YES-TA Series

HMDS Vacuum Bake/Vapor Prime Ovens

Yield Engineering Systems, Inc.

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 hexamethyldisilizane (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.

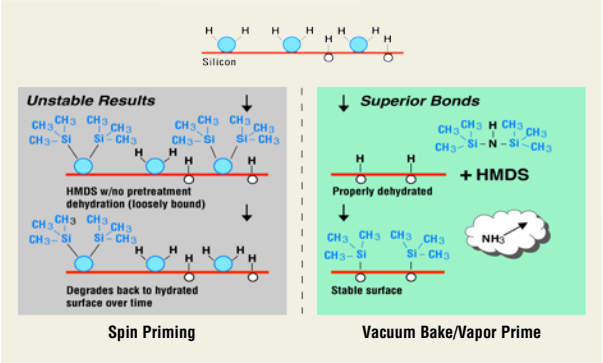
Benefits to Your Process:

- 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 and 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 vapor 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.

Image Reversal

The YES-TA Series ovens are dual function and are capable of vacuum bake/vapor prime and image reversal capabilities. The image reversal process flips 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:

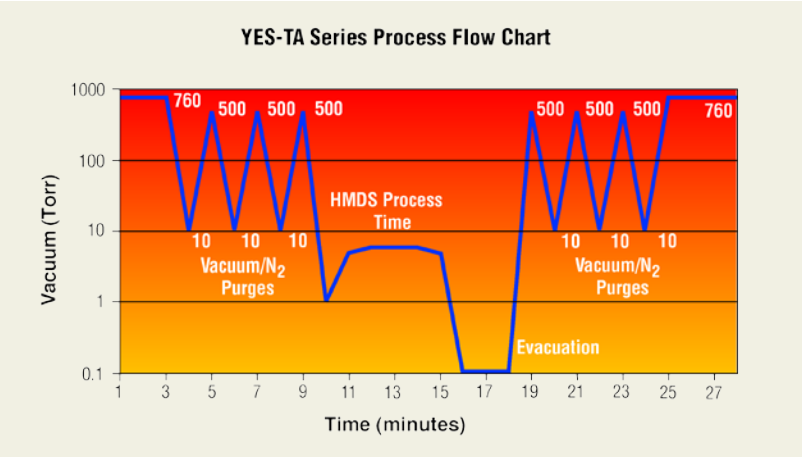
- Improves photoresist resolution and lift off.
- Replaces use of harsh chemicals or plasma "metal etch" processes.
- Image reversal done with dark or light fields eliminates standing waves; this allows steep and straight profiles, repeatable results, and excellent chemical deposition uniformity.
- Image 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 than cyclized rubber negative photoresist, and it uses aqueous-based developer. 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 (NH_3) into a vacuum oven. There are two advantages of using anhydrous ammonia in the system:

1. Repeatable process pressure.
2. An absence of residual water vapor. This prevents a reaction with NH_3, which would produce ammonium hydroxide (NH_4OH). Ammonium hydroxide would be corrosive to the system and would create contaminating particles.



Why not use an in-line priming system?

In-line or track systems are required to process a wafer every minute to keep up with the exposure tools. The throughput requirement leaves inadequate time to dehydrate and properly react the HMDS with the substrate. The result is a poorly primed wafer that may loose adhesion at the extreme resolutions of today's processing requirements.

An Ideal Process Environment

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

Each YES-TA oven offers the following features:

1. Nitrogen is preheated prior to entering chamber to prevent adiabatic cooling. (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).
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. Microprocessor 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.

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

Safety

While HMDS is flammable in an oxygen environment, YES-TA 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/76x76x76x760

HMDS isn't admitted into the oven chamber until the end of the fourth vacuum cycle. Direct measurements have shown less than 5 ppm 0_2 in the chamber after nitrogen purge cycles.

The enclosed flasks offer additional safety while not obstructing accessibility.

Specifications

Hardware	YES-310TA	YES-58TA
Clean Room Compatibility	Class 10	Class 10
Wafer Size	Up to 200mm	Up to 300mm
Capacity	8 cassettes 100mm wafers 2 cassettes 125mm wafers 2 cassettes 150mm wafers 1 cassette 200mm wafers	12 cassettes 100mm wafers 8 cassettes 125mm or 150mm wafers 2 cassettes 200mm wafers 2 cassettes 300mm wafers
Batch Throughput	2 load/hr vacuum bake/vapor prime 1 load/hr image reversal	2 load/hr vacuum bake/vapor prime 1 load/hr image reversa
Operation Temperature	Ambient to 160°C	Ambient to 160°C
Interior Chamber Dimensions	30.48 cm (W) x 33.66 cm (D) x 30.48 cm (H) (12" x 13.25" x 12")	40.64 cm (W) x 45.72 cm (D) x 40.64 cm (H) (16" x 18" x 16")
Overall System Dimensions	63.20 cm (W) x 50.17 cm (D) x 77.29 cm (H) (24.88" x 19.75" x 30.43")	73.51 cm (W) x 62.56 cm (D) x 88.27 cm (H) (28.94" x 24.63" x 34.75")
Chamber Material	316L stainless steel, aluminum door plate	316L stainless steel, aluminum door plate
Process Gas Inputs	1 N_2 vent gas, 1 ammonia, 1 vapor flask	1 N_2 vent gas, 1 ammonia, 1 vapor flask
Cleanliness	<5 x 1 micron particles per 150 mm wafer	<5 x 1 micron particles per 150 mm wafer
Nitrogen Consumption	7 SCF per process	16 SCF per process
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	188-253VAC, 50/60Hz, 10 amps	188-253VAC, 50/60Hz, 10 amps
Shipping Weight, Crated (approx.)	158 kg (350 lbs)	181.44 kg (400 lbs)
Crate Dimensions	86 cm (W) x 107 cm (D) x 102 cm (H) (34" x 42" x 40")	96.52 cm (W) x 111.76 cm (D) x 114.3 cm (H) (38" x 44" x 45")

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.

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.

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