NCCAVS CMP Users Group Fall Meeting

October 2021
Utilizing Advanced POU Filters for Two-Stage Filtration in Slurry Distribution Systems

Bradley Wood
Applications Engineering Manager, CMP Filtration
Agenda

1. About Entegris
2. Background on CMP Filtration
3. Experimental Procedure
4. Results/Discussion
5. Conclusions and Future Work
Entegris at a Glance

A world-class supplier of advanced materials and process solutions for the semiconductor, life sciences, and other high-tech industries

Our Mission
To help our customers improve their productivity, performance and technology by providing enhanced materials and process solutions for the most advanced manufacturing environments

Business Divisions
Advanced Materials Handling (AMH)
Microcontamination Control (MC)
Specialty Chemicals & Engineered Materials (SCEM)
CMP Filtration
• Agglomeration of slurry abrasive can lead to large particles or aggregates in the slurry during slurry distribution
• These particles can lead to scratches, which are one of the most important yield killers and require continuous improvement
• Filters facilitate scratch reduction, but scratches can come from various sources
• Filtration can address scratches and the particles that create scratches

<table>
<thead>
<tr>
<th>Abrasive</th>
<th>FILTRATION</th>
<th>FILTRATION</th>
<th>Slurry formation</th>
<th>Post-clean</th>
<th>Pad and conditioner</th>
<th>Facility</th>
<th>Wafer</th>
<th>Uniformity, topography, roughness</th>
<th>Type and lifetime</th>
<th>Roughness and uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scratches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall On</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Depth vs. Membrane Filtration

![Diagram of Depth and Membrane Filtration](image)

<table>
<thead>
<tr>
<th></th>
<th>Depth</th>
<th>Membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media</td>
<td>Interlock fibers</td>
<td>Continuous polymer sheet</td>
</tr>
<tr>
<td>Form</td>
<td>Interlock fibers</td>
<td>Continuous polymer sheet</td>
</tr>
<tr>
<td>FM holding</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retention</td>
<td>Lower</td>
<td>Higher</td>
</tr>
<tr>
<td>Shedding</td>
<td>Can be high with pulsation</td>
<td>Low</td>
</tr>
<tr>
<td>Application</td>
<td>• Pre-filtration</td>
<td>Impurity removal from:</td>
</tr>
<tr>
<td></td>
<td>• Slurry filtration</td>
<td>• Ultrapure chemicals</td>
</tr>
<tr>
<td></td>
<td>• Chemical recirculation</td>
<td>• Photoresists</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• UPW</td>
</tr>
</tbody>
</table>
Slurry Filter Mechanisms for Large Particle Removal

- Slurry filters are traditionally depth-graded with polypropylene (PP) fibers
- Slurry filters are available in different retention ratings
- Nano-melt blown technology can reduce shear force during filtration, which has a strong impact on large particle counts (LPC)
Experimental Procedure
Utilized two filter types for this testing
• 5” disposable (POU* 70 nm, 50 nm, 30 nm)
• 10” cartridge (CDS or global loop 0.1 µm)

Constant parameters
• 2.7 LPM loop recirculation flow
• 300 mLPM POU single pass flow
• Acidic silica slurry (15 L per test)
• Test time ~2 hours
• Sampling time
  – Pre-test (baseline sample)
  – T1 (1 tank turn over)
  – T20 (20 tank turn overs)

*POU (Point of Use)
CMP Filter Test Stand

- Recirculation high-flow and low-flow test loops
- High-flow loop is Chemlock® compatible (Chemgard™ housing shown)
- Two low-flow loops for Solaris® or PlanarCap® style filters
- Single tank system
  - DIW or slurry compatible
  - Single process chemistry at a time
  - Constant stir mixer integrated with tank
  - Single pass to drain or recirculation flow paths configurable
Example of Recirculating System Filtration Behavior

- Typical trend seen in recirculation systems
- Examples of recirculation with 2 different pore rating cartridge filters with batch-to-batch slurry variation
- Can be described as slurry clean-up or filter polishing of the slurry
Experimental Results

- Typical scenario pictured on previous slide
- What if the loop filter doesn’t perform optimally?
- Data shown here represents excursion at 20 tank turnovers
- How does one protect the wafer from such excursions?

Recirculation Behavior of NMB01 Monitor at 0.56 µm

Normalized Particle Counts >0.56 µm

- Tank Turnover
  - T1
  - T5
  - T10
  - T20

- NMB01-3
- NMB01-5
- NMB01-7
Experimental Results

• As indicated above, Solaris 30 nm, 50 nm, and 70 nm filters were employed as POU filtration options for this testing
• Significant improvement of LPC counts shown with utilizing a POU/POD or guard filter
• Additional filtration step can safeguard the end-user process against premature loop filter excursions
  – In the case of the A3 testing, the loop filter did not experience an issue, but the POU filter still maintained a lower than loop level of particle counts
Entegris Solution
NMB A3 depth media features and benefits

Features

• Entegris NMB technology offers low shear force filtration
• More nanofibers in both volume and thickness
• Optimized pore gradient

Benefits

• Reducing slurry agglomeration
• Improve overall retention
• Stabilize retention under high-flow/high-concentration condition

Cross-section of filter media (top view)

NMBA3
NMBA5

• High retention for large particle
• Low shear stress reduces slurry agglomeration
• Stable filtration efficiency
Conclusions

- CMP slurry filtration can aid in scratch reduction via large particle removal
- It is typical that loop filtration is employed as a safeguard against high LPC in a slurry batch
- In the event of batch-to-batch slurry variation, the loop filter will control most of the LPC
- If the variation induces a filter excursion, the only way to safeguard the process is a point-of-use filter
- Advanced filtration can also aid in the case of a stable process with a more open loop filter
- The POU filter will further polish the slurry to ensure stable performance on wafer