Investigation of Valve Effects on Wafer Defectivity using an Oxide Slurry

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“2007 3rd Annual Levitronix CMP User Conference”
Rohm and Haas Electronic Materials
CMP Technologies
Phoenix, AZ
Outline

- Objective of Study
- Experimental Setup
- Historical Data
- Analytical Results & Discussion
- Polishing Results
- Summary
Objective

- Test New Valve vs. Old Valve Technologies on Oxide Slurry Shear Effects.
- Collect Analytical Data to Ascertaing any Shifts in Slurry Health.
- Polish Wafers and Review Polishing Performance Effects of Valve Technologies.

Acknowledgements:
- Parker Hannifin Corp. (Valves)
- Levitronix (Pump)
- Rohm and Haas (CMPIC Polishing Lab.)
New Valve Technology

OLD TECHNOLOGY

Tongue & Groove caused Areas for Slurry to Cake Up and Cause Premature Failure and Leak by

NEW! TECHNOLOGY

Enhanced Flow Characteristics
No Areas for Entrapment or Agglomeration

Slide Courtesy of Parker Hannifin Corp.
Experimental Setup

- Maglev Pump
- Sample Port
- Test Valve
- Valve Actuator
- Slurry Tank

Technology ▪ Consistency ▪ Productivity
Polishing Tool Used:
- Applied Materials Mirra®

Wafer Type:
- TEOS Blanket Wafers

Slurry:
- Klebosol™ 1501-50 Oxide Slurry

Pads:
- IC1010™
- Politex™
- Suba™

Conditioner:
- DiaGrid™

Klebosol is a registered trademark of AZ Electronic Materials

IC1010, Suba, and Politex are trademarks of Rohm and Haas Company or its affiliates

DiaGrid is a registered trademark of Kinik Co.

Mirra is a Registered Trademark of Applied Materials, Inc.
Historical Large Particle Size Results

Oxide Slurry
Levitronix Pump (Without Valves)

Cumulative Counts ≥ Diameter

Micron Size (µ)

- Time 0 Hour
- Time 24 Hour (~3x > Turnovers)
Historical Pump Results without Valves

Oxide RR and Defectivity Response

- STANDARD (0 Hour)
- LEVITRONIX (336 Hour)

Defect Counts

normalized values

Wafer Results

0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8

Defect Counts

RR
Analytical Lab Testing

**Laboratory Analysis:**

- Large & Mean Particle Size
- Zeta Potential
- Conductivity
- pH
- Viscosity
- Density
- Total Percent Solids
Large Particle Size Results

Parker Old Valve vs. New Valve Technology
Levitronix Pump Recirculated Oxide Slurry

Cumulative Counts ≥ Diameter

Micron Size (µ)

- Old Valve Delta (24 Hour)
- New Valve Delta (24 Hour)
Delta of LPD

ANOVA Analysis

Data Shows Significant Difference Between Valve Technologies
Possible Effects of LPD Shift

Effects of Slurry Shear:

- Increase in LPD’s
- Decreased Filter Life
- Distribution System Cleanliness
  - Day-tanks
  - Valves, Pneumatic & Manual
  - Synergistic Effects with Poor Pumps
  - May Effect Wafer Defectivity Over Time
  - May Influence RR & % NU
Filter Life can be Reduced with Increased Slurry and Gels and Agglomerations
No Significant Difference between New and Old Valves on Mean Particle Size Distribution
No Significant Difference between New and Old Valves on Zeta Potential

ANOVA Analysis
Conductivity

ANOVA Analysis

No Significant Difference between New and Old Valves on Conductivity

Conductivity (uS/cm) of New vs. Old Valve

<table>
<thead>
<tr>
<th>Conductivity (uS/cm)</th>
<th>New Valve</th>
<th>Old Valve</th>
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<tbody>
<tr>
<td>Sampling Time (hr)</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>2200</td>
<td>2250</td>
<td>2300</td>
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<td>2230</td>
<td>2235</td>
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</table>
No Significant Difference between New and Old Valves on pH

ANOVA Analysis

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<thead>
<tr>
<th>pH</th>
<th>10.5</th>
<th>10.6</th>
<th>10.7</th>
<th>10.8</th>
<th>10.9</th>
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</thead>
<tbody>
<tr>
<td>New Valve</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old Valve</td>
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</tbody>
</table>

![Diagram showing pH values for new and old valves over time](image-url)

- **Valve Type**
  - New Valve
  - Old Valve

- **Sampling Time (hr)**
  - 0 to 25

- **pH of New vs. Old Valve**

- **Student's t**
  - 0.05
No Significant Difference between New and Old Valves on Viscosity

ANOVA Analysis
Density

ANOVA Analysis

No Significant Difference between New and Old Valves on Density

Density of New vs. Old Valve

- New Valves
- Old Valves
Total Percent Solids

No Significant Difference between New and Old Valves on Total Percent Solids

ANOVA Analysis
ANOVA Analysis of Removal Rate and % NU

No Significant Difference on RR and %NU

Normalized Removal Rate

% NU
No Significant Difference on Defect Counts

ANOVA Analysis

- Filtered
- New Valve
- Unfiltered-Control
- Old Valve

Each Pair Student’s t 0.05

Normalized Defect Count

- 0.5
- 0.75
- 1
- 1.25
- 1.5

Defectivity
Increase in Large Particle Size Distribution was Evident with Old Valve Technology

This Shift can Decrease Filter Lifetimes

Distribution System Cleanliness can be Effected

The Data Shows that Polishing Results Showed No Significant Differences in:
- Defectivity
- RR
- % NU
Synergistic Response on Wafer Defectivity may be more Evident if:

- Old Valve Technologies are Coupled with Shear-causing Distribution Systems
- Number of Valves in the Distribution System
- Slurry Distribution System Resident Time

Wafer Defectivity may Vary with Specific Slurry Chemistries

THANK YOU FOR YOUR TIME