The Mask Maker Survey 2016

2015: Members requested the eBeam Initiative to “fill the gap” that the SEMATECH survey had served through 2013

- 8 participating mask makers
- AMTC, DNP, GLOBALFOUNDRIES, HOYA, Photronics, Samsung, SMIC and Toppan

2016: Thank you to the 10 participating mask makers

- AMTC, DNP, GLOBALFOUNDRIES, HOYA, Intel, PDMC, Photronics, Samsung, SMIC and Toppan
- More survey questions to capture historical data from Q3 2015-Q2 2016
Q: What was the number of masks delivered in the last 12 months? Percent by technology node?
Majority of Masks (79.7%) are Binary

Masks Delivered by Type
Q3 2015 - Q2 2016 (n=9)

- Binary: 79.7%
- AttPSM: 17.6%
- EUV: 0.2%
- AltPSM: 0.1%
- Other: 2.4%

Q: What was the % by type?
Chromium Substrates in the Majority (79%)

Q: What was the % by substrate type?

Masks Delivered by Substrate Type
Q3 2015 - Q2 2016 (n=9)

- Chromium: 79%
- MoSION AttPSM: 17%
- OMOG: 2%
- Other: 2%

Q: What was the % by substrate type?
Even Split in Etch Type Reported

Q: What was the % wet vs dry etch?
Q: What was the % written by the following pattern generation: eBeam, Laser, other?
Largest Data Volume Reported – 16 TB
Could it be due to multi-beam?

Q: What was the largest data volume for any mask level?
Q: What was the average write time over the past 12 months?
Q: What was the longest write time over the past 12 months?
Q: In the past year, what was the slowest resist that was used for a production mask intended for production wafer manufacturing?
Dose Assignment Reported by 7 out of 9
5 reported between 1.3x to 1.8x, 2 reported ≥ 2.8x

Q: In the past year, what was the max dose assigned to shots in the data provided to the mask writing machine? Please answer relative to 1.0 (nominal dose)
TAT Approaching 10 Days
Did TAT increase dramatically at 16-20nm?

Q: What was the average turn-around-time (TAT) by technology node?

<table>
<thead>
<tr>
<th>Technology Node</th>
<th>Days</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥90nm &lt;130nm (n=9)</td>
<td>4.98</td>
<td></td>
</tr>
<tr>
<td>≥65nm &lt;90nm (n=9)</td>
<td>4.66</td>
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<tr>
<td>≥45nm &lt;65nm (n=9)</td>
<td>5.34</td>
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<td>≥32nm &lt;45nm (n=8)</td>
<td>6.22</td>
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<tr>
<td>≥22nm &lt;32nm (n=9)</td>
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<td>≥16nm &lt;22nm (n=7)</td>
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<tr>
<td>≥11nm &lt;16nm (n=9)</td>
<td>8.67</td>
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<tr>
<td>≥7nm &lt;11nm (n=5)</td>
<td>9.52</td>
<td></td>
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</table>
Q: What was the average number of defects per mask for the past 12 months?
Q: What was the percentage of masks repaired by...no repair, eBeam, laser, nanomachining, FIB?
Average Mask Yield of 96% Reported
EUV mask yield on average >80% (4 reported)

Q: What was your overall mask yield for the past 12 months?
Q: What was your percent mask yield by category?
Strong Participation in 2016 Mask Survey

• 10 mask makers in total – merchant and captive
• Largest data set reported to be 16 TB
• But mask write times decreased significantly with a weighted average of 4 hours
• TAT continues to increase, approaching 10 days