

YES Equipment Solutions for Imprint Lithography

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A successful imprint process begins with surface preparation. High adhesion between the substrate and the imprint material is critical to ensure that imprinted film does not delaminate from the substrate. Low adhesion to the master mold surface is needed when the imprinted film and mold are separated. YES's inductively coupled plasma cleaning tools strip contaminants from the surface of the substrate prior to application of vapor-deposited self-assembled monolayers (SAMs) of a functionalized silane. Currently in widespread use in the semiconductor industry to promote adhesion of photoresists to Si wafers using Hexa-Methyl-Di-Silazane (HMDS), all aspects of this process can be tailored to specific material systems. YES has demonstrated >100 chemical processes for a wide range of purposes.

- Alkyl Silane Compounds (such as OTS,OTES, HMDS, etc.)
 - Create surfaces with various surface tension to promote adhesion and act as moisture barriers
 - Contact Angle: 64° - 107°
- Amino Group (such as APTES, APTMS, etc.)
 - Create a positively charged reactive surface. Acts as an adhesion promoter for epoxy-based resist or organic materials such as DNA
 - Contact Angle: 50° - 74°
- Epoxy, Acrylate, Methacrylate Compounds (such as GOPS, Valmat, etc.)
 - Create a reactive surface, hydrophilic surface. Epoxy rings are easily reacted to form alcohols or to bind
 - Contact Angle: 45° - 75°
- Fluorinated Compounds (such as FDTS, FOTS, etc)
 - Create extremely hydrophobic or anti-corrosion coatings
 - Contact Angle: 100° - 133°
- Thiol, PEG, or Isocyanate Functional Silane

For imprint materials processed from solution, complete removal of residual solvents is key to achieving repeatable and uniform results. With approximately 1% temperature uniformity over the volume of the process chamber and automated process controls, YES's vacuum cure ovens are effective at removing residual solvents such that imprint material properties are uniform wafer-to-wafer and lot-to-lot. As shown in Table 1, <1% temperature uniformity (1 sigma) results in superior film uniformity as indicated by Water Contact Angle (WCA) of APTES (3-Amino-Propyl-Tri-Ethoxy-Silane) film on Si wafer.

YES provides equipment ranging from laboratory systems to high volume manufacturing solutions that leverage the demanding requirements of the semiconductor industry for accuracy and repeatability to produce resist films that generate the highest fidelity imprints. List of equipment and main applications has been summarized by the following as well as in Table 2.

- EcoClean Systems: Automated plasma surface cleaning solution.
- EcoCoat Systems: Vapor phase deposition of functionalized silane SAMs for adhesion promotion with excellent repeatability and precision.
- VertaCure System: Vacuum-based, low temperature curing.

Table 1: Temp uniformity of ÉcoCoat and superior film uniformity indicated by WCA of APTES.

Position	Temperature Average	Temperature Uniformity (1 sigma)	WCA Average of APTES	WCA Uniformity of APTES (1 sigma)
Top shelves	152.6°C	0.36%	60.5	2.24%
Middle shelves	152.2°C	0.29%	60.9	1.69%
Bottom shelves	153.2°C	0.72%		
All points	152.7°C	0.53%	60.7	1.90%

Table 2: List of YES Clean, Coat and Cure equipment and representative applications.

Clean	Coat	Cure
<p>Plasma Clean System 200mm (Manual)</p>  <p>Plasma Clean</p>	<p>ÉcoCoat / 58TA, 310TA</p>  <p>HMDS Vapor Prime/Image Reversal</p>	<p>PB Series Cure System PB6/PB8/PB12 Vacuum Cure</p>  <p>Polyimide/BCB/PBO/Low Temp Polymer Cure</p>
<p>ÉcoClean 200mm Clean 300mm (Automated)</p>  <p>Photoresist Strip/Clean/Descum</p>	<p>VertaCoat (Monolayer Vapor Deposition)</p>  <p>SAMs Silane Prime</p>	<p>VertaCure 300mm Vacuum Cure (Panel)</p>  <p>Polyimide/BCB/Other Polymer Cure</p>