Advanced Tungsten CMP with No Pad Conditioning

Presentation to the NCCAVS CMP Users Group
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By

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Contents

Background Information

Process Data Using ASP-W3525 Pads
(Peroxide concentration, downforce, table speed, etc.)

Process Qualification and Production Results
- Extended run
- Contamination data
- Lot-to-lot consistency

Contact info
PSI provides professional outsource CMP for everything from prototypes and development work through volume outsource production.

Desired properties for a tungsten CMP production process:
- Excellent pad-to-pad and lot-to-lot consistency
- Reasonable removal rate and very low uniformity
- Low defectivity
- Minimal conditioning (zero if possible)
- Long pad life

Multiple pads screened and best performance achieved with the psiloQuest ASP-W3525 pad.
Peroxide Concentration Study

RR Study comparing Down-Force @ % H2O2 concentration variations

Polisher: IPEC 472
Slurry: Cabot SSW-2000
Simplified DOE shows strongest response to oxidizer concentration.

Negative slope for removal rate vs table speed is likely an artifact of simplified design.
AMAT Mirra Process DOE Results

- Membrane pressure (downforce) is largest predictor coefficient
- Wide process margin on all other variables tested
- Consistent with trends observed in IPEC 472 data

**Least Squares Fit**

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<thead>
<tr>
<th>Response</th>
<th>Value</th>
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<tr>
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**Response Surface Effects on AMAT MIRRA MESA using 1:1 SSW2000:DIW**

Variables:
- MP
- RRP
- ITP
- TS
- HS
- Head Sweep
- Oxidizer Conc.
- SF
Ebara EPO222 Process DOE Results

Recent data taken on Ebara EPO222 polisher

• Downforce (DF) has the biggest effect on measured response parameters
• TurnTable (Table Speed) has very minimal effect on the response parameters.

• As expected, tungsten RR (W-RR) increases as Downforce (DF) increases.
• BSP has mild inverse effect on W_RR, W-WIWNu and W-Pad Temperature
Pad Variability Study

Polishing data taken across multiple pads
- Total of 20 ASP-W3525 pads
- Includes 5 different raw material lots

Rate and uniformity data taken on 3 monitor wafers per pad
- All polishing performed on IPEC 472 polisher at psiloQuest apps lab
- Data compiled into single dataset for comparison

Demonstrates excellent pad-to-pad consistency across multiple lots
Multi-Lot Removal Rate Variation

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**Moments**

- Mean: 2532.7365
- Std Dev: 94.865909
- Std Err Mean: 11.027938
- upper 95% Mean: 2554.7151
- lower 95% Mean: 2510.7578
- N: 74
Multi-Lot WIWNU Variation

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<td>P-Stdev</td>
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<td>lower 95% Mean</td>
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Production Qualification

Elements of Rapid Qual Plan

- 50-wafer baseline run for blanket film rate and uniformity
- SIMS/TXRF data showing residual contamination levels
- Defectivity
- Device yield on multiple split lots

Results

- All qualification runs completed in very short timeframe
- Comparison to in-fab process showed equal or better performance on all critical metrics
First attempt 50-wafer baseline run

Date: March 2004
Polisher: IPEC 472
Pad: psiloQuest
Slurry: Cabot SSW-2000 (diluted 1:1 + 4% H2O2)
Conditioning: None
SIMS / TXRF contamination data

Key Points

- Comparison to IC1000 shows equal or better performance
- All values from PSI lab are less than or equal to fab reference

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Cross section of completed via

- Excellent plug planarity and controlled recess.

- End-of-line device yield equivalent between outsourced CMP and existing qualified fab process.
Blanket Film Qual Data through Typical Pad Life

ASP-W3525, IPEC472, SSW2000 @ 4% H₂O₂

Cumulative Polish Time = 2,561 minutes
Normalized Production Lot Polish Time

Over 100 production lots across multiple pads showing very repeatable polishing performance
Conclusions

The psiloQuest ASP-W3525 tungsten CMP pad provides:

- Excellent pad-to-pad and lot-to-lot consistency
- Reasonable removal rate and very low uniformity
- Zero conditioning required
- Low defectivity
- Long pad life

Through PSI, the end customer has achieved:

- Immediate capacity with no capital outlay
- Product yield equivalent to current fab in-house production
Contact Information

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