

CONCENTRATION
MONITORING OF
FAB CHEMICALS IN
CLEANROOM
ENVIRONMENTS

K-PATENTS
PROCESS INSTRUMENTS

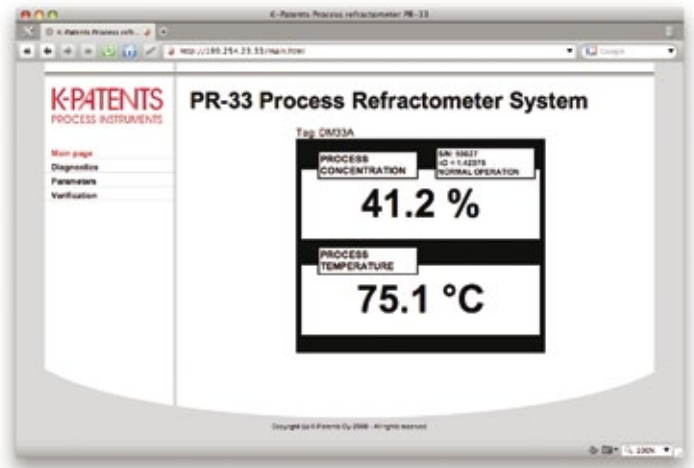


SEMICON PROCESS REFRACTOMETER PR-33-S

APPLICATIONS

K-Patents Semicon Process Refractometer PR-33-S monitors real-time the consistency of liquid chemical concentrations in the ultra-clean semiconductor fabrication processes and integrated process tools. Typical uses of the K-Patents PR-33-S include:

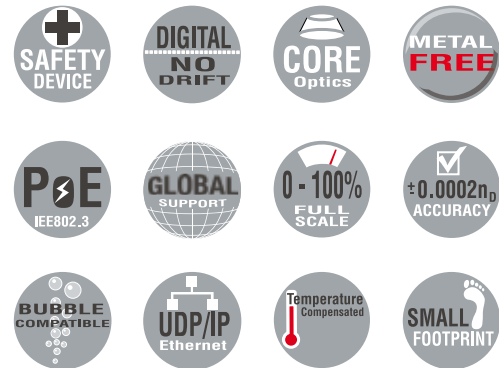
- Preventing wrong chemicals or wrong concentrations from entering the process tool or the wet bench and thus helping to prevent expensive equipment damage and wafer scrap.
- Assisting in optimizing the etch process and in increasing the bath life of the etch solution.
- Increasing wafer throughput typically by up to 20%, and reducing cleaning chemical (e.g. EKC-265) consumption in the post etch polymer removal.
- Helping to achieve tight control of CMP slurries and better uniformity of the planarization process.



MONITORED CHEMICALS

Acetic acid CH_3COOH , Acetone CH_3COCH_3 , Ammonia NH_4OH , Ammonium fluoride NH_4F , Ammonium hydroxide NH_4OH , Ammonium sulphate $(\text{NH}_4)_2\text{SO}_4$, Citric acid $\text{C}_6\text{H}_8\text{O}_7$, Chromic acid CrO_3 , Dilute Hydrofluoric acid DHF, Ferric chloride FeCl_2 , Formic acid HCO_2H , Hydrofluoric acid HF, Hydrochloric acid HCl, Hydrogen peroxide H_2O_2 , Isopropylalcohol IPA, Lactic acid $\text{CH}_3\text{CHOHCOOH}$, Magnesium chloride MgCl_2 , Nickel chloride NiCl_2 , Nitric acid HNO_3 , Phosphoric acid H_3PO_4 , Potassium hydroxide KOH, Sodium chloride NaCl, Sodium hydroxide NaOH, Sulphuric acid H_2SO_4 , Tetramethyl-ammonium hydroxide TMAH $(\text{CH}_3)_4\text{NOH}$, etc.

Customized applications upon feasibility study.



SEMICON PROCESS REFRACTOMETER PR-33-S

REAL-TIME MONITORING

K-Patents is a company specialized in in-line liquid concentration measurements. K-Patents has over 30 years of experience in supplying digital refractometers for thousands of industrial applications around the world.

K-Patents Semicon Process Refractometer PR-33-S is designed specifically for the cleanroom environments and integrated process tools in the semiconductor industry.

The PR-33-S monitors real-time the chemical concentrations and provides an Ethernet output signal and immediate feedback, if the chemical is not within the specifications. For example, low and high concentration alarms can be configured to increase bath life of costly chemicals and decrease the wafer scrap.

The concentration is determined by making an optical measurement of the solution's refractive index n_D and temperature. The advantage of this principle is that the same instrument can be used to measure any chemical.



Our extensive representative network offers technical support and field service in all industrialized countries worldwide.



No sampling or handling of hazardous chemicals in the laboratory. Better environmental performance and chemical waste management.

DRIFT-FREE CALIBRATION

K-Patents PR-33-S has no calibration drift and needs no maintenance, adjustment or recalibration over time.

The sensor is factory calibrated to measure refractive index n_D and temperature T in standard units. Each sensor has identical calibration $n_D=1.32...1.53$ (corresponding to 0-100% b.w.).

Because the sensors have identical calibration and each sensor gives Refractive Index n_D and temperature as output, the same instrument can monitor all kinds of liquid chemicals. Also all sensors can be freely interchanged without optical calibration or parameter changes.

Each sensor comes with a calibration certificate comparing a set of standard liquids to the actual sensor output. The calibration and accuracy can be easily verified on-site with certified refractive index liquids.



Fully digital instrument: No calibration drift and no maintenance, adjustment or recalibration over time.



Full measurement range n_D 1.3200...1.5300 (equals to 0-100% by weight).



Accuracy is $\pm 0.0002 n_D$ which corresponds typically to $\pm 0.1\%$ by weight, e.g. for HCl in water.

REMOTE FUNCTIONS

The PR-33-S consists of a Kynar® PVDF sensor and an Ethernet cable that any standard PoE switch can use for transmitting power to the sensor and data to a computer.

Via Ethernet it is easy to view real-time measurement data and diagnostics, and remotely alter instrument configuration settings without having to go to the cleanroom.



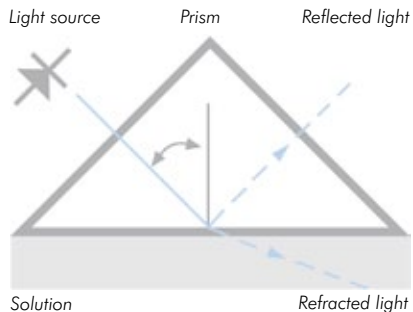
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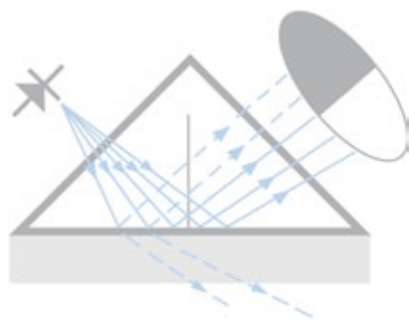
The communication is built on the standard UDP/IP protocols.

DIGITAL MEASUREMENT PRINCIPLE

The light source sends light against the interface between the prism and the process solution, where the rays meet the surface at different angles.

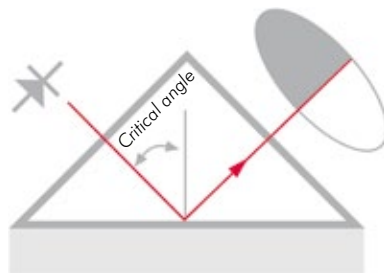


All rays coming to the surface below a certain angle, are totally reflected. The light coming to the surface at a higher angle is refracted into the process solution.



Thus an optical image with a dark sector and a light sector is created.

The angle corresponding to the shadow line is called the Critical Angle of Total Reflection. The Critical Angle is a function of the refractive index and hence the concentration of the solution.



A digital CCD-camera detects the optical image and the shadow line. The camera transforms the optical image point-by-point to an electrical signal. The exact shadow line position is located and converted to a reading in refractive index.

A built-in temperature sensor measures the temperature close to the interface of the process liquid. Then the refractive index and temperature are converted into concentration units.

A built-in diagnostics program ensures that the measurement is reliable.



The measurement is not influenced by particles, bubbles or impurities in the ppm range.



Fully automatic temperature compensation.

SENSOR MOUNTING

Vertical line



Horizontal line

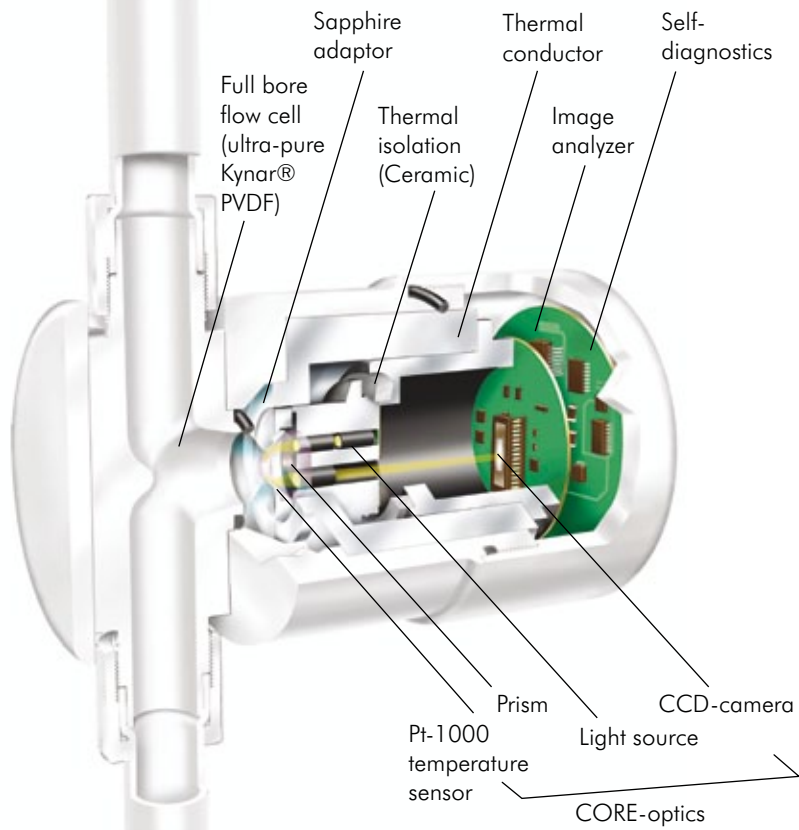


The PR-33-S has a compact metal-free construction that allows integration in a process tool or in an ultra-clean cabinet.



PR-33-S needs only a small footprint area.

DESIGN



K-Patents PR-33-S utilizes the patented CORE-optics (Compact Optical Rigid Element) module that is isolated from the sensor body. The CORE-optics protect the measuring components from any influence of pressure, flow or temperature changes.

(US Patent Nos. US6067151 and US6760098 B2, German Patent No. DE19855218).

