Next Gen CMP Challenges in 3D Memory Architectures

F4 CMP Team, Micron Technology

SEMICON WEST 2018, NCCAVS Users Group

Speaker: Sri Sai Vegunta

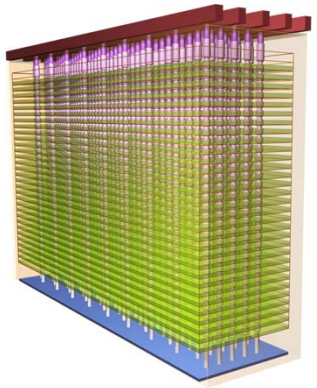
Sr. Manager-CMP-NVM, F4 CMP

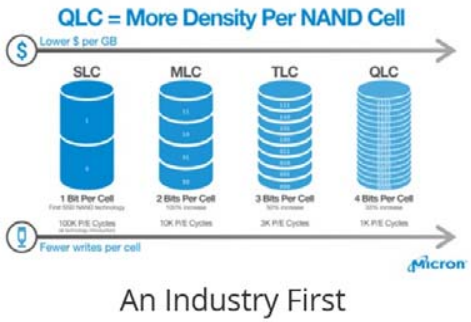
Micron Technology: 40 Years…

…and we believe strongly in the future

Non-Volatile Technology Announcements

3D NAND & QLC

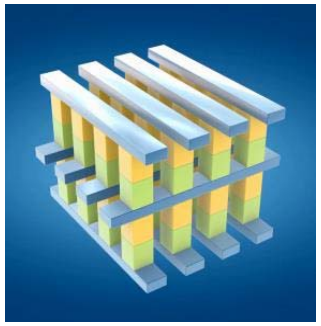




An Industry First

QLC: Lower TCO, More Capacity & Smaller Footprint

3D XPoint™ & QUANTX



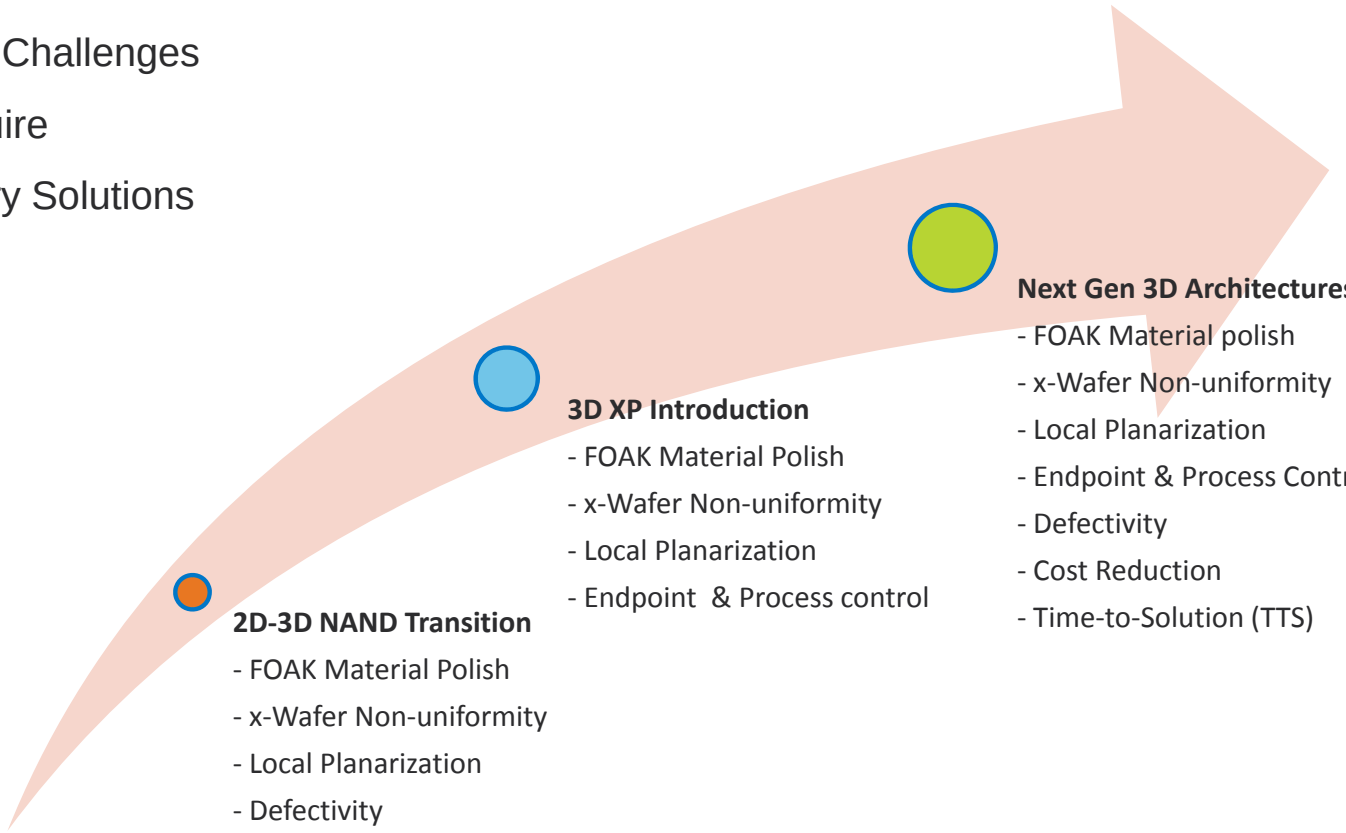
QUANTX: 10x better performance than NAND SSDs

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

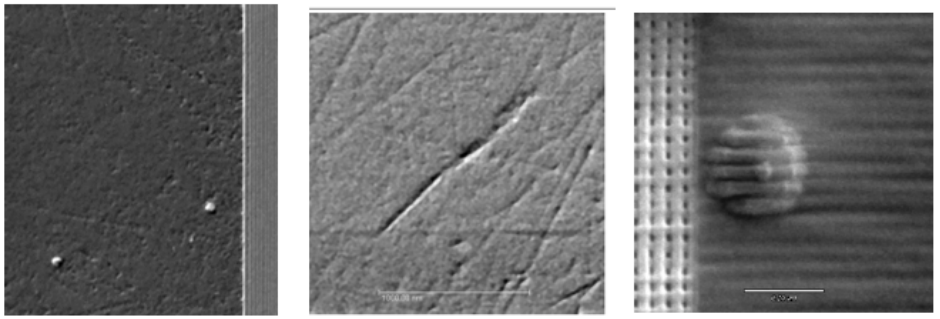
3D XP Introduction
- FOAK Material Polish
- x-Wafer Non-uniformity
- Local Planarization
- Endpoint & Process control

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

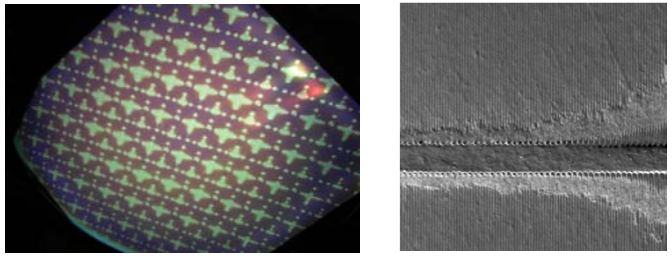
FOAK Material Polish

Versatile FOAK Materials driven by

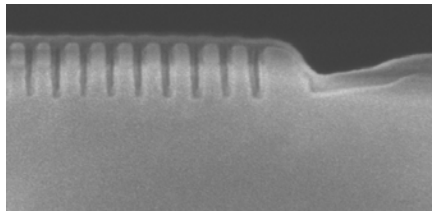
- High Aspect ratio Gap fill
- Large Area Gap fill
- Mechanical Integrity Requirements
- Variable Dielectric constants
- Exotic materials for Pillar etch



Increased defectivity w. Low modulus film



EOA Erosion in high lbf regime



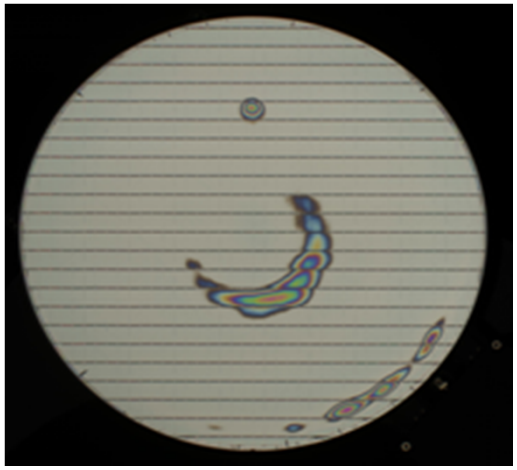
Potential Requirements

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

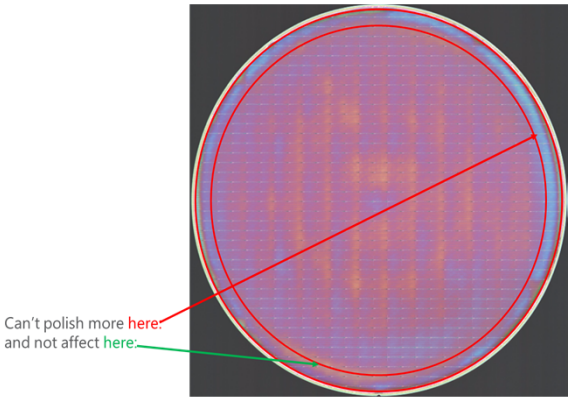
x-Wafer Non-uniformity

High x-Wafer Non-uniformity driven by

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



x-Wafer Asymmetry



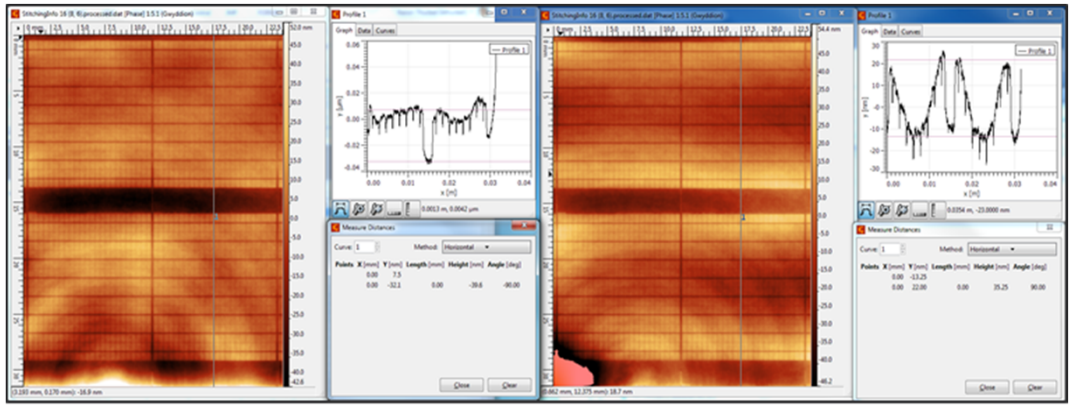
Potential Requirements

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

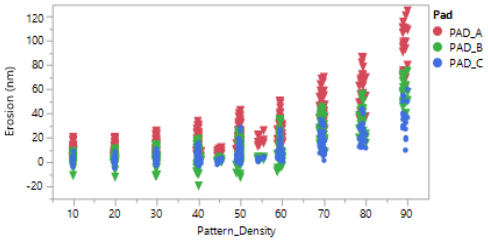
Local Planarization

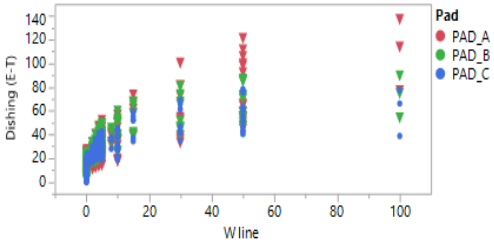
Worse Local Planarization driven by

- Local/Frame-level Stress
- Consumable compatibility
- Slurry selectivity tuning
- Variable pattern densities



Chucked Unchucked





$$Erosion = a + b * e^{c*PD}$$

$$\text{Dishing} = \frac{c}{(1 + e^{-a*(Wline-b)})}$$

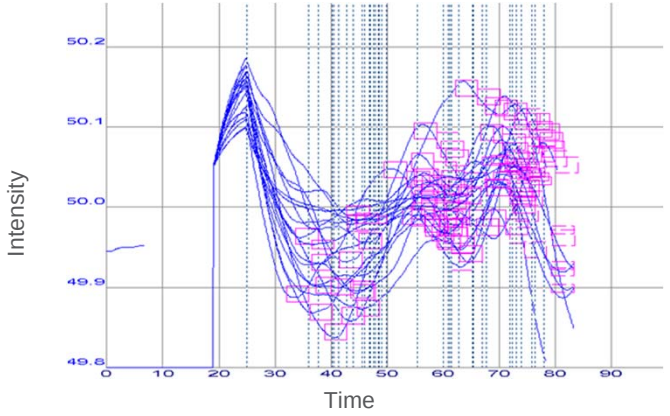
Potential Requirements

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

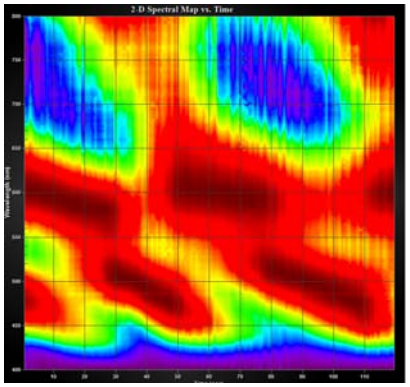
Endpoint & Process Control

Higher Process variability driven by

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



Final platen EP variability due to prior platen non-uniformity



Redundant spectral signature issue with White Light

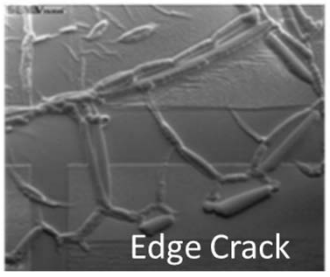
Potential Requirements

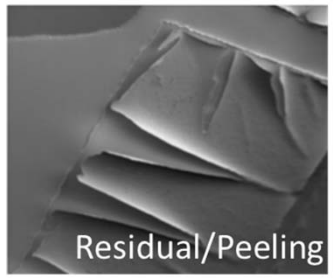
- Insitu Zonal Endpoint Detection & Control
- Insitu Metrology and Process control
- Big Data Solutions to extract & Correlate spectral info
- Cost effectiveness

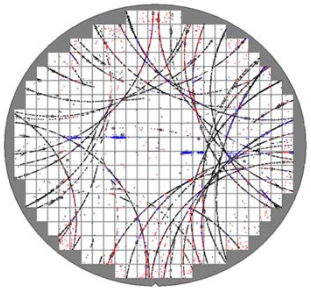
Defectivity

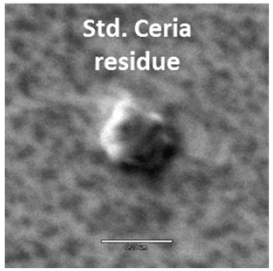
High Defectivity driven by

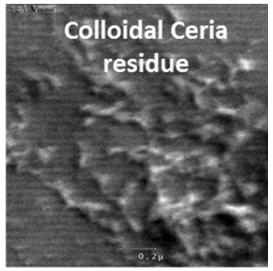
- Complexity in maintaining Reg E/Bevel health
- Process Scratch/particle defectivity
- Film Quality Versus Polish consumables
- Incoming/Equipment contamination











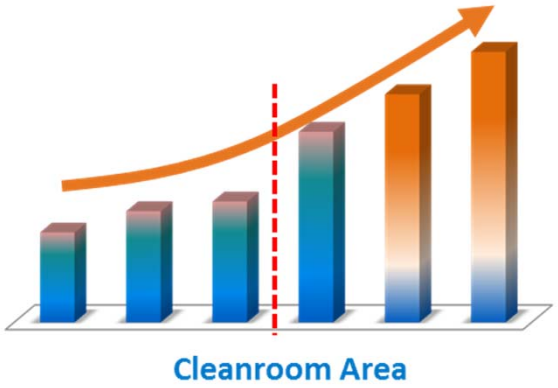
Potential Requirements

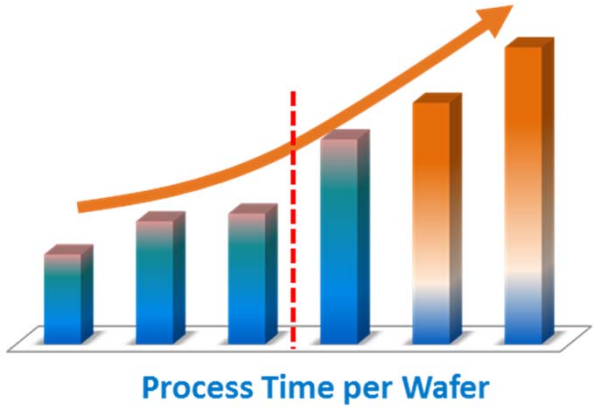
- Low Defectivity Consumable combinations
- Edge tunability/Bevel roll-off improvements
- Enhanced Insitu Cleans performance
- Low TCO/High Through-put Buff platform

Cost Reduction & Faster TTS

Cost effective & Faster TTS opportunities

- Enhanced Process capability
- Long-term Roadmap sharing
- Cost effective TTS



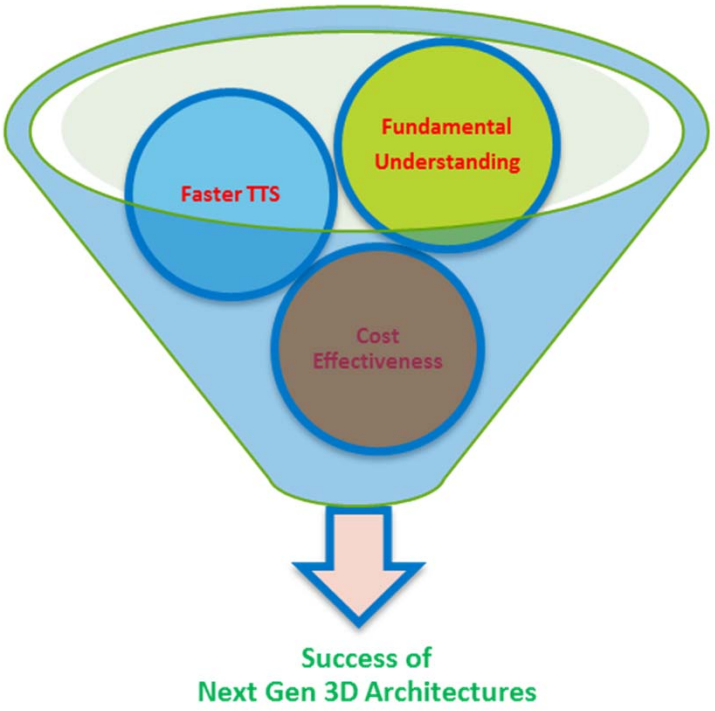


Potential Requirements

- 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?


Micron®