PECVD Recipes

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OUTLINE

Introduction
Recipe Names
TEOS Oxide
Properties of TEOS Oxide
PECVD Nitride
Properties of PECVD Nitride
This document was prepared to document FACTORY P-5000 recipes for deposition of oxide from TEOS and nitride from SiH4 and NH3.
RECIPe NAMES

10K CLEAN (Clean for Chamber A)
A6-FAC 0.4M TEOS (Dep of 4000Å Oxide)
A6-FAC 0.8M TEOS (Dep of 8000Å Oxide)
A6-FAC 1.0M TEOS (Dep of 10,000Å Oxide)

B-10K CLEAN (Clean for Chamber B)
B6-10K NIT CON (Dep of 10,000Å Nitride)
PECVD OXIDE FROM TEOS

10K CLEAN (Clean)
A6-FAC 0.4M TEOS (Dep)
  or
A6-FAC 0.8M TEOS (Dep)
  or
A6-FAC 1.0M TEOS (Dep)
10K CLEAN (Clean)
## 10K CLEAN

<table>
<thead>
<tr>
<th>Step #</th>
<th>Chamber</th>
<th>By Time</th>
<th>Time Max</th>
<th>endpoint</th>
<th>Pressure</th>
<th>Ramp</th>
<th>RF1</th>
<th>RF1 Tune</th>
<th>RF2</th>
<th>DPA RF</th>
<th>Temp</th>
<th>Temp Ramp</th>
<th>Purge Flow</th>
<th>Spacing</th>
<th>Cham Bypass</th>
<th>Plasma Monit</th>
<th>O2</th>
<th>C2F6B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Low</td>
<td>Chamber B Only</td>
<td>By Time</td>
<td>45 sec.</td>
<td>No endpoint</td>
<td>Full Open</td>
<td>0 Torr/sec</td>
<td>650 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>0 C</td>
<td>0</td>
<td>Off</td>
<td>999 mils</td>
<td>Off</td>
<td>Off</td>
<td>400 sccm</td>
<td>300 sccm</td>
</tr>
<tr>
<td>2 – Stabilization</td>
<td>Chamber B Only</td>
<td>Press &gt;5 Torr</td>
<td>10 sec</td>
<td>No endpoint</td>
<td>Closed</td>
<td>0 Torr/sec</td>
<td>0 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>0 C</td>
<td>0</td>
<td>Off</td>
<td>180 mils</td>
<td>Off</td>
<td>Off</td>
<td>600 sccm</td>
<td>500 sccm</td>
</tr>
<tr>
<td>3 – High</td>
<td>Chamber B Only</td>
<td>By Time</td>
<td>25 sec</td>
<td>No endpoint</td>
<td>10 Torr</td>
<td>0 Torr/sec</td>
<td>650 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>0 C</td>
<td>0</td>
<td>Off</td>
<td>180 mils</td>
<td>Off</td>
<td>Off</td>
<td>600 sccm</td>
<td>500 sccm</td>
</tr>
<tr>
<td>4 – Pump</td>
<td>Chamber B Only</td>
<td>By Time</td>
<td>5 sec.</td>
<td>No endpoint</td>
<td>Full open</td>
<td>0 Torr/sec</td>
<td>0 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>0 C</td>
<td>0</td>
<td>Off</td>
<td>0 sccm</td>
<td>0 sccm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## A6-FAC 0.4M TEOS (or 0.8M or 1.0M)

<table>
<thead>
<tr>
<th>Step #</th>
<th>Chamber</th>
<th>By Time</th>
<th>Time Max</th>
<th>endpoint</th>
<th>Pressure</th>
<th>Ramp</th>
<th>RF1</th>
<th>RF1 Tune</th>
<th>RF2</th>
<th>DPA RF</th>
<th>Temp</th>
<th>Temp Ramp</th>
<th>Purge Flow</th>
<th>Spacing</th>
<th>Cham Bypass</th>
<th>Plasma Monitor</th>
<th>TEOS</th>
<th>O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Setup</td>
<td>Chamber A Only</td>
<td>By Time</td>
<td>15 sec.</td>
<td>No endpoint</td>
<td>9 Torr</td>
<td>0 Torr/sec</td>
<td>0 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>390 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>220 mils</td>
<td>Off</td>
<td>400 sccm</td>
<td>285 sccm</td>
</tr>
<tr>
<td>2 – Dep</td>
<td>Chamber A Only</td>
<td>By Time</td>
<td>40 sec. (for 4000Å)</td>
<td>No endpoint</td>
<td>9 Torr</td>
<td>0 Torr/sec</td>
<td>205 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>390 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>220 mils</td>
<td>Off</td>
<td>400 sccm</td>
<td>285 sccm</td>
</tr>
<tr>
<td>3 – Pump</td>
<td>Chamber A Only</td>
<td>By Time</td>
<td>10 sec.</td>
<td>No endpoint</td>
<td>Full open</td>
<td>0 Torr/sec</td>
<td>50 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>390 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>999 mils</td>
<td>Off</td>
<td>0 sccm</td>
<td>285 sccm</td>
</tr>
</tbody>
</table>

63 sec. (for 8000 Å)  
104 sec. (for 10,000 Å)
PECVD TEOS OXIDE PROPERTIES

Etch Rate (Å/min) Data:
PECVD Oxide from Recipe **A6-FAC 0.4M TEOS (or 0.8M or 1.0M)**

<table>
<thead>
<tr>
<th>Etchant</th>
<th>10:1 BOE</th>
<th>7:1 BOE</th>
<th>50:1 DI:HF</th>
<th>Pad Etch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Densification = None</td>
<td>2062</td>
<td>611</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Densification 1000 °C, 60min</td>
<td>814</td>
<td>115</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Densification 1100 °C, 360min</td>
<td>562</td>
<td>107</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thermal Oxide
Etch Rate (Å/min)

|                | 629    | 1122   | 187     | 623     |
PECVD NITRIDE FROM AMMONIA AND SILANE

B-10K CLEAN (Clean)
B6-10K NIT CON (Dep)
B-10K CLEAN (Clean)
## B-10K CLEAN

<table>
<thead>
<tr>
<th>Step #</th>
<th>Chamber</th>
<th>By Time</th>
<th>Time Max</th>
<th>endpoint</th>
<th>Pressure</th>
<th>Ramp</th>
<th>RF1</th>
<th>RF1 Tune</th>
<th>RF2</th>
<th>DPA RF</th>
<th>Temp</th>
<th>Temp Ramp</th>
<th>Purge Flow</th>
<th>Spacing</th>
<th>Cham Bypass</th>
<th>Plasma Monit</th>
<th>O2</th>
<th>C2F6B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – Low</td>
<td>Chamber B Only</td>
<td>60 sec.</td>
<td>No endpoint</td>
<td>Full Open</td>
<td>0 Torr/sec</td>
<td>650 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>0 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>999 mils</td>
<td>Off</td>
<td>400 sccm</td>
<td>300 sccm</td>
</tr>
<tr>
<td></td>
<td>2 – Stabilization</td>
<td>Chamber B Only</td>
<td>20 sec</td>
<td>No endpoint</td>
<td>Closed</td>
<td>0 Torr/sec</td>
<td>0 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>0 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>180 mils</td>
<td>Off</td>
<td>600 sccm</td>
<td>500 sccm</td>
</tr>
<tr>
<td></td>
<td>3 – High</td>
<td>Chamber B Only</td>
<td>75 sec</td>
<td>No endpoint</td>
<td>10 Torr</td>
<td>0 Torr/sec</td>
<td>600 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>0 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>180 mils</td>
<td>Off</td>
<td>600 sccm</td>
<td>500 sccm</td>
</tr>
<tr>
<td></td>
<td>4 – Pump</td>
<td>Chamber B Only</td>
<td>20 sec</td>
<td>No endpoint</td>
<td>Full open</td>
<td>0 Torr/sec</td>
<td>0 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>0 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>0 sccm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### B6-10K NIT CON

<table>
<thead>
<tr>
<th>Step #</th>
<th>Chamber</th>
<th>By Time</th>
<th>Time Max</th>
<th>endpoint</th>
<th>Pressure</th>
<th>Ramp</th>
<th>RF1</th>
<th>RF1 Tune</th>
<th>RF2</th>
<th>DPA RF</th>
<th>Temp</th>
<th>Temp Ramp</th>
<th>Purge Flow</th>
<th>Spacing</th>
<th>Cham Bypass</th>
<th>Plasma Monitor</th>
<th>SiH4</th>
<th>NH3</th>
<th>N2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Setup</td>
<td>Chamber B Only</td>
<td>By Time</td>
<td>15 sec.</td>
<td>No endpoint</td>
<td>4.5 Torr</td>
<td>0 Torr/sec</td>
<td>0 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>400 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>290 mils</td>
<td>Off</td>
<td>130 sccm</td>
<td>60 sccm</td>
<td>2000 sccm</td>
</tr>
<tr>
<td>2 – Dep</td>
<td>Chamber B Only</td>
<td>By Time</td>
<td>60 sec. (for 10K)</td>
<td>No endpoint</td>
<td>4.5 Torr</td>
<td>0 Torr/sec</td>
<td>600 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>400 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>290 mils</td>
<td>Off</td>
<td>130 sccm</td>
<td>60 sccm</td>
<td>2000 sccm</td>
</tr>
<tr>
<td>3 – Pump</td>
<td>Chamber B Only</td>
<td>By Time</td>
<td>20 sec.</td>
<td>No endpoint</td>
<td>Full open</td>
<td>0 Torr/sec</td>
<td>0 watt</td>
<td>0.0 volts</td>
<td>0 watt</td>
<td>Off</td>
<td>400 C</td>
<td>0</td>
<td>Off</td>
<td>Off</td>
<td>330 mils</td>
<td>Off</td>
<td>0 sccm</td>
<td>0 sccm</td>
<td>0 sccm</td>
</tr>
</tbody>
</table>
## PECVD NITRIDE PROPERTIES

<table>
<thead>
<tr>
<th>Recipe</th>
<th>B6-10K NIT CON</th>
<th>10K NIT LowSiH</th>
<th>10K Low H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (watts)</td>
<td>600</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Pressure (Torr)</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Gap (mils)</td>
<td>290</td>
<td>330</td>
<td>290</td>
</tr>
<tr>
<td>SiH₄ (sccm)</td>
<td>130</td>
<td>45</td>
<td>75</td>
</tr>
<tr>
<td>NH₃ (sccm)</td>
<td>60</td>
<td>55</td>
<td>0</td>
</tr>
<tr>
<td>N₂ (sccm)</td>
<td>2000</td>
<td>2700</td>
<td>2700</td>
</tr>
<tr>
<td>Index</td>
<td>2.0</td>
<td>1.5</td>
<td>3.3</td>
</tr>
<tr>
<td>Stress (Kpascal)</td>
<td>10 to –10</td>
<td>1000</td>
<td>20</td>
</tr>
<tr>
<td>Al etch rate (Å/min)</td>
<td>3.1</td>
<td>20.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Hot Phos etch rate (Å/min)</td>
<td>890</td>
<td>651</td>
<td>1269</td>
</tr>
<tr>
<td>KOH etch rate (Å/min)</td>
<td>19.3</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>BOE etch rate (Å/min)</td>
<td>290</td>
<td>369</td>
<td>209</td>
</tr>
<tr>
<td>Dep Rate (Å/min)</td>
<td>148</td>
<td>42</td>
<td>67</td>
</tr>
<tr>
<td>Good for LOCOS</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>
MEASURED STRESS IN PECVD NITRIDE

At 600 watts

Stress = 1.5E9 dynes/cm²
At 500 watts
Stress = -4.9E8 dynes/cm²
MEASURED STRESS IN PECVD NITRIDE

At 400 watts
Stress = -7.2E8 dynes/cm²
PECVD OF CARBON FILM (DIAMOND LIKE FILM)

Drytech Quad Tool
CH4 flow 45 sccm
50 mTorr
200 Watt
Deposition Rate ~ 320 Å/min
Index of Refraction = 2.0
These PECVD materials are quite different than oxides and nitrides deposited by thermal oxidation or LPCVD.
REFERENCES