SPCC Clean Panel Discussion
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Where do the challenges lay in the formulated clean world?

Is collaboration the key to success?
Challenges for Formulated Clean

#1 Technical
- Fragmentation
  - Each customer is different, each node is different
- Increasing complexity:
  - More materials, increased selectivity, lower defects
- Lack of relevant test vehicles and metrology
  - Only customer wafers tell the story
- Supply chain, quality and change control requirements tightening

#2 Commercial
- Dilutions are increasing
- ASP Pressure intensifies
- Volume per solution significantly reduced

#3 Competition
- Commodity chemicals
- Traditional competitors
- Customers
  - Increased activity in developing formulations and tolling
- OEMs
  - Driving down chemical consumption to improve CoO for tool sales
- Fast followers
  - Increasing numbers of local companies attacking N-2 business (28nm)
### Real World Example for PCMP Cleans

<table>
<thead>
<tr>
<th></th>
<th>Formulation A</th>
<th>Formulation B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Sold</strong></td>
<td>2000</td>
<td>2015</td>
</tr>
<tr>
<td><strong>Customers</strong></td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>Fabs</strong></td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td><strong>Tech Nodes</strong></td>
<td>130 – 28nm</td>
<td>10nm</td>
</tr>
<tr>
<td><strong>CoA Parameters</strong></td>
<td>~10</td>
<td>&gt;45</td>
</tr>
<tr>
<td><strong>Complexity</strong></td>
<td>-</td>
<td>5x</td>
</tr>
<tr>
<td><strong>ASP Expectation</strong></td>
<td>-</td>
<td>-20%</td>
</tr>
<tr>
<td><strong>Dilution</strong></td>
<td>-</td>
<td>2x</td>
</tr>
<tr>
<td><strong>Volumes</strong></td>
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Success Depends on Increased Collaboration

Opportunity to “put the pieces together” in the materials space
- Advanced precursors, advanced surface preparation, novel doping
- Materials handling, sensing, and delivery components

Customers Care About:
- Technology **Performance**
  - Process **Yield**
  - Device **Cost**

**Significant overlap within the Semiconductor Ecosystem**
- Targeted collaborations are the key to profitable solutions for all parties
Accelerating Development Cycles and Improving Yields

- Combine capabilities to unlock new value
  - Technical capability for rapid innovation
  - Breadth of technologies
  - Global reach, local support

- Enable new paradigms within the semiconductor ecosystem
  - Wet chemistries and wetted surfaces
  - Gases and gas-wetted surfaces
  - Solids and solid material delivery

- Create differentiated solutions to accelerate customer yield ramps

Enable the customers to focus on process integration and product performance