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Press Release

Scientists in Freiburg Optimize Efficiency and Costs of PV Modules

New Technology Center at Fraunhofer ISE Builds Bridge to PV Industry

On the way from the solar cell to the solar module, the output efficiency decreases. Optical losses occur in solar modules due to the increase in inactive area, reflection on the glass surface and absorption in the top coatings. In addition, there are electrical losses due to series resistance in the cell and string connectors. Gains through encapsulation effects can not compensate for these losses, so that module efficiencies lie about 10-15 % below cell efficiencies. Based on a standard-sized PV module priced at 1.60 €/Wp, these losses amount to approximately 50 €. Putting the focus on minimizing these losses and improving the efficiency, Fraunhofer ISE has set up the Module Technology Center (MTC) which cooperates closely with the photovoltaic industry.

The new Photovoltaic Module Technology Center (MTC) in Freiburg offers a wide range of platforms for processing and analyzing solar modules. This infrastructure enables comprehensive product development, process development and material qualification. With this center, Fraunhofer scientists can now take their developments directly from the laboratory to production scale by turning out significant module quantities and formats. For investigating and optimizing the soldering processes as well as its compatibility with new solar cell types, the researchers have set up various experimental solder platforms. By being able to precisely control the soldering process, high-resolution parameter studies can be performed. A fully automated tabbing and stringing machine serves as a reference for the process development and string patterning. For fabricating the

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modules, a laminator with a useful area up to 1700 mm x 1000 mm is available.

Through the comprehensive characterizations, which are carried out throughout all manufacturing steps, the optimization of all products and processes is targeted. Upon entry, we first carry out investigations on the materials looking specifically at the cells, cell connectors, coatings and glass plates. The quality of the cell joint can be checked by means of wettability investigations, peel tests, metallographic cross-sections, accelerated aging tests and high resolution (100 nm) x-ray images. By means of step-wise characterization, the efficiency and integrity of the cell can be measured starting from the point of arrival through the stringing and encapsulating processes up to the module after it has undergone the accelerated aging tests. Thus, the sources of error can be located and minimized.

The experimental methods used in the center are supplemented by a range of computer simulation tools which include finite element analyses as well as analytical models. With such models, the scientists can investigate the mechanical stress, electrical losses and the optical efficiency of the module construction. The differentiated analysis of profit and loss factors in solar modules has been shown to be especially advantageous for reaching our goals.

"In our R&D work over the past few months, we have succeeded in constructing a PV module with dimensions of 1592 mm x 962 mm and an efficiency of 15.2 %, made up of sixty commercial solar cells having a nominal efficiency of 16.0 %. Only 5 % of the initial solar cell efficiency was lost," says Dr. Harry Wirth, Director of the Division Photovoltaic Modules, Systems and Reliability. The cells used in the module are commercial multicrystalline silicon solar cells of the type installed today on the gigawatt scale in PV power plants. Decreasing the losses in efficiency was achieved through a combination of measures. Using a narrower

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module border with a special edge encapsulation reduced the amount of inactive area. Additionally, the optical and electrical efficiency were improved. The precision measurement of the optimized module was carried out at the accredited CalLab PV Module at Fraunhofer ISE with a relative accuracy of ±2.3 %. "Our next goal is to reduce the losses in efficiency from the cell to module level by half, i.e. to a value of 2.5 %," states Wirth.

The Photovoltaic Module Technology Center (MTC)

The Photovoltaic Module Technology Center has been realized with the support of the German Federal Ministry for the Environment, Conservation and Reactor Safety (BMU). The center offers manufacturers of cells and modules a unique range of services for module qualification. System manufactures can expect support in the process development. In optimizing their products, module manufacturers can make use of the expertise of scientists and engineers. MTC closes the gap between laboratory development and industrial production technology by facilitating the processing of large quantities and formats. Customers and project partners profit from both the close proximity and cooperation with other research and testing centers available at Fraunhofer ISE. For example, solar cells produced at the Photovoltaic Technology Evaluation Center (PV-TEC) can be assembled into PV modules and subsequently tested at the TestLab PV Modules.

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PV module (1592 mm x 962 mm) with an efficiency of 15.2% made from sixty solar cells. Using efficient module technologies, scientists at Fraunhofer ISE were able to reduce the losses in efficiency from the cell to the module level to only 5%.
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View of the Photovoltaic Module Technology Center (MTC) at Fraunhofer ISE
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