Your Global Partner in Material Solutions™

Front-end, Back-end and Substrate Slurries: Key Process Data and Advantages
Current Products

• Ceria Slurry
  – STI/RMG process (used for 22nm HVM)
  – Poly Si CMP: high rate and selective to oxide and SiN
  – Poly Stop – High TEOS/Poly selectivity
  – TSV – Backside: Tunable Cu, TEOS rate

• Cu Slurry
  – TSV: Frontside: high Cu rate, Cu/Ta, Ti ratio
  – Cu: High planarization on soft pad

• Barrier: Customized for integration
• Sapphire: good Ra, low cost
• SiC: good Ra
Device Integration and Polishing applications

Logic application

- Cu / Barrier CMP
- APLANADOR series
- PMD CMP CES series
- STI CMP CES series
- Bare-Si CMP CES series

TSV application

- Poly-Si CMP CES series
- High Cu rate CMP
- APLANADOR series

Flash application

- Cu / Barrier CMP
- APLANADOR series

DRAM application

- Cu / Barrier CMP
- APLANADOR series
- ILD CMP CES series
- Poly-Si CMP CES series
- STI & RMG CMP CES series

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Comparison of defect count as a function of ceria particle size

The CES-350 abrasive show 1/3 of the defectivity for CES-330 abrasive.
Step Height Reduction and Overfill Removal:

• CES-333-2.5 demonstrated auto-stop properties.
• Thick overfill cleared by dilute slurry polishing.
• High selectivity to SiN
Additive chemistry engineering for improved planarization: Concept of higher planarity polishing slurry

Higher planarity
- smaller dishing (range)
- smaller SiN loss (range)

Auto stop polishing

Polishing pressure

Threshold > polishing pressure
Removal rate would be lower, when step height cleared.

Low dishing polishing

Polishing pressure

Threshold < polishing pressure
Removal rate would be lower, when dishing occurred.

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Concept of new additive for higher planarity

New additives protect trench oxide at low down force area. Removal rate ratio (High/low pressure) is higher with new additive.
CES-336F series for high planarity and over-polish Window

Results of patterned wafer polishing (trench oxide)

CES-330 F + ADD-106 = CES-336F slurry
Improved Dishing and over-polish margin.
Dishing as a function of over-polish

/Slurry with ADD-106 showed wider over polish margin against dishing.
High selective Poly Si slurry: Two step Ceria slurry process for reduced step height

- Conventional Ceria slurry polish for planarization
- High selective Poly-Si slurry for poly-Si clearing and stop on oxide.
Poly Si stop Slurry with high oxide rate

Slurry: CES series p-Si stop type
Polisher: AMAT Mirra
Pad: IC-1400 k-groove
Conditioning: Mitsubishi Material MEC-100, In-situ, 9lbf
Wafer: P doped (3E20) poly-Si
Measurement: KLA-Tencor UV-1280SE

Polish Recipe:

<table>
<thead>
<tr>
<th>Inner</th>
<th>Membrane</th>
<th>R. Ring</th>
<th>Platen</th>
<th>Head</th>
<th>Slurry</th>
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<tbody>
<tr>
<td>[psi]</td>
<td>[psi]</td>
<td>[psi]</td>
<td>[rpm]</td>
<td>[rpm]</td>
<td>[mL/min]</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>1.15x</td>
<td>77</td>
<td>73</td>
<td>200</td>
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TEOS/poly selectivity is higher than 500.
High Planarization Efficiency on Soft Pad

Equipment/Consumables
- Equipment: AMAT Mirra
- Slurry: CL-1524
- Polishing Pad: softer pad
- Conditioner:
- Wafer: Sematech 854 Pattern

Polishing condition
- Polishing Time: 30, 50 sec
- Membrane/R-ring Pressure: 2.0 / 4.0 psi
- Platen/Head rotation speed: 123 / 117 rpm
- Slurry flow rate: 200 ml/min
- Conditioning: Ex-situ 30 sec

CL-1500 Series Cu slurry: CL-1524

- CL-1524 has good PE.

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CL-2100 Series Barrier Slurry: Customization for Integration scheme & Design Concept

- Cu removal rate (R/R) is controlled by H₂O₂ content.
- TEOS R/R is controlled by abrasive content and size.
- Low-k R/R is controlled by variation of suppresser and quantity.

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**CL-216X Series**

- TEOS/Low-k high selective type

**CL-213X Series**

- Cu high removal rate type

**CL-214X Series**

- Cu/TEOS non-selective type

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CX-1001 Series Front side TSV slurry

High Copper Removal Rate and barrier Selectivity

- Cu/Ta Selectivity is 6124@2.0psi, 2619@4.0psi
- Cu/Ti Selectivity is 145.7@2.0psi, 95.2@4.0psi
Ceria Based back side TSV slurry:

Si/Cu Non-selective slurry (High TEOS RR type)

Slurry: CES-330 series for Silicon/Copper polish
Polisher: AMAT Mirra
Pad: IC-1000/Suba 400 XY-P (A21)
Conditioning: Mitsubishi Material MEC-100, ex-situ 9lbf
Wafer: bare-Si, Cu, Ta, TEOS
Polish Time: bare-Si 5min, Cu, TEOS 1min, Ta 10sec

<table>
<thead>
<tr>
<th>IT</th>
<th>M</th>
<th>R.R</th>
<th>Platen</th>
<th>Head</th>
<th>Slurry</th>
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</thead>
<tbody>
<tr>
<td>[psi]</td>
<td>[psi]</td>
<td>[psi]</td>
<td>[rpm]</td>
<td>[rpm]</td>
<td>[mL/min]</td>
</tr>
<tr>
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<td>4</td>
<td>4.6</td>
<td>127</td>
<td>123</td>
<td>200</td>
</tr>
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</table>

High TEOS rate without changing the rate of Si and Cu

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### UD 1900B Sapphire slurry: Low Cost Removal rate

<table>
<thead>
<tr>
<th>Polishing pressure (psi)</th>
<th>Rotation speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UD1900B/suede</td>
<td>3.0</td>
</tr>
</tbody>
</table>

![Graph showing removal rate vs dilution ratio](image)

- UD1900B on suede pad maintains high removal rate with wide dilution range.
  - Slurry cost reduction!
  - Minimal removal rate change due to slurry dilution shift.
Sapphire surface roughness & scratch

UD1900B/suede shows very smooth surface and no scratches on surface.

SEM images after polishing with UD1900B/suede

Ra=0.10nm

Five points measurement
Center
Sapphire wafer

Equipment
SEM
Zygo

× 1K
50um
× 10K
5um

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UD-1405 SiC substrate polish slurry

SiC: good Ra
Surface observation by AFM (3”, On-axis, Si)

Achieves high planarity (Ra < 0.1nm)