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Stacked Perovskite/CIGS Solar Module Achieves Unprecedented Efficiency at 17.8 Percent

Scientists from Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (Centre for Solar Energy and Hydrogen Research, ZSW), Karlsruhe Institute of Technology (KIT) and imec (partner in Solliance and EnergyVille) have fabricated a thin-film solar module stack made up of perovskite and Copper Indium Gallium Selenide (CIGS) with a conversion efficiency of 17.8 percent. For the first time, this tandem module surpasses the highest efficiencies of separate perovskite and CIGS modules.

The stacked module (3.76cm²) implements a fully scalable device concept: both the perovskite top module and the CIGS bottom module feature a monolithic interconnection scheme, using seven and four module cell stripes respectively. The result is a reduction of area loss of less than eight percent for both technologies.

The consortium's process for creating this efficient perovskite/CIGS multi-junction solar module relies upon efficient exploitation of the solar spectrum. The higher energy part of the spectrum is harvested in the semitransparent perovskite module on top, while the light with lower energy passes and is harvested in the bottom CIGS cell. As a result, the prototype shows an unprecedented power conversion of 17.8 percent, which outperforms the world-record upscaled perovskite module of 15.3 percent efficiency presented by imec, and also the highly-efficient stand-alone upscaled CIGS module of ZSW with efficiencies nearing 15.7 percent.

"This result was achieved through close and intricate collaboration leveraging the expertise of the three partners. Imec's expertise in perovskite technology was underscored by the use of a perovskite top module in these stacked solar modules," stated Dr. Tom Aernouts, head of thin-film PV research at imec.

According to Dr. Ulrich Paetzold, head of the research group at KIT, this result is just a starting point, with more exciting results to come in the next years such as perovskite/CIGS multi-junction solar modules surpassing efficiencies of 25%. The Helmholtz Young Investigator group of Dr. Paetzold is focusing on the optics in multi-junction perovskite solar modules and will develop further specialized nanophotonic materials for these devices.

Finally, ZSW contributed with its world class expertise in CIGS solar modules. ZSW holds the current world record for CIGS solar cells at 22.6%. Prof. Dr. Michael Powalla, member of the board and head of the Photovoltaics Division at ZSW, points out: "This success is an elegant way of combining the advantages of two highly advanced

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thin-film technologies. It will contribute greatly to ever more cost-efficient solar power for the customer.”

The module and technical details were presented to the research community at the PSCO-2016 in Genova, Sept. 27 by Dr. Tom Aernouts, imec; Dr. Ulrich Paetzold, KIT; and Dr. Erik Ahlswede, ZSW.

The Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (Centre for Solar Energy and Hydrogen Research Baden-Württemberg, ZSW) is one of the leading institutes for applied research in the areas of photovoltaics, renewable fuels, battery technology, fuel cells and energy system analysis. There are currently around 230 scientists, engineers and technicians employed at ZSW's three locations in Stuttgart, Ulm and Widderstall. In addition, there are 90 research and student assistants.

Karlsruhe Institute of Technology (KIT) pools its three core tasks of research, higher education, and innovation in a mission. With about 9,300 employees and 25,000 students, KIT is one of the big institutions of research and higher education in natural sciences and engineering in Europe.

Imec performs world-leading research in nanoelectronics and photovoltaics. Imec leverages its scientific knowledge with the innovative power of its global partnerships in ICT, healthcare and energy. Imec delivers industry-relevant technology solutions. In a unique high-tech environment, its international top talent is committed to providing the building blocks for a better life in a sustainable society. Imec is headquartered in Leuven, Belgium, and has offices in Belgium, the Netherlands, Taiwan, USA, China, India and Japan. Its staff of about 2,500 people includes about 740 industrial residents and guest researchers. In 2015, imec's revenue (P&L) totaled 415 million euro.

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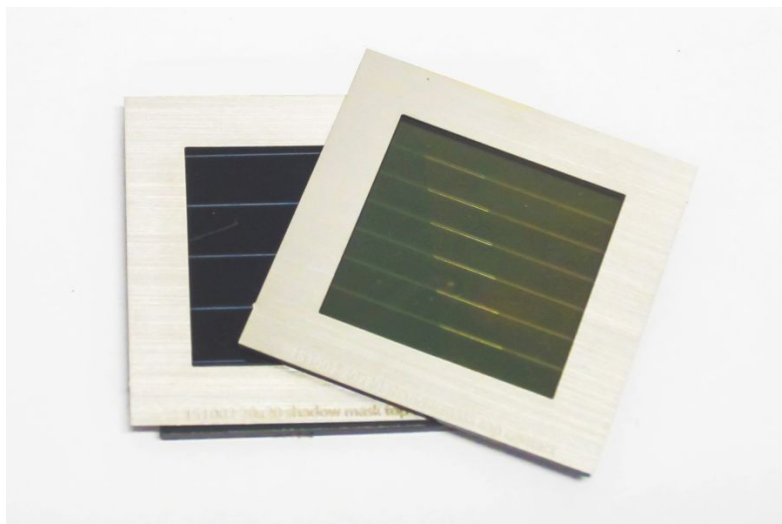
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Pictures and a fact sheet on ZSW are available from:

Solar Consulting GmbH



The two thin-film modules of the highly efficient stack: CIGS below, perovskite on top.

Photo: ZSW/KIT/imec

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