Recommended K-PATENTS® Semicon Refractometer Installation in CMP Slurry Delivery Systems

INTRODUCTION

Chemical Mechanical Planarization (CMP) is the process of smoothing and polishing the wafer's surface. This is done with the aid of an oxidizing agent, e.g. Hydrogen Peroxide (H\textsubscript{2}O\textsubscript{2}), which contains abrasive particles suspended in the carrier fluid.

CMP slurries require mixing or dilution before use. Oxide polishing slurries are commonly purchased in concentrated form and diluted with water on-site to minimize shipping and labour costs. Some multicomponent polishing slurries may only be blended just prior to their use because of their short post-mix lifespan. In the latter case, it is essential to monitor the H\textsubscript{2}O\textsubscript{2} concentration of the mixed slurry for CMP of tungsten and copper as the slurry constituents will affect the chemical reaction rates and wafer polishing rate.

Extensive studies at different fabs show that refractive index measurement by the K-Patents refractometer is suitable for replacing auto-titration in qualifying H\textsubscript{2}O\textsubscript{2} concentration in slurry delivery systems. In addition, it has been proven that the refractometer remains stable for up to 4 years with no instrument maintenance beyond routine flushing of the slurry blender.

REFRACTIVE INDEX FOR QUALIFYING PEROXIDE CONTENT IN SLURRIES FOR CMP

The slurry, DI water and H\textsubscript{2}O\textsubscript{2} are directed into the blend tank by weight or flow and recirculated in the blend loop until the mixture becomes homogenized. The blend must be qualified before the slurry can be distributed to the day tank and/or CMP tools.

The K-Patents Semicon Refractometer PR-33-S is mounted as an integrated device in the blender cabinet to monitor the H\textsubscript{2}O\textsubscript{2} content in the slurry during blending. The refractive index measurement by the K-Patents refractometer is a continuous, non-slurry consuming method, that can help fabs to identify faults in slurry composition quickly, reducing the number of wafers at risk. As such, it provides a more accurate picture of variations in slurry composition than conventional sampling method can.

Moreover, refractive index can be used to detect settling and degradation of slurry over time and reduce batch-to-batch variations.

The K-Pats Semicon refractometer provides Ethernet output signal that is used as immediate feedback to the control system. For instance, the Slurry Delivery System (SDS) can be configured with a concentration set-point for high and low values. The real-time measurement by the refractometer creates a trigger on/off point in a H\textsubscript{2}O\textsubscript{2} spike function arrangement. The chemical dispense valve opens and closes when concentration is below or above the set point. This creates a pulsing injection cycle of H\textsubscript{2}O\textsubscript{2} flow that decreases as the sensor detects the increase in H\textsubscript{2}O\textsubscript{2} concentration over time, until the monitored value is above the low point.

RECOMMENDED REFRACTOMETER INSTALLATION

The nature of CMP slurry is challenging as such, carrying nanoparticles to different solids content levels of 1-30 % depending on the slurry type. The K-Patents Semicon Refractometer successfully provides high accurate measurements of peroxide content of ±0.03 % by weight even at these difficult slurry conditions.

For this, it is essential to take under consideration the following recommendations when choosing the location and installing the refractometer:

1. The K-Patents Semicon Refractometer can be installed in a circulation line at the slurry blending cabinet and/or in the slurry dispensing line. The refractometer should be mounted away from the cabinet bottom at a mid or top position.
2. In CMP slurries application, the recommended installation point is on a vertical pipeline with flow upwards.
3. For lines where there is a sequence of N\textsubscript{2} gas purge of slurry, the sensor should be valved-off to carry fluid at all times and avoid emptying the pipe. The purge will leave the sensor prism dry, scaling the prism with slurry solids and creating the risk of wrong concentration readings. In this case, the
refractometer is capable also to monitor the water flush sequence.

4. Installation should be always on the supply discharge side, after the pump and never in the return of supply loop.

![Diagram showing installation steps]

**Figure 1.** Recommendations for successful installation of the K-Patents Semicon refractometer in CMP slurry application.

5. The flowrate should be adjusted depending on the pipeline size. Recommended flowrates are described in the table below:

<table>
<thead>
<tr>
<th>Line size (inches)</th>
<th>Recommended flowrate (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>2</td>
</tr>
<tr>
<td>1/2</td>
<td>6</td>
</tr>
<tr>
<td>3/4</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>26</td>
</tr>
</tbody>
</table>

![Diagram showing flowchart]

**Figure 2.** K-Patents Semicon refractometer in a CMP slurry delivery system. Image courtesy of Diversified Fluid Solutions, USA.

![Diagram showing installation in a cabinet]

**Figure 3.** General guidelines for the installation of the K-Patents Semicon refractometer in a cabinet.