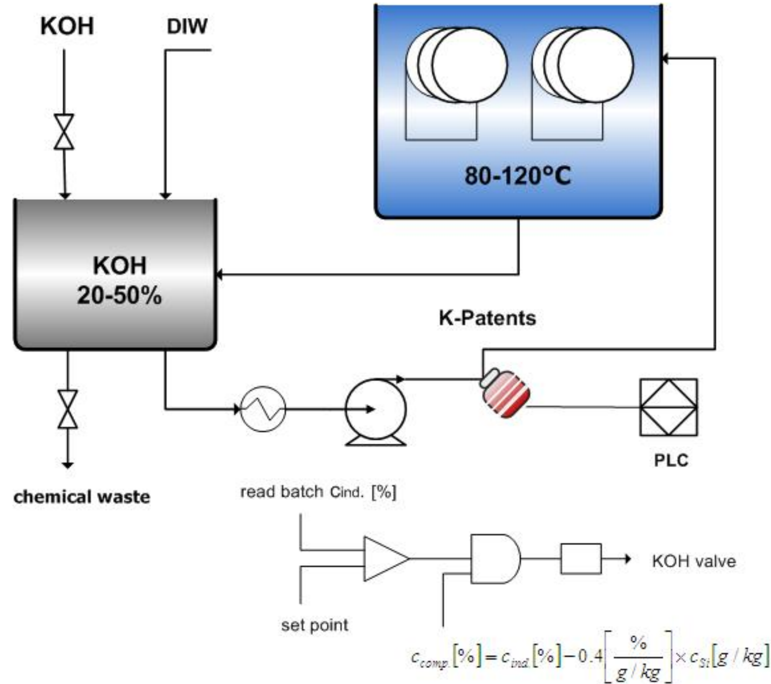
ANISOTROPIC ETCH OF SILICON

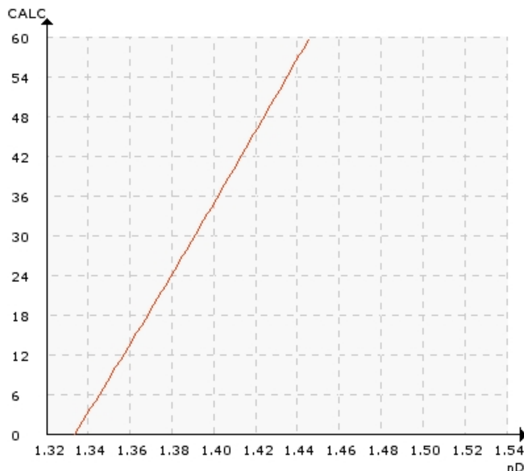


KOH ETCH OF SILICON

Typical end products

Semiconductors, MEMS (microelectromechanical systems), micromachines, silicon wafers

Refractive Index of Potassium hydroxide KOH:



PROCESS

Wet etching is used to chemically remove layers (metal, silicon, photoresist) from the surface of a wafer during manufacturing. Etchants that erode the substrate equally in all directions are called isotropic. Modern processes prefer anisotropic etches because they produce sharp, well-controlled features. Several anisotropic wet etchants are available for silicon. For instance, Potassium hydroxide (KOH) is commonly used for this purpose, especially in the MEMS processing.

APPLICATION

The etch rate of silicon in a KOH bath depends on the bath temperature and the KOH concentration. As etching progresses, some KOH (namely OH^- ions) is consumed in the process.

A K-Patents Semicon Refractometer gives a real-time indication of KOH concentration and helps to determine the correct etch end point. This way the bathlife can be increased and wafer scrap and chemical waste can be minimized. In some cases the KOH bathlife can even be doubled.

INSTALLATION

The K-Patents Refractometer is installed inside an etch cabinet in a circulation line prior to an etch bath and right after a pump. Typical KOH concentration is 30-50% and the process temperature 80-120°C (can be up to 160°C for

heated KOH etching). The sensor can be installed in a vertical or in a horizontal pipe line. The sensor should be mounted in the horizontal axis position. K-Patents recommends a minimum flow velocity of 1.5 m/s (5 ft/s).

COMPENSATION OF SILICATE

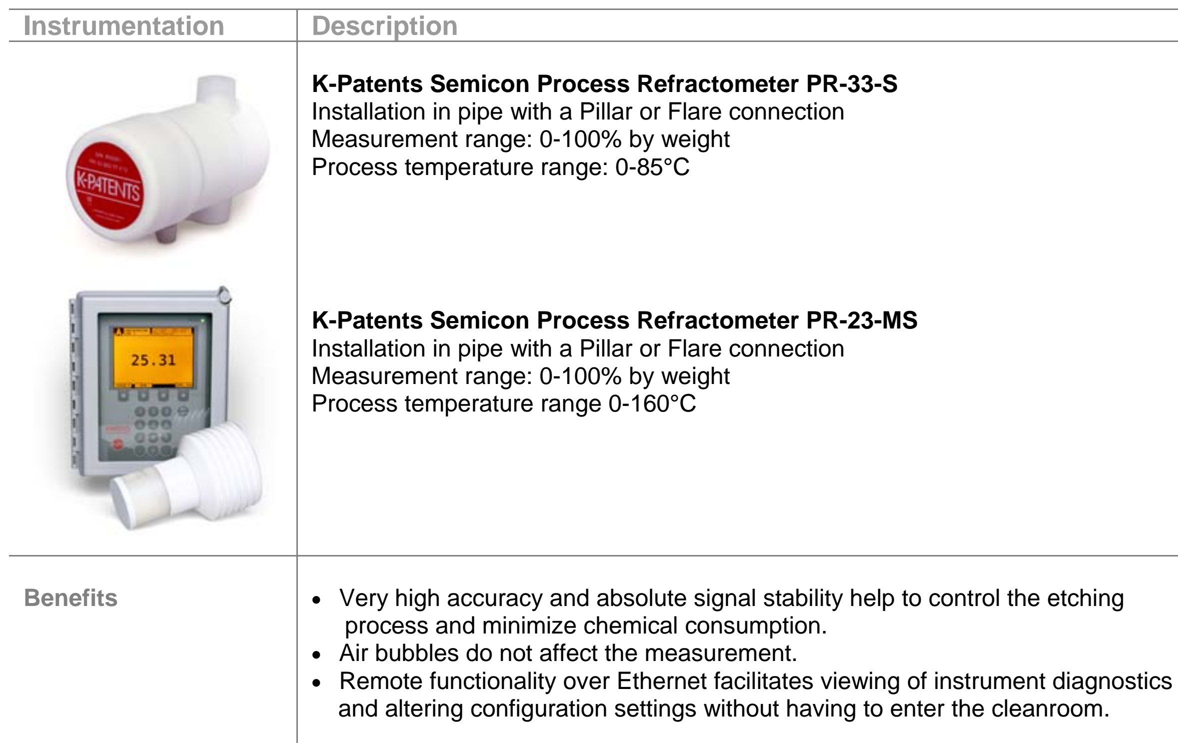
Refractive Index gives an indication of total dissolved solids. Etching of silicon using KOH in water forms a tertiary solution with dissolved silicate. The influence of Silicate needs to be compensated from the KOH concentration reading. K-Patents provides a method (patent pending) for compensating this in the refractometer output reading.

Dissolved Silicate increases the concentration reading. This offset can be compensated with K-Patents' simple balance calculation and without introducing any extra measurements.

The amount of potassium (K^+) does not change. The only two variables that change are:

- the amount of water (which may change due to evaporation and in the reaction),
- and the amount of silicon (which depends on the wafer design and etch depth). The amount of silicon can be estimated when the number and type of wafers etched in the solution are known.

The compensation factor can be implemented in the control system. The same phenomenon is seen when etching Silicon nitride with heated KOH.

Instrumentation	Description
	**K-Patents Semicon Process Refractometer PR-33-S** Installation in pipe with a Pillar or Flare connection Measurement range: 0-100% by weight Process temperature range: 0-85°C **K-Patents Semicon Process Refractometer PR-23-MS** Installation in pipe with a Pillar or Flare connection Measurement range: 0-100% by weight Process temperature range 0-160°C
Benefits	• Very high accuracy and absolute signal stability help to control the etching process and minimize chemical consumption. • Air bubbles do not affect the measurement. • Remote functionality over Ethernet facilitates viewing of instrument diagnostics and altering configuration settings without having to enter the cleanroom.