peak efficiencies for large-area easy-to-fabricate silicon solar cells. Using more advanced cell structures, as compared to today's industry standard, they could demonstrate that efficiencies of 20 percent are realistic in the near future.

More than 80 percent of the solar cells manufactured today are based on crystalline silicon. The goal of industry and research is to further optimize the cost of silicon solar cells, the "workhorse" of photovoltaics. Currently, silicon solar cells convert an average of 14-19 percent of the incident solar energy into electricity. Researchers are already looking at the 20 percent efficiency mark. The transfer of these research results into the production arena, concurrent with rapid market development in Germany, will help even further to reduce the costs of photovoltaic electricity.

"Just now, we were able to conclude several areas of development work on crystalline silicon solar cells. The results that we achieved belong to the best in the world," explains a visibly pleased Christian Schmiga, project leader for high efficiency silicon solar cells at Fraunhofer ISE. The investigated cell structures distinguish themselves in the type of silicon material, the so-called base, and in the type of emitter, a thin layer which collects the electrical charge carriers. Solar cells with a negatively conducting base are referred to as n-type and those with a positively conducting base as p-type cells. The emitter always has the inverse polarization of the base. "For processing the emitter layer, we used three different procedures as follows: aluminum alloying and boron diffusion for the p-emitter layer of our

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n-type solar cells and phosphorous diffusion for the n-emitter layer of our p-type solar cells," says Christian Schmiga.

For an n-type silicon solar cell with aluminum-alloyed emitter, the researchers reached a record efficiency of 19.3 percent. To form the emitter, they screen-printed a paste containing aluminum, followed by a short high-temperature firing step. Also for an n-type silicon solar cell, but rather with a boron-diffused emitter whose surface was passivated with an additional, new layer of aluminum-oxide (Al_2O_3), Armin Richter, Ph.D. student at Fraunhofer ISE, demonstrated an efficiency of 19.6 percent. As a further important result for p-type solar cells with phosphorous-diffused emitter the scientists achieved 19.6 percent efficiency using the laser-fired contact (LFC) technology, developed and patented by Fraunhofer ISE. All solar cells were processed on 125 x 125 mm² monocrystalline silicon wafers. A big advantage is that no additional adjusting or structuring steps were necessary, thus both simplifying and accelerating the processing procedure.

Fraunhofer ISE has been developing novel high-efficiency silicon solar cells for almost 30 years. In consideration of the newest results from the researchers in Freiburg, the large-scale production of silicon solar cells with efficiencies of over 20 percent can be expected in the near future.

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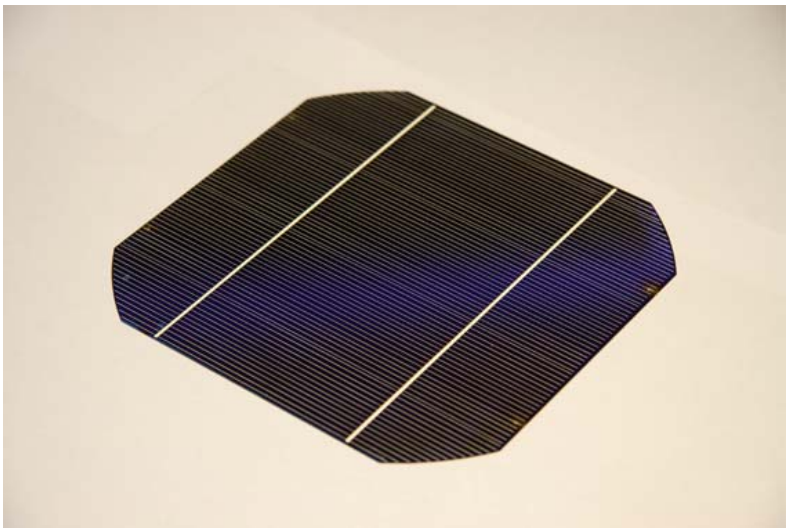

Crystalline silicon solar cell with 19.6 percent efficiency manufactured under near-industry conditions. ©Fraunhofer ISE

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