Addressing Pricing Pressures from a Filtration Company Perspective
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Presentation Outline

• Identify the issue (pricing pressures on a CMP consumable supplier – Filters)

• How are we addressing this issue?
  – Advanced manufacturing and quality techniques
  – Development of new product platforms
  – Enhancing existing product platforms

• Conclusions
Identify the issue
Recent trends in market price for slurry filters

SLURRY SUPPLIERS

Pricing trend causes:

- Early awareness by purchasing (especially mature, HVM products)
- Small premium still put on leading edge filtration products
- Competition among filtration companies

* Cost of filtration is among the two largest consumable expenses for a slurry supplier (other is abrasive)
Recent trends in market price for slurry filters

**DEVICE MANUFACTURES:**

Pricing trend causes:

- More recently on radar of purchasing/procurement
- Consumable costs are now being considered (and driven down) during early stages of development
- Competition

*Cost of filtration typically accounts for <5% of the overall CMP consumables cost at a Fab*
Comments on Pricing Pressures

• Slurry Manufacturers
  – Same pricing pressures as filter companies
  – Filters are a key consumable cost
  – Profitability directly related to consumable costs

• Device Manufacturers
  – Overall consumable costs contribute significantly to CoO
  – Filters typically account for <5% of consumable costs
  – Looking at all contributing factors (including filtration) to control CoO
Addressing the issue
Advanced Manufacturing and Quality Techniques
Lean Manufacturing

- Manufacture to order (not stock)
  - reduction of material and product inventory
- Cellular Flow
  - minimizes processing steps
  - reduces product handling
  - improves inventory turns
Lean Manufacturing (Results)

- Lead times reduced 20%
  - reduces costs associated with carrying excess inventory
- Labor costs reduced when operating optimally
- Helped to partially offset cost increases related to polypropylene and energy
  - polypropylene costs mirror petroleum
Improving Product Consistency by Incorporating Quality Methodology

Typical manufacturing data for a legacy CMP product

Manufacturing data for a recently developed CMP product
Comments on Manufacturing/Quality

- Advanced Manufacturing techniques like Lean can be utilized to improve process flow and reduce costs.

- Lean also provides an added benefit of improving quality by eliminating unnecessary manufacturing steps.
  - Less handling decreases the possibility of contamination.

- Utilizing quality metrics early in process development can lead to improved product consistency.
  - Longer qualification runs lead to greater process knowledge and ultimately greater consistency.
Addressing the issue
Developing New Product Platforms
Finer Product Development

Methods for Manufacturing Finer Melt blown Filters

<table>
<thead>
<tr>
<th>Manufacturing Methods</th>
<th>Potential Impact on Filter Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produce finer fibers</td>
<td>Efficiency: ↑</td>
</tr>
<tr>
<td></td>
<td>Differential Pressure: ↑</td>
</tr>
<tr>
<td></td>
<td>Life: ↔</td>
</tr>
<tr>
<td>Increase media depth</td>
<td>Efficiency: ↑</td>
</tr>
<tr>
<td></td>
<td>Differential Pressure: ↑</td>
</tr>
<tr>
<td></td>
<td>Life: ↔</td>
</tr>
<tr>
<td>Reduce void volume (media calendaring)</td>
<td>Efficiency: ↑</td>
</tr>
<tr>
<td></td>
<td>Differential Pressure: ↑</td>
</tr>
<tr>
<td></td>
<td>Life: ↓</td>
</tr>
</tbody>
</table>

- Finer fibers and increased media depth can lead to improved performance without significant filter life tradeoff.
- Customer results have shown microscratch defects are reduced using finer filtration.
## Finer Melt-blown Filter Development (media comparison)

<table>
<thead>
<tr>
<th>Media Properties</th>
<th>Finest layer Y003</th>
<th>Finest layer Y002</th>
<th>Finest layer New Melt-blown filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean pore size (normalized)</td>
<td>1.1X</td>
<td>x</td>
<td>0.4x</td>
</tr>
<tr>
<td>PSL challenge % efficiency (0.8μm bead) log removal</td>
<td>&lt;70 % (&lt;0.5 log)</td>
<td>70 % (0.5 log)</td>
<td>&gt;99 % (&gt;2 log)</td>
</tr>
</tbody>
</table>
## Finer Melt-blown Filter Development (cartridge comparison)

<table>
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<tr>
<th>Media Properties</th>
<th>Y003 filter</th>
<th>Y002 filter</th>
<th>New Melt-blown filter</th>
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<td>x</td>
<td>0.4X</td>
</tr>
<tr>
<td>PSL challenge % efficiency (0.8µm bead)</td>
<td>70 % (&lt;0.5 log)</td>
<td>90 % (1 log)</td>
<td>99.9 % (3 log)</td>
</tr>
<tr>
<td>(log removal)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Finer Melt-blown Depth Filter (Field Results)

Filter Evaluation

- Pressure Drop (Psid)
- Total throughput (Kg)

Y002
New Melt-blown Filter
Finer Melt-blown Depth Filter (Field Results)

Defectivity Results using a ceria slurry

Microscratch Defects (Normalized)

Y002
New Melt-blown Filter
Addressing the issue
Enhancing Existing Product Platforms
Development Based upon Slurry Characteristics

Evolution of typical LPC distributions for fumed silica CMP slurries

Filter efficiency and life testing with 12% solids fumed silica CMP slurry

*Improving CoO by developing products for CMP slurries based upon PSD

*Imporving CoO by developing products for CMP slurries based upon PSD
New Extended Life filter
(Lab Results using fumed silica slurry)

<table>
<thead>
<tr>
<th></th>
<th>LPC @ 0.56 μm (normalized)</th>
<th>Differential Pressure (normalized)</th>
<th>Filter Life (normalized)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Product</td>
<td>1.00</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Extended life product</td>
<td>1.08</td>
<td>0.5</td>
<td>up to 4</td>
</tr>
</tbody>
</table>

- Product is made using existing Pall technology (product performance is enhanced utilizing an existing product platform)

- Best benefit (4x life of the standard product) occurred with fumed silica slurry targeting 0.2μm (Y002) filter retention
Comments on Product Development

• New technology developments will always be important since they enable solutions for the next generation applications

• Utilizing application knowledge (slurry PSD) to improve an existing product is a means to address customer (both supplier and device manufacturers) CoO issues

• Applying product knowledge (modifying pore taper to extend life) is the best way to make significant improvements to existing product platforms
Summary

• Efforts by device manufacturers to control costs have put enormous pricing pressures on CMP consumable suppliers
• Filtration companies see these pressures from both the device manufacturers and the slurry suppliers
• A multi-step approach is needed to address this issue
• Advanced manufacturing and quality techniques can be implemented to increase efficiency and reduce scrap
• New media and product developments by Pall can lead to reduced on wafer defects
• Enhancing existing product platforms allows Pall to meet the ever changing needs of the semiconductor industry in a manner that is both timely and less costly than traditional product development