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Press Release

New Silicon Solar Cell Concepts for Improved Efficiency

Researchers at Fraunhofer ISE Achieve Efficiencies over 20 % Using Screen Printing Technology

In order to reduce the cost of solar electricity, Fraunhofer ISE is working hard on increasing solar cell efficiency. Their goal is to convert as much sunlight as possible into electricity using new solar cell concepts based on industrial-level production processes. Especially for silicon solar cells, industry-tested processes, like screen-printing, combined with new cell architecture, such as back contacts, holds enormous potential for increasing efficiencies and lowering costs at the same time. At the Photovoltaic Technology Evaluation Center PV-TEC of the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, researchers have been pressing ahead to explore such new concepts for several years now. For back-contact silicon solar cells, efficiencies up to 20.2 % have been achieved. "We are very pleased to present these excellent results upon the fifth anniversary of PV-TEC. The results demonstrate, that silicon photovoltaics is still in the steep part of the learning curve," says Dr. Daniel Biro, project leader.

For the so-called **MWT-PERC solar cells**, two different approaches for increasing efficiency were applied. In the Metal Wrap Through (MWT) concept for solar cells, the external front-contacts are transferred to the backside of the solar cell. As a result, more sunlight is incident on the front surface and the solar cell efficiency increases. In the Passivated Emitter and Rear Cell, or PERC, concept, both the optimized reflection of the solar cell backside as well as passivation of the rear surface contribute to higher efficiencies. The screen-printed aluminum back-contact is

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connected to the p-type silicon material using local laser alloying – the so-called Laser Fired Contact (LFC) process. Just recently, PV-TEC at Fraunhofer ISE manufactured large-format PERC solar cells (edge length 156 mm, with solder contacts on the backside) from monocrystalline Czochralski silicon with efficiencies reaching 19.3 %.

Decisive for even higher efficiencies is the reduced amount of shading that is gained through the MWT concept. For the MWT-PERC solar cells produced, the efficiency increased up to 19.4 %. Through the use of high quality float-zone silicon material, the Fraunhofer researchers increased the efficiency even further to 20.2 % – the highest efficiency measured up to now for large format solar cells manufactured with cost-effective and industrially applicable screen printing, diffusion and thermal oxidation processes. The edge length of the solar cells corresponds to the original wafer size of 125 x 125 mm^2. Solder contacts of both polarities are located on the backside and used for connecting the cells in the module. The know-how for manufacturing MWT-PERC solar cells is already being transferred to several German solar cell manufacturers.

The PV-TEC team also achieved efficiencies of 20.0 % for **Back-Contact Back-Junction (BC-BJ) solar cells** based on n-type monocrystalline float-zone silicon material. The development could be substantially accelerated by the excellent cooperation with Fraunhofer ISE's ETAlab. Presently this type of solar cells has an aperture area of 37 x 45 mm^2, however, all of the used technologies can be transferred to the production of larger formats. BC-BJ solar cells not only have both polarities located on the backside, as in MWT-PERC solar cells, but also the emitter. Thus, the shading losses on the front side can be reduced even further. This results in a very high efficiency and an enormous cost saving potential. For this solar cell concept, both the metallization with Al-alloyed emitter as well as the structuring steps are carried out exclusively with screen-printing technology. "For

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us, it is especially relevant that the Al-alloyed emitter has such a high potential. We still see many possibilities here to further increase the efficiency," says Robert Woehl, Ph.D. student at Fraunhofer ISE.

Both types of solar cells were produced using the industry-level equipment available at PV-TEC (www.pvtec.de). The cell efficiencies were confirmed by the certified solar cell calibration laboratory CalLab PV Cells. "With these results, an important milestone in cost savings has been reached. Remarkably high solar cell efficiencies of over 20 % have been achieved using the established industry-level production technology," states Dr. Ralf Preu, Division Director of PV Production Technology and Quality Assurance and Chief Manager of PV-TEC. "The public funding received from the federal government and the European Union together with our close cooperation with manufacturers of solar cells, production systems and materials have enabled this path-breaking success."

Both solar concepts will be presented at **SiliconPV – 1st International Conference on Silicon Photovoltaics** (www.siliconpv.com) from 17-20 April 2011 in Freiburg, Germany.

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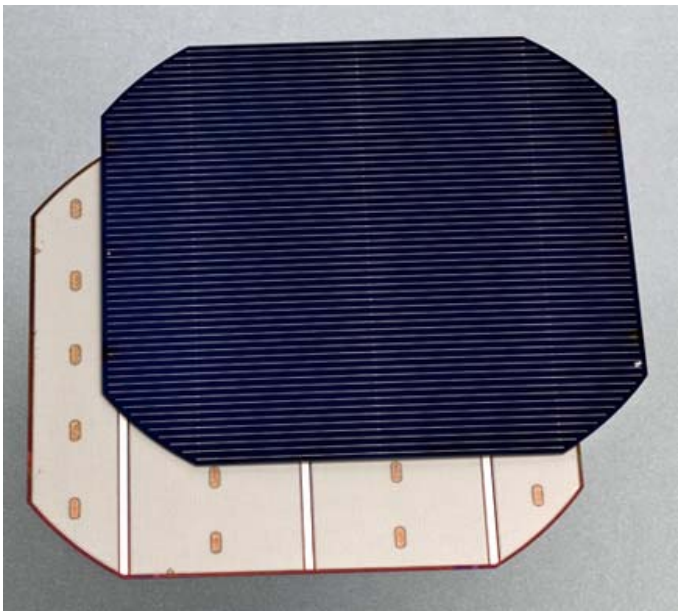

Large-format screen-printed metallized p-type silicon MWT-PERC solar cell with 20.2 % efficiency – manufactured at the PV-TEC Fraunhofer ISE. ©Fraunhofer ISE

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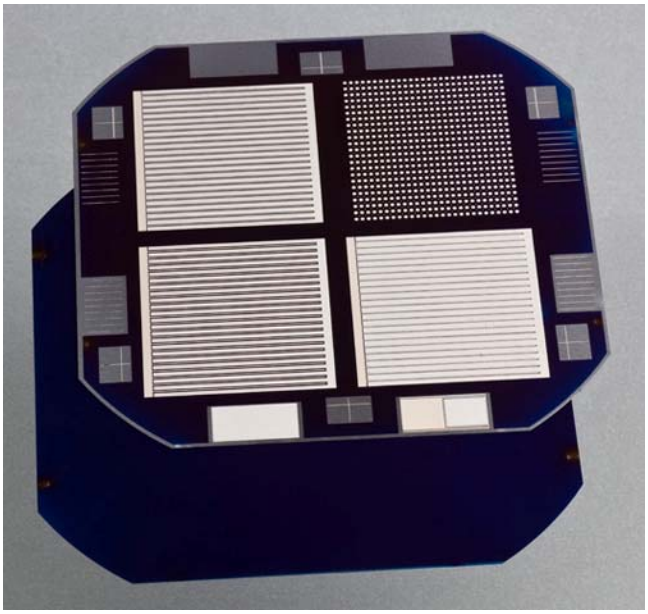

n-type silicon wafer with four BC-BJ solar cells featuring screen-printed contacts and Al-alloyed emitter reaching efficiencies up to 20.0 %, manufactured at PV-TEC Fraunhofer ISE. ©Fraunhofer ISE

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