MET HMDS process documentation

We use a Yield Engineering Systems (YES) 5TA vacuum bake / vapor prime system from HMDS deposition. Below we list the configuration parameters of the tool. You'll also find a copy of the technical overview supplied by YES.

Program Select Recipe Define Setting: 1

Temperature Controller Set Points:

Chamber Front Heater Zone: 125°C
Chamber Rear Heater Zone: 125°C

Pressure Setup Parameters (Vapor Prime):

Set Purge Pressure Hi: 500 torr
Set Purge Pressure Low: 10 torr
Base Pressure Trip Point: 1 torr
Set Process Pressure Trip Point: 500 torr
Hi Abort Pressure Trip Point: 600 torr

Process Variables:

Number of dehydration cycle purges: 3
Number of exit cycle purges: 2
Process Duration: 300 seconds

Total cycle time for the recommended process is approximately 31 minutes.
**YES-TA Series**

**Yield Engineering Systems (YES)** introduced a process now commonly known in the semiconductor industry as vacuum bake/vapor prime, a key step in the front end processing of silicon chips. The process dramatically improves the application of hexamethyldisilazane (HMDS) as a surface priming treatment, which is used to enhance adhesion of photoresist on a wafer surface.

Old wet processes for depositing silane generated a substantial amount of hazardous waste. Plus, the coating had a limited lifespan, meaning a process engineer had a small window of time to apply photoresist before the bond would degrade.

But today, using YES-TA™ vacuum bake/vapor prime ovens, you can significantly extend time available between process steps. Plus, chemical usage for a vapor deposition process is typically less than 1% of the amount needed for wet application processes, significantly reducing waste and chemical costs.

**Benefits to Your Process:**
- Chemical deposition uniformity
- Contact angle uniformity within ±3 degrees
- Moisture resistant surface modification
- Increased time available between process steps
- Enhanced photoresist adhesion
- Less chemical usage & chemical cost

**Vacuum Bake**

**The Need for Complete Dehydration**

In order to promote a strong HMDS bond to the substrate, first, wafers must be completely dehydrated—not only surface moisture, but the chemically bound water molecules as well. To achieve this, YES developed a process combining heat with low pressure.

**Vapor Prime**

**Precise Silane Deposition**

Once dehydrated, wafers are then primed with HMDS vapor to strengthen photoresist adhesion. When chemical is applied, a superior bond is formed that is stable even after exposure to atmospheric moisture. Wafers properly treated will last for weeks with no change to surface adhesion.

The quality of the photoresist adhesion forms the basis for all the process steps that follow. Only a totally primed surface will accurately reproduce submicron CDs without undercutting or ragged edges, which can cause problematic electromigration sites.
An Ideal Process Environment

YES-TE Series vacuum bake/vapor prime ovens provide a "one stop" environment for substrate dehydration and vapor deposition of hexamethyldisilazane (HMDS). YES ovens give an HMDS prime layer with superior uniformity and stability.

Each YES-TE oven offers the following features:
1. Nitrogen is preheated prior to entering the chamber to prevent adiabatic cooling.
2. Filtration mechanisms and input locations virtually eliminate introduction of particulates from system sources.
3. Surge suppression systems in the nitrogen input lines significantly limit turbulence and particle introduction typically associated with loading a cassette into the oven.
4. Analog controlled system gives the process engineer the ability to set any temperature and/or time. Any process deviation will sound an alarm.
5. Chamber size and volume is selected for maximum strength, efficiency, and particle control.

The YES-3TA and YES-5TA models are our standard vacuum bake/vapor prime ovens. For increased functionality, please consider our image reversal and dual function models.

YES-3TA, YES-5TA - Vacuum Bake/Vapor Prime
YES-8TA, YES-10TA - Image Reversal
YES-310TA, YES-58TA - Dual Function (vapor prime + image reversal)

In addition to being used for silicon wafer processing, YES-TE ovens can also be utilized for low temperature HMDS priming of gallium arsenide, lithium niobate, and other exotic materials.

Safety

While HMDS is flammable in an oxygen environment, YES-TE Series systems are designed to mitigate risk. This is because oxygen is progressively diluted during each vacuum cycle. To illustrate, if we say "x" is the amount of oxygen in the oven chamber at the onset of the process, then we can show the amount of oxygen at the end of each vacuum cycle:

- Vacuum Cycle 1: x/76
- Vacuum Cycle 2: x/76x76
- Vacuum Cycle 3: x/76x76x76
- Vacuum Cycle 4: x/76x76x76x76

HMDS isn't admitted into the oven chamber until the end of the fourth vacuum cycle.

Image Reversal

The image reversal process reverses the action of positive resist so negative images can be formed with the same resolution and processing ease that a positive resist allows. What's more, image reversal allows variation of the slope of the photoresist sidewall for higher resolution and/or lift off profiles.

Image reversal advantages:
- Improves photoresist resolution and lift off
- Replaces use of harsh chemicals or plasma "metal etch" processes

• Using image reversal on two or more layer resist levels can eliminate residual photoresist along the sidewalls, preventing "shorts" from level to level without reducing line width
• Image reversal done with dark or light fields eliminates standing waves; this allows steep and straight profiles, repeatable results, and excellent chemical deposition uniformity
• Image reversal achieves excellent results for rework problems; the underlying substrate is protected (for a double metal process), so unwanted metal can be stripped away without "pitting" or eroding the underlying level

Why not just use negative resist?
Positive resist offers far better resolution, and it doesn't require solvents for development. In contrast, the resolution limit of negative resist is approximately 1 micron, and it requires solvents known to be carcinogens.

YES image reversal systems deliver anhydrous ammonia (NH₃) into a vacuum oven. There are two advantages of an ammonia system:
1. Repeatable process pressure.
2. An absence of residual water vapor, which reacts with NH₃ to produce NH₂OH, which is corrosive to the system and creates contaminating particles.

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1. Adiabatic cooling occurs when a gas (nitrogen in this case) is caused to suddenly expand into a low-pressure area such as an evacuated oven. Typically, room temperature gas will fall well below freezing as it expands in this environment.
Specifications

**Models**

<table>
<thead>
<tr>
<th>Model</th>
<th>Model YES-3TA</th>
<th>Model YES-5TA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum Bake/Vapor Prime</td>
<td></td>
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</tr>
<tr>
<td>Image Reversal</td>
<td>Model YES-10TA</td>
<td>Model YES-8TA</td>
</tr>
<tr>
<td>Dual Function (vapor prime + image reversal)</td>
<td>Model YES-310TA</td>
<td>Model YES-587A</td>
</tr>
</tbody>
</table>

**Hardware**

<table>
<thead>
<tr>
<th>Clean Room Compatibility</th>
<th>Class 10</th>
<th>Class 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wafer Size</td>
<td>Up to 200mm (8&quot;)</td>
<td>Up to 300mm (12&quot;)</td>
</tr>
<tr>
<td>Capacity</td>
<td>8 cassettes 100mm (4&quot;) wafers 2 cassettes 125mm (5&quot;) wafers 2 cassettes 150mm (6&quot;) wafers 1 cassette 200mm (8&quot;) wafers</td>
<td>12 cassettes 100mm (4&quot;) wafers 8 cassettes 125mm (5&quot;) or 150mm (6&quot;) wafers 2 cassettes 200mm (8&quot;) wafers 2 cassettes 300mm (12&quot;) wafers</td>
</tr>
<tr>
<td>Batch Throughput</td>
<td>2 load/hr vacuum bake/vapor prime 1 load/hr image reversal</td>
<td>2 load/hr vacuum bake/vapor prime 1 load/hr image reversal</td>
</tr>
<tr>
<td>HMDS Usage, Vapor Prime</td>
<td>&lt;4 ml/200 waters (120 prime cycles/pint)</td>
<td>&lt;5 ml/200 waters (75 prime cycles/pint)</td>
</tr>
<tr>
<td>Ammonia Usage, Image Reversal</td>
<td>1 cubic foot</td>
<td>2.5 cubic feet</td>
</tr>
<tr>
<td>Operation Temperature</td>
<td>Ambient to 160°C</td>
<td>Ambient to 160°C</td>
</tr>
<tr>
<td>Interior Chamber Dimensions</td>
<td>30.48 cm (W) x 53.655 cm (D) x 30.48 cm (H) (12&quot; x 13.25&quot; x 12&quot;)</td>
<td>40.64 cm (W) x 45.72 cm (D) x 40.64 cm (H) (16&quot; x 18&quot; x 16&quot;)</td>
</tr>
<tr>
<td>Overall System Dimensions</td>
<td>60.32 cm (W) x 49.53 cm (D) x 69.85 cm (H) (23.75&quot; x 19.5&quot; x 27.5&quot;)</td>
<td>71.12 cm (W) x 59.42 cm (D) x 81.28 cm (H) (28&quot; x 23&quot; x 32&quot;)</td>
</tr>
<tr>
<td>Chamber Material</td>
<td>316L stainless steel, aluminum door plate</td>
<td>316L stainless steel, aluminum door plate</td>
</tr>
<tr>
<td>Process Gas Inputs</td>
<td>1 N₂ vent gas, 1 ammonia, 1 vapor flask</td>
<td>1 N₂ vent gas, 1 ammonia, 1 vapor flask</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>&lt;10 x 1 micron particles per 100 mm wafer</td>
<td>&lt;5 x 1 micron particles per 150 mm wafer</td>
</tr>
<tr>
<td>Nitrogen Consumption</td>
<td>7 SCF per process</td>
<td>16 SCF per process</td>
</tr>
</tbody>
</table>

**Software**

| Number of Recipes | 8 process recipes | 8 process recipes |
| Range of Exposure Time | 0-999999 seconds | 0-999999 seconds |
| Resolution of Timer Setting | 1 second | 1 second |

**Performance**

| Temperature Uniformity | ±5°C after stabilization period | ±5°C after stabilization period |

**Additional**

| Power Requirements | 220VAC, 50/60Hz, 10 amps (European, CE compliant) 115VAC, 50/60Hz, 20 amps (domestic) | 220VAC, 50/60Hz, 10 amps (European, CE compliant) 115VAC, 50/60Hz, 20 amps (domestic) |
| Shipping Weight, Crated (approx.) | 158 kg (350 lbs) | 204 kg (450 lbs) |
| Crate Dimensions | 86.4 cm (W) x 106.7cm (D) x 101.6 cm (H) (34" x 42" x 40") | 93.38 cm (W) x 111.76 cm (D) x 114.3 cm (H) (37" x 44" x 45") |

Call for more details on specific models. All systems include a 1-year warranty for parts and labor.

**Contact Us**

YES has been designing and manufacturing innovative process equipment since 1980. When you're ready to run process tests, a demonstration can be arranged using your chemicals and samples.

Call +1 925-373-8353 (worldwide), 1-888-YES-3637 (US toll free) or visit us online at www.yieldengineering.com. We look forward to meeting your specific process requirements.