

In-line Analysis and Process Control in Wet Chemical Texturing Processes for Solar Applications

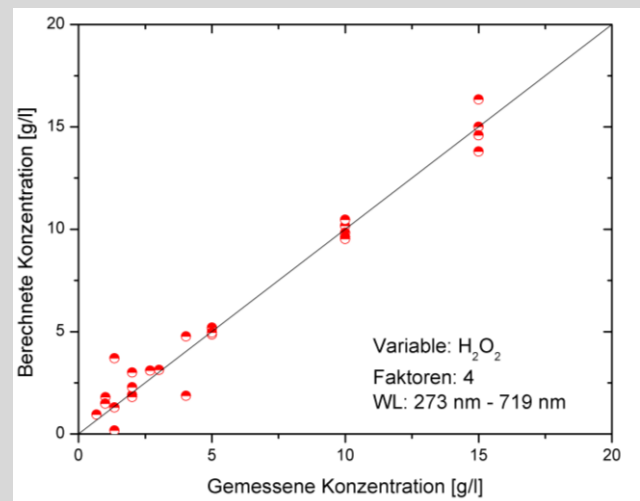
Acidic etching is a widely used texturing process in solar cell fabrication. For many applications liquids like HF, HNO₃, H₂SiF₆, HCl, H₂O₂, KOH and NaOH are used. In order to obtain reproducible results the concentration of the main components is essential. The use of UV/NIR spectroscopy allows a fast in-line analysis, which produces one datapoint per second. This is superior to widely used techniques, such as ion chromatography or titration with their corresponding measurement times of 6 to 10 minutes.

The MultiSpec system was integrated into a production process and used for the analysis of etching baths at a leading solar energy research institute.



Measurement Principle

The concentration of the main components can be determined by means of a UV/NIR spectrometer, an acid and leach resistant measurement probe and a calibration model. The spectrometer acquires a characteristic spectrum of the etching bath for different mixtures. Based on the acquired spectra, a calibration model incorporating multilinear regression is created which is used for data analysis during the inline measurements. The model operates independently from the number of components within the etching bath.



Measurement System

tec5 diode array spectrometer systems of the MultiSpec series are ideally suited for this application as they feature high dynamic range and excellent signal-to-noise ratio. The sensors are permanently calibrated and maintenance free. The systems short measurement times of

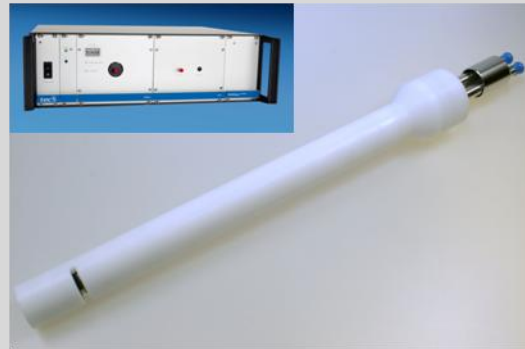
a few milliseconds allow in-line process analysis without delay due to time consuming analyzing techniques. The combination of UV and NIR wavelength ranges extends the number of constituents detectable and increases the achievable precision significantly.

Application Notes – MultiSpec System Vol. 40

A customized process dipping probe was developed by Hellma. The used materials Teflon and Sapphire withstand both acid and alkaline baths within a temperature range of 5 to 150 °C.

The MultiSpecPro software by tec5 is a powerful software solution for in-process measurements. The software is capable of detecting bubbles or particles and therefore producing continuously trustworthy measurement results without interference. In addition, chemometric models can be implemented, compatible to those created by Camo, Grams or SensoLogic. The resulting concentrations can be displayed and communicated by a variety of process interfaces (e.g. Profibus or OPC).

With an fiber-optical piezo multiplexer (FSM) a simultaneous measurement of up to 8 baths is possible. The described setup can be used both for process, as for laboratory applications. The creation of calibration models can be performed with the same setup that is used in the process.



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Since 1993 **tec5 AG** has been developing fiber-optic spectrometer systems based on diode array technology. Today, tec5 is operating worldwide with subsidiaries in the USA and UK and global representatives are positioned to better serve the market.

At tec5 we pair our core competencies in high speed diode array readout technology, optical, mechanical, electronic and software engineering with excellent customer support. Our high quality products range from standard OEM electronics modules to complete application specific solutions. In close cooperation with our customers, a multitude of applications have been successfully implemented in different industries.

We are proud to be at the frontend in the field of spectroscopy and to provide cutting edge technology – today and in future.

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Technology for Spectroscopy

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