Application Note
Semiconductor Industry

SCHMIDT HAENSCH

Monitoring KOH Concentration in Silicon Wet Etching

Continuous Inline Measurement for Stable Etch Rates and Improved Bath Utilization

Wet chemical processing is a key step in semiconductor and silicon-based microelectromechanical systems (MEMS) manufacturing. Potassium hydroxide (KOH) is widely used for anisotropic silicon etching, where the etch rate and resulting structures depend strongly on the chemical condition of the bath. Reliable control of KOH concentration and temperature is therefore essential for stable, repeatable etching.

KOH in Silicon Wet Etching

Etching with KOH is a wet-chemical process widely used in semiconductor manufacturing to create microstructures for MEMS. Typical KOH concentrations for silicon etching range from approximately 30 to 50%. KOH removes silicon in a crystallographically selective manner and is used in applications such as MEMS structures and deep silicon etching. During operation, however, the composition of the etching bath changes continuously. Hydroxide is consumed by the etching reaction, water can be lost through evaporation, and dissolved silicon species accumulate in the solution. These effects can shift the bath away from its defined operating point and influence the etch rate.

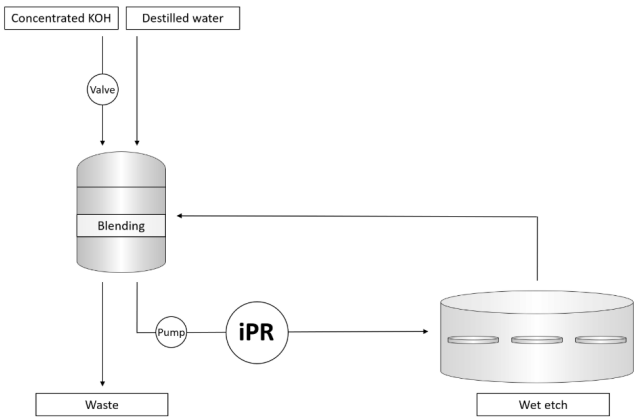
Why Continuous Concentration Monitoring?

Conventional offline analysis provides information only at individual sampling points. Changes occurring between samples may therefore remain undetected. Continuous inline monitoring makes the chemical condition of the bath visible in real time and enables deviations to be recognized earlier. This supports more consistent process conditions.
Continuous process measurement is already established in other semiconductor chemical applications. RI-based measurements have been applied for example to H_2O_2 concentration in CMP slurries, demonstrating the suitability of optical inline metrology for real-time monitoring of semiconductor process chemicals.

Refractive Index as a Process Analytical Tool (PAT)

The refractive index of a liquid changes systematically with its composition. By measuring both refractive index and temperature, an inline process refractometer can continuously determine the KOH concentration using an application-specific concentration scale. The inline refractometer measures directly in the circulating process liquid, providing continuous real-time information and eliminating the need to rely exclusively on manual sampling. The resulting signal can be transferred to the process control system for process trending, alarm functions or concentration control.

As silicon is etched, dissolved silicon species accumulate in the bath and can influence the measured refractive index. Combining refractive-index and temperature measurement with a process-specific calibration and suitable compensation for dissolved silicon therefore enables the measurement to reflect the actual bath condition more accurately. Continuous monitoring can consequently support controlled replenishment, improved bath utilization and more reproducible etching conditions, while reducing the dependence on periodic laboratory measurements and allowing deviations from the target concentration to be detected at an early stage.



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Solution from SCHMIDT + HAENSCH

Using the **SCHMIDT + HAENSCH iPR S Inline Process Refractometer** for semiconductor industry provides a reliable solution for continuous KOH concentration monitoring directly in the silicon wet-etching process. Designed for demanding semiconductor applications, the refractometer continuously measures the refractive index and temperature of the etching solution, providing real-time information on bath condition without relying solely on periodic laboratory sampling. By integrating the refractometer into the KOH circulation loop, process operators gain immediate insight into concentration changes caused by etching, evaporation, dilution, or replenishment. With an application-specific scale for dissolved silicon, deviations from the defined process conditions can be detected at an early stage. The measurement signal can be integrated into the process control system to trigger alarms or initiate corrective actions, helping to maintain stable KOH concentration, improve bath utilization, and ensure reproducible etching conditions and consistent wafer quality.



Product type	Product
Process Refractometer	**iPR S** Inline Process Refractometer

Advantages

- Continuous, real-time monitoring of KOH etching solutions
- Fast detection of concentration changes and process drift
- Supports stable and reproducible silicon wet-etch conditions
- Application-specific temperature compensation
- Reduced dependence on manual sampling and offline analysis
- Supports optimized KOH replenishment and bath management
- Potential for longer utilization of etching chemistry and reduced chemical waste
- Immediate process information for alarms and control functions
- Supports improved process consistency and wafer quality

Typical industries

- Semiconductor manufacturing
- Anisotropic silicon wet etching
- Deep silicon etching
- Semiconductor wet benches
- KOH bath monitoring
- Chemical distribution and recirculation systems
- Process development and etch-bath optimization

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