Field Validation of Sub-Micron Defect Correlation with ≥1 Micron Particle Behavior in Undiluted POU CMP Slurry

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Outline

- Groundrules
- Production Conditions
- Principles Confirmed
Groundrules

- ICPT 2014 abstract acceptance pending
  - Customer management has approved release
  - Details of fab correlation data will be released at that time

- Metadata: data about data
  - The lessons learned from this customer fab experience, combined with others, are the subject of this presentation
Production Conditions

- Chip manufacturing operation, fab floor
- Ceria slurry
- SlurryScope measuring inside the CMP tool *before* the POU slurry filter
- Continuous monitoring for 3 weeks during each wafer polish operation
- Correlation of LPC data to subsequent physical and electrical defect data for each wafer
- Standard statistical methods for complex data sets
SlurryScope Data Modes

Particle Size Distribution

Particles vs. Time by Size
- Expanded LPC vertical scale
- Normalized total defect data in blue
- 3 weeks of data along X-axis
- Blank spaces in data when not polishing
Particle counts in the 1.0-1.2µm size bin are a good proxy for what is happening in the majority sub-micron particle size distribution

- For systemic slurry issues, large particles track the behavior of sub-micron particles

- Continuous, real-time measurement of particles >0.8µm in undiluted slurry is well demonstrated by SlurryScope
- Comparable measurement <0.8µm by any method remains an unsolved technical challenge
Principle #2 Confirmed

- There is signal in the noise
  - Small variations in stable LPC are the data that correlates with defects
  - Correlations that can be established over extended periods (several days, weeks) may be *undetectable* over shorter periods (hours, few days)

- Offline dilution particle data are noisy
  - Small sample size, infrequent measurements
  - Correlation to SlurryScope can be established over extended periods
Principle #3 Confirmed

- Batch-to-batch and tote-to-tote LPC differences comprise a significant driver for defect trends
  - Customers are asking slurry vendors to adapt methods and report SlurryScope data for QC

- LPC excursion events are not the defect driver in a stable SDS operation
  - Excursions are operational, largely self-inflicted
  - Identify the root cause and STOP DOING THAT
  - Defects may be caused by LPC excursions, but these are a separate population from the defects caused by systemic slurry changes
The particles removed by filtration are not necessarily those that cause defects

- SlurryScope measured >1.0µm
- SlurryScope sampling was *before* the POU filter
- After measurement, slurry passed through POU filter onto the polishing platen
  - *This is the SlurryScope data that correlated with defects*

**Say it again:** LPC data for particles >1.0µm is a good proxy for monitoring behavior of the sub-micron majority
Principle #5 Confirmed

- The smallest particle size bin carries systemic slurry information
  - Correlates with defects
  - Slurry tote and lot changes
  - Slurry pot aging

- Larger particle size bin data can be used to concurrently monitor operational events
  - Day tank changes
  - Filter changes
  - Pump changes
Final Thoughts

- One engineer was responsible for fab process operations and sub-fab slurry management
  - No “Upstairs Downstairs” contention
- The statistical data analysis methods used must be as sophisticated as the data itself
  - Simplistic number crunching can be easily overwhelmed by normal noise levels in the data
- Once SlurryScope data behavior is characterized in retrospect, methods can be developed for better managing fab operations and reducing defects
"It is not the answer that enlightens, but the question."

"The most important thing is not to stop questioning."

Any Questions?