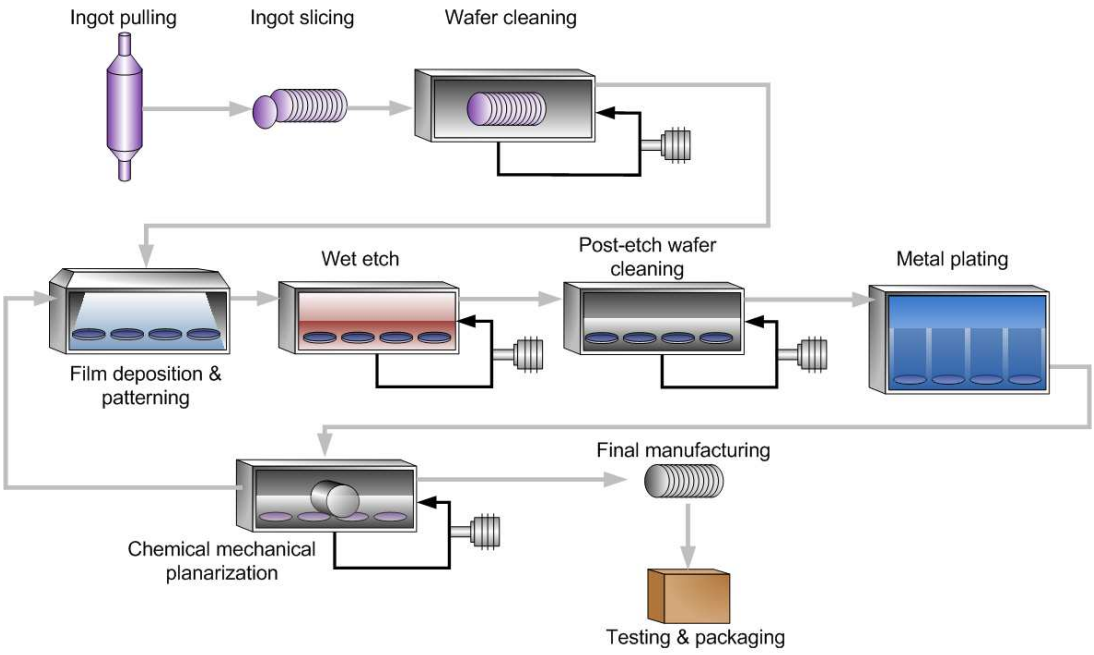

SEMICONDUCTOR WET CHEMICALS

Typical end products

Silicon wafers for semiconductors and microelectronics

Introduction

The K-Patents Semicon Refractometers PR-33-S/-23-MS are designed for real-time concentration monitoring of wet chemicals used in the silicon wafer fabrication. The K-Patents refractometer provides a continuous measurement signal (4-20 mA or Ethernet output), which offers many possibilities for real-time monitoring and process controlling. Due to the unique digital measurement principle there is no signal drift.

The main benefit of the real-time monitoring with the K-Patents refractometer is the potential yield improvement in the form of increased wafer throughput. This is achieved through extended bathlife and the optimization of chemical consumption. The exact chemical flow depends on bath chemistry and sequence, chemical concentration, cleaning time and temperature. The purpose is to process more wafers with an optimized chemical volume and to minimize equipment down times in the entire wafer handling process.

Certain wet chemicals require a separate disposal system. The waste streams are typically not amenable to internal recycling or reuse. Consequently, both economical and environmental savings in the waste chemical treatment can be achieved with the optimized use of chemicals.

Application

Wafer Cleaning

Wafer Cleaning is performed by using various liquid chemicals to remove contaminants from the surface of a silicon wafer. The most commonly used method is the RCA clean process, where RCA-1 clean, also called SC-1 (Standard clean 1), is used for the removal of organic residues and particles. RCA-2 clean, or SC-2 (Standard clean 2), cleans metal contaminants from the wafer. Diluted HF and SPM remove Silicon oxides and heavy organics respectively. The K-Patents PR-33-S/-23-MS provides a method for monitoring the point of use (POU) blending and delivery of the chemicals.

Wet Etch

Wet etching is used to chemically remove layers (metal, silicon, photoresist) from the surface of a wafer during manufacturing. Etchants, which 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) and

Tetramethyl ammonium hydroxide (TMAH) are commonly used for this purpose.

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

The Refractive Index gives an indication of the total of dissolved solids. The etching of silicon using a KOH water mix forms a tertiary solution with the dissolved silicate. The influence of the 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. The compensation factor can be implemented in the control system. The same phenomenon is seen in the etching of Silicon nitride with hot phosphoric acid.

Post –Etch Wafer Cleaning

The purpose of the post-etch wafer cleaning is to remove residues from the wafer. Post-etch cleaning is typically accomplished by Amine (e.g. Hydroxyl amine), Fluoride or Quaternary (e.g. NMP) based chemicals.

The K-Patents refractometer measures the concentration of the post etch cleaners, e.g. polymer removals such as EKC. This provides a real-time indication of the bath lifetime, which assists in increasing the wafer throughput and achieving significant savings in the chemical consumption.

Chemical Mechanical Planarization

In order to make the wafer surface smooth after the metal deposition, a method called *Chemical Mechanical Planarization (CMP)* is applied. Excessive metal is removed by using abrasive CMP slurries, which typically contain silica or alumina particles and a moving polishing pad. Bulk dispensing and blending methods are needed because of the large quantities of slurry, which are required in high-volume manufacturing fabs.

Typically, CMP processes use hydrogen peroxide (H_2O_2) as oxidizing agent to slurries. Hydrogen peroxide, used as oxidizer in the slurries, requires on-site blending as it has a short pot life and is not stable for long enough to permit shipping. Tight control of the hydrogen peroxide when blending the mixture is important, since too much of it can result in wafer contamination.

The K-Patents PR-23-MS provides a real-time method for the concentration monitoring of H_2O_2 in the POU blending of the CMP abrasive slurries.

Further Processing

After the wafer surface is polished, the wafer processing starts all over again with *film deposition, patterning and etching.* Layer after layer is created on the wafer. Between each step, the transistors are connected with copper or aluminium interconnects. The interconnects are separated from each other with insulators. One micro chip can have up to ten layers of interconnects.

Installation

The K-Patents Semicon Refractometer monitors the chemical concentrations in real-time, and provides immediate feedback of chemicals reaching their out-of-specifications limit. The refractometer can be used in the bulk chemical delivery systems in the sub-fab, in the point-of-use chemical blending and spiking applications in the cleanroom.

The benefit of a K-Patents sensor is that one can measure all constituent chemicals within a solution, as every component chemical is unique in terms of the physical property of its Refractive Index.