Next Gen CMP Challenges in 3D Memory Architectures

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Micron Technology: 40 Years...

...and we believe strongly in the future

**Non-Volatile Technology Announcements**

### 3D NAND & QLC

- An Industry First
- **QLC**: Lower TCO, More Capacity & Smaller Footprint

### 3D XPoint™ & QUANTX

- **QUANTX**: 10x better performance than NAND SSDs

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QLC: Lower TCO, More Capacity & Smaller Footprint

QUANTX: 10x better performance than NAND SSDs
CMP Evolution for 3D Memory Architectures

Evolutionary Challenges require Revolutionary Solutions

- **2D-3D NAND Transition**
  - FOAK Material Polish
  - x-Wafer Non-uniformity
  - Local Planarization
  - Defectivity

- **3D XP Introduction**
  - FOAK Material Polish
  - x-Wafer Non-uniformity
  - Local Planarization
  - Endpoint & Process control

- **Next Gen 3D Architectures**
  - FOAK Material polish
  - x-Wafer Non-uniformity
  - Local Planarization
  - Endpoint & Process Control
  - Defectivity
  - Cost Reduction
  - Time-to-Solution (TTS)
**FOAK Material Polish**

**Versatile FOAK Materials driven by**
- High Aspect ratio Gap fill
- Large Area Gap fill
- Mechanical Integrity Requirements
- Variable Dielectric constants
- Exotic materials for Pillar etch

**Potential Requirements**
- Proactive FOAK Material polish R&D
- Extreme Mechanical polish regimes
- Faster Time-to-solution (TTS)
- Cost Effectiveness
- Continuous Improvement plan

*Increased defectivity w. Low modulus film*

*EOA Erosion in high lbf regime*
x-Wafer Non-uniformity

High x-Wafer Non-uniformity driven by

- Stress Impacts due to 3D stack films
- Head Design limitations
- Edge Tunability
- Asymmetry Management

Potential Requirements

- Multi-Zone Heads
- Stress Impact Management
- Consumable parameter study
- Asymmetry Management
Local Planarization

Worse Local Planarization driven by
- Local/Frame-level Stress
- Consumable compatibility
- Slurry selectivity tuning
- Variable pattern densities

\[ Erosion = a + b \cdot e^{c \cdot PD} \]
\[ Dishing = \frac{c}{1 + e^{-a \cdot (Wline-b)}} \]

Potential Requirements
- Bulk Vs. Local Stress Modeling & Handling
- Pad & Slurry options for Planarization
- Consumable parameter study
- Proactive Pattern Density Studies
Endpoint & Process Control

Higher Process variability driven by
- Incoming Module/stress variability
- Process/Consumable variability
- Friction Endpoint regime fail (S/N)
- Ineffective/Insufficient Metrology

Potential Requirements
- Insitu Zonal Endpoint Detection & Control
- Insitu Metrology and Process control
- Big Data Solutions to extract & Correlate spectral info
- Cost effectiveness

Final platen EP variability due to prior platen non-uniformity

Redundant spectral signature issue with White Light
Defectivity

High Defectivity driven by
- Complexity in maintaining Reg E/Bevel health
- Process Scratch/particle defectivity
- Film Quality Versus Polish consumables
- Incoming/Equipment contamination

Potential Requirements
- Low Defectivity Consumable combinations
- Edge tunability/Bevel roll-off improvements
- Enhanced Insitu Cleans performance
- Low TCO/High Through-put Buff platform
Cost Reduction & Faster TTS

Cost effective & Faster TTS opportunities
- Enhanced Process capability
- Long-term Roadmap sharing
- Cost effective TTS

Potential Requirements
- Faster, Capable & Flexible platforms
- Faster & Capable consumables
- Insitu Process Metrology & Characterization
- Lookahead Roadmap Solutions Development
- Pursuit of continuous improvement
Summary

- Transition to 3D architectures (NAND, XP) presented complex CMP challenges over past few years.

- Next-gen 3D technodes present even more stringent requirements for FOAK Material polish, WIW and WID NU, process control, defectivity and cost reduction.

- Fundamental understanding of problem statement and root cause, combined with latest scientific opportunities such as AI and advanced Big Data analytics will foster innovative CMP technology solutions such as statistical modeling of consumables and insitu process control.

- Long term Vendor Partnerships are key to identifying these advanced cost effective solutions with excellent TTS.
Questions?