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Press Release

Where there is light, there is shade

How known weaknesses in measuring equipment can cancel the strengths of new production technologies.

As a consequence of the improvements achieved in the mass production of solar cells enabling a higher yield of sunlight, the necessity for more precise measuring equipment has arisen to reproduce this light. This is because powerful artificial suns such as e.g. Xenon flashers also have their shady sides: compared to the normed Standard Test Conditions (STC) according to IEC 60904-3 they show significant deviations in the lower and upper range of the spectrum (Fig. 1). They are, however, still being used for quality assessment in cell and module production lines.

The fluctuations between measuring equipment lamps and the norm have been known for a long time. For example an analysis carried out in 2009 by the Fraunhofer institute for solar energy systems (ISE)[1] in cooperation with major German cell manufacturers and suppliers of measuring technologies brought the physical causes of incorrect measurements in cell and module manufacture to light, hereby naming the *Spectral Mismatch* as a critical factor[2].

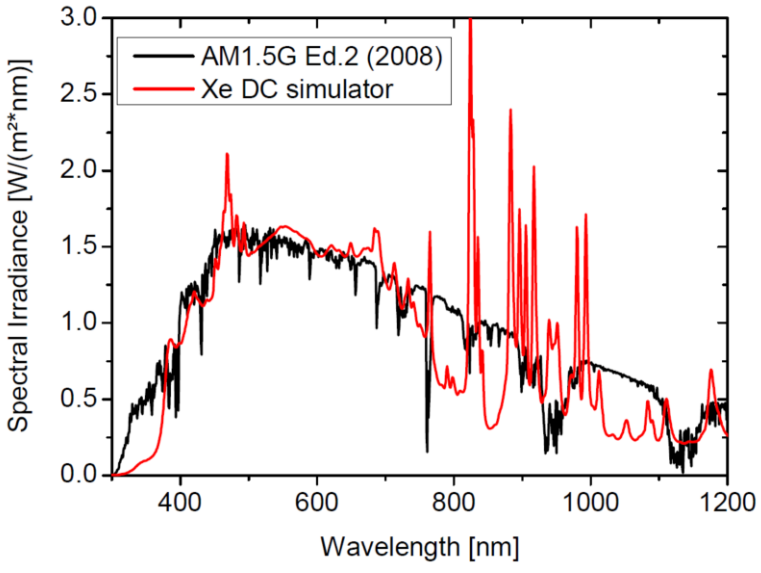

Fig. 1 Spectral Mismatch, ISE 2009[2]

The illustration clearly shows the shady sides of artificial suns: deficits of a xenon simulator in the range under 400 nm and extreme fluctuations in the range over 800 nm, compared to normed sunlight.

The industry is well advised to take the topic of *Spectral Mismatch* seriously, as becomes evident in the example of selective emitter etching. This young technology which has already roused considerable interest among cell producers, achieves promising efficiency gains of up to 0.8% in the light spectrum under 450 nm. As standard measuring equipment can hardly stimulate the solar cell in this range, efficiency gains remain practically negligible.

[1] Fraunhofer institute for solar energy systems ISE, www.ise.fraunhofer.de
[2] Warta, W. et al (2009). Precise Measurement of Solar Cell Performance in Production. Presentation at the PVSEC in Hamburg.

If cell manufacturers are not aware of the technical limits of their measuring equipment, this can be fatal. Process engineers must then assume that the "lost" efficiency increase is due to a lacking passivation of the selectively etched emitter layer because in particular the electron-hole pairs generated by short-wave light in the emitter have the tendency to recombine very quickly, and thus require a reliable passivation. This is controlled by the thickness of the silicon nitride layer (SiN layer). This means that the thickness of this layer is adapted to achieve a maximum short circuit current - subject to the measuring equipment used. However, a very recent, as yet unpublished joint research project carried out by the University of Konstanz and the Schmid Group who have been studying the effects of the *Spectral Mismatch* in actual practice, shows that the improvement achieved in this way under artificial sunlight constitutes a worsening of the measurements taken under normed sunlight.

Dr. Helge Haverkamp, research director in the Photovoltaic sector of the Schmid Group and Dr. Christian Buchner, director of the Schmid Group's CELL business sector, are now focusing on passing this information on to cell manufacturers: ideally the efficiency of the measuring equipment should be improved in the range of under 450 nm down to far into the ultraviolet range, which currently involves very high costs. They strongly recommend that cell manufacturers who choose to continue to use standard equipment until these high prices are reduced, take a close look at the weakness of their measuring equipment and do not fail to have reference cells measured in a calibration laboratory.

As "best practice" Dr Buchner mentions the introduction of Schmid technologies for the production of cells with the selective emitter in a combined printing and etching process (see box) at Sunrise Global Energy (Taiwan)[3]. With the easily integrable Schmid equipment, Sunrise is successfully producing high-efficiency cells in a 60 MW line and has already ordered further equipment for the second half of 2011. The efficiency increase achieved by Sunrise and the high-level reduction of production costs were however only possible because

Selective emitter technology of the Schmid Group

The Schmid Group is a worldwide technological market leader and supplier of system and process solutions, inter alia for the production of solar wafers, cells and modules. Their product portfolio ranges from individual equipments to turnkey production lines with guaranteed output parameters such as production capacity and efficiency in the wafer, cell and module sectors.

The easily integrable systems by Schmid for the production of cells using the selective emitter are already successfully in operation. By the end of 2011 the Schmid Group anticipates an installed capacity of 5.5 GW of their equipment worldwide.

The SE Jet is a highly precise ink-jet printer which applies the wax mask for the selective emitter contact-free with a precision of ± 7 micrometers. Subsequent inline wet processes for back-etching the emitter and stripping the wax mask are a further development of the Schmid Group's reliable process and system technologies.

The advantages of this combined printing and etching process are the gentle treatment of the cells, high accuracy and process stability as well as low investment and running costs.

[3] www.sunriseglobalsolar.com

the cell manufacturer invested specifically in their measuring equipment and ensures this is consistently and correctly calibrated.

The effects of *Spectral Mismatch* applicable to the technology of selective emitter etching, apply in a similar way to the improvements achieved through dielectrically passivated and reflected rear sides, which promise a higher output of the upper range of the sun spectrum and do not stop at module production either. With their processes in module production, the Schmid Group shows that only consistent calibration and the use of suitable standard materials for encapsulation ensure the efficiency gains of the selective emitter, also in the module.

Because manufacturers of solar cells and modules do not want to forfeit these very promising new technologies, we can now hope that in the mass production of both products, not only further improvements but also new, normed sunlight will soon shine.

CFK/Schmid Group

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