Analysis and Optimization of AlTiC CMP Using Advanced Heads

Brown, Feeney, Shumway
Axus Technology
Outline

• Results with rigid plate carriers
• Tuning of modified Titan carrier tuning with single factors
• Initial oxide/AlTiC CMP data
• Simultaneous tuning of modified Titan
• Summary and Follow-up work
Rigid Plate Carrier Edge Exclusion

- Best NU only achieves 5mm edge exclusion at best
- Requires high downforce and slow speeds
  - Incompatible with most modern processes
200mm Mirra Taken Through Upgrades

- Started with Titan (3 zone) membrane carrier
  - Membrane enables front referencing technology
  - Flat edge to 3mm, some edge tuning
  - Has advantages for volume production applications
    - ISRM, multiplaten, etc.

- Upgrades have been available
  - Profiler (4 zone) head
    - Increased edge tuning
  - Contour (6 zone) head
    - Full radial control
Path for 150/200mm Legacy Tools

- Older equipment with rigid plate carriers being extended
  - IPEC 372M/472
  - Strasbaugh 6DS–SP/6EC
    - ViPRR controls retaining ring
  - Ebara EPO
  - Still good for lower volume / flexible purpose
- Carrier upgrade path developed
  - 200mm: ViPRR, Titan, Profiler, and Contour
  - 150mm: Titan and now Profiler (from AMAT)
AlTiC Wafer Process on 6DS–SP/Titan

Uniformity improved with 8 psi 55 RPM process
Customer/New Processes on 472/Titan

Titan: NU 2.6% Rate 3391 A/min

Standard: NU 12.3% Rate 1476 A/min

Uniformity improved 5X, Rate 2x with new process
Dramatic changes in edge rate possible with Profiler
Similar results now available with modified Titan
Axus Technology Modified Titan 200mm
Normalized Diameter Scan 3mm EE
Oxide on Silicon Blanket Wafers

NU improved by raising the retaining ring pressure up to 7

www.axustech.com
Axus Technology Modified Titan 1 200mm
Normalized Diameter Scan, 3mm EE
Oxide on Silicon Blanket Wafers

Overall shape of edge can be driven by IT piston pressure
AlTiC Diameter scan, 60 sec at 5 psi, Initial BKM (Non-optimized*) 5mm Edge

Initial run using Axus Technology BKM prior to optimization
Even non-optimized process gives 2.0-2.6% radial NU at 5mm
Want to investigate tuning edge up and down
DOE with R Ring and Modified IT Plate

Ox on Si, Membrane 5 psi, Platen/Carrier 93/87 rpm
Retaining Ring 6.4-7.6 & IT bladder 4-6 (piston) psi
Rate at 3mm varies ~1500A/min

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Rate Across Wafer Center

Parameters have influence on center rate
Likely the result of fluid film and temperature changes
Zone control will be evaluated as delta to center rate

\[ p = 0.09 \quad p < 0.01 \quad \text{Model Rsq} = 0.89 \]
Rate at 3mm from Edge

Retaining Ring pressure has large influence on 3mm rate

\[ p = 0.06 \quad p < 0.01 \]

Model Rsq = 0.99
Rate at 6mm from Edge

Both factors influence 6mm rate
Can utilize higher pressure to raise 6mm rate without large effect on 3mm

$p < 0.01$  $p < 0.01$  Model Rsq = 0.97
Rate at 9mm from Edge

Main Effects Plot for Delta 9mm

Data Means

\[
\begin{array}{c|c|c}
\text{IT psi} & \text{RR psi} \\
\hline
-100  & 0  \\
-60   & 100 \\
-20   & 25  \\
0     & 35  \\
20    & 45  \\
60    & 55  \\
100   & 65  \\
\end{array}
\]

\[p = 0.05\]

\[p < 0.01\]

Model Rsq = 0.94

Both parameters have smaller effect on 9mm rate
Optimization of 6mm and 9mm Rates

Best uniformity
Want 0
Fix shape instead

Flattest edge
Want +100
Go beyond IT of 6
Summary and Follow-up

• Back referenced carriers create limits on non-uniformity and edge tuning as well as rate and cost of ownership
• Upgrading legacy tools with original Titan carriers enables gains in non-uniformity and rate/CoO
• Modifications to Titan IT done at Axus enable edge tuning that was previously only possible with Profiler
• Tuning characterized for easy optimization

• Latest results to be tested on AITiC wafers