Application Note AN N522

Control of Semiconductor Production Processes with FT-NIR

Semiconductors are today more than ever part of our daily lives. They are used as the base material for micro or computer chips which operate all of our modern technology. More and more consumer products are becoming "smart" like refrigerators, washing machines, heater etc. and for that they need to be outfitted with microcontrollers, circuit boards and computer chips. The demand of semiconductors is therefore increasing even further. Optimizing the production process and keeping out of spec production at a minimum is imperative to stay competitive.

NIR in combination with multivariate analysis is a perfect inline tool for various production steps of semiconductors to reach this goal. Typical semiconductor production steps where NIR can be used are:

- Cleaning solutions
- Etching solutions
- Photoresist development
- Photoresist stripping

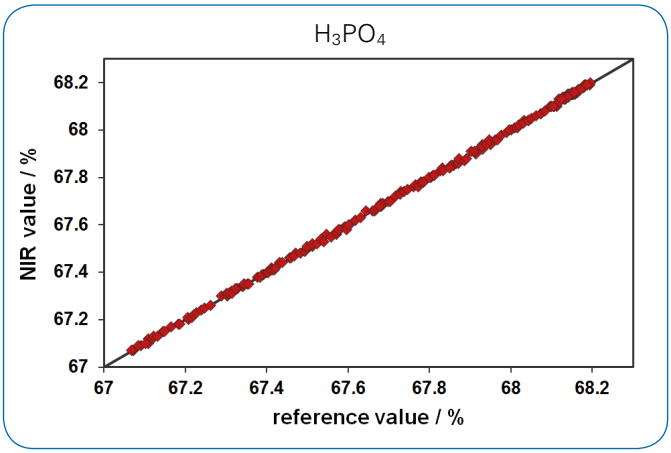
A NIR transmission probe is immersed inside a bath and light is transmitted from the spectrometer via a fiber optical cable to the probe and back to the detector. The distance between the sampling point and installed spectrometer can be more than 100 m. Due to high corrosive chemicals used for semiconductor productions the NIR probes are usually made of PTFE with a sapphire window guaranteeing a long life time in the process.

The advantage of using a Bruker's Matrix-F process spectrometer are:

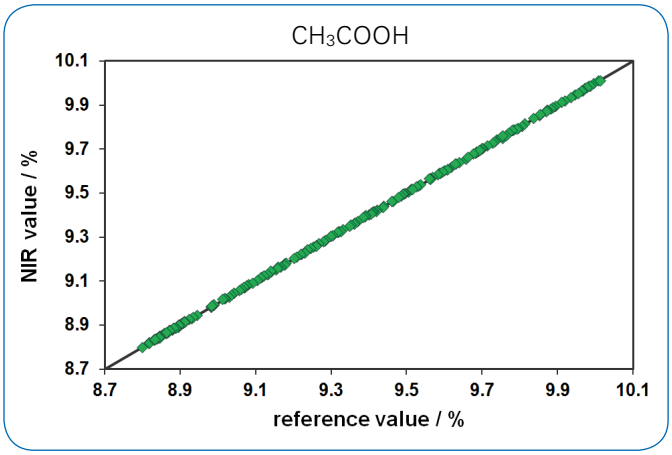
- No wet chemistry required
- Fast Measurement at up to 6 sampling points
- Multi-component analysis
- Process integration (remote triggering, monitoring, alarms)
- Long term stability
- Low maintenance
- Outstanding sales and after sales support

With an inline NIR solution there is no need to pump or transfer a hazardous sample to the analyzer and therefore reducing the risk of exposing the operators to it. The collected spectrum is evaluated and the results of several components are displayed on a screen. In addition the results can be transferred to a distributed control system (DCS) or programmable logic controller (PLC). Based on the information the operators can decide whether to exchange the cleaning or etching solution, or when to add specific components to it.

In addition to the NIR inline applications Bruker also offers FT-Raman microscopes for semiconductor quality control and material research.



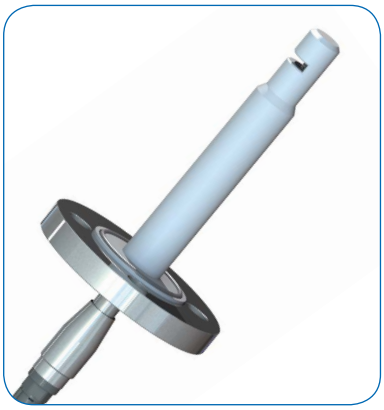
Cross validation results of a PLS based model for the online prediction of H_3PO_4 during the reaction



Cross validation results of a PLS based model for the online prediction of the CH_3COOH during the reaction

Parameters by FT-NIR:

- H_3PO_4
- Acetic Acid
- HNO_3
- H_2O
- HF
- HCl
- H_2O_2
- NH_4OH
- H_2SO_4
- Ethylene Glycol



Two examples of in-line fiberoptic probes made from PTFE for demading process conditions (left: Hellma Analytics, right: Solvias AG)

FT-NIR Spectrometers: Bruker Optics offers various FT-NIR spectrometer models for lab, at-line and on-line applications:

TANGO

Touch-screen operated FT-NIR analyzer for routine use in the lab and atline.

MPA II

Multi Purpose Analyzer for maximum flexibility with ease-of-use.

MATRIX-F

Process monitoring with probes and contact-less sensor heads.

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