HD MicroSystems™
An Enterprise of Hitachi Chemical and DuPont Electronics

Revised September 2008

PROCESS GUIDE

HD-3007 Polyimide Adhesive

HD-3007 is a non-photodefinable polyimide designed for use as a temporary or permanent adhesive in 3D packaging applications. These polyimides exhibit thermoplastic behavior after cure and during bonding at moderate temperature and pressure. HD-3007 has high adhesion to silicon, glass, polyimide and other substrates.

Process Guide Note:
These process recommendations are based on our current best understanding of conditions for using HD-3007 as a bonding adhesive for 3D packaging. Process recommendations will be enhanced as our knowledge of this application increases.

Summary of Process Conditions

1. Spin-Coat: 2000 – 3000 rpm, 30 – 60 sec.
2. Soft-Bake: 120°C/90 sec. (hot plate)
3. Cure: 280 - 350°C / 60 minutes (oven)
4. Bond: 350°C, >10 psi, 10 minutes
5. De-Bond using: Laser, solvent or thermal
6. Die-Bond: 275°C, 14Kg/cm^2, 3 seconds

Detailed Process Conditions

1. Spin-Coat
   Dispense the HD-3007 polyimide to the center of the wafer. Spin at 1000 rpm for 5 seconds to spread the HD-3007. Spin at speed for 30-60 seconds to obtain desired thickness. Typical spin conditions and film thicknesses are shown in Table 1. For best uniformity, a dynamic dispense is preferred. If static dispense is used, dispense carefully to the center of the wafer. Dispense amounts depend on wafer size and spin conditions and should be optimized for the coating tool.

Table 1.
Spin Speed vs. Film Thickness

Spin Speed (rpm)	Spin Time (sec.)	Soft-Baked Thickness (µm)	Cured Thickness (µm)
1500	60	6.60	5.06
2000	60	4.98	3.84
2500	60	4.02	3.13
3000	60	3.37	2.64

2. Soft-bake / B-stage
   This bake step is necessary to allow evaporation of solvent and water from the applied HD-3007 and obtain a tack free film. Soft-bake on a hot-plate for 90 sec. at 90°C and then 90 sec. at 120°C. If available, a proximity hot plate bake is preferred.

3. Cure
   Coated substrates should be cured under nitrogen or other inert atmosphere. A recommended procedure for curing in an oven is:

   - Ramp at 5°C/min to 200°C and hold for 30 minutes.
   - Ramp at 5°C/min to 300°C and hold for 60 minutes.
   - Cool slowly (ramp rate <10 °C/min) to below 150°C.
   - Cool to below 40°C before removing from the oven.

   Cure temperatures from 280 to 350°C should give adequate cure and removal of volatiles. Cure should be at or slightly below the bonding temperature.

   Note: Above 200°C, HD-3007 films have high tack so place the coated substrates in the cure oven in a manner that avoids contact of the HD-3007 with wafer boats or oven surfaces.

4. Wafer Bond Process

Wafers coated with HD-3007 can be bonded to a support wafer in preparation for back-grinding and thinning. Proper bonding requires flow of the HD-3007 to cover the wafer edge, reduce thickness non-uniformity at the edge-bead, and compensate for non-uniform heat and pressure at the wafer clamps.

Inert atmosphere is recommended during the bonding step and bonding under vacuum is preferred. Parts that are to be bonded should be aligned and brought to the bonding temperature. Thermal ramp rates will vary depending on the bonding tool and the parts to be bonded. HD-3007 can be heated at ramp rates of 20°C/min, however lower rates may be required to reduce thermal stress on the parts.

When the parts reach the target bonding temperature, the bonding faces should be brought into contact and pressure slowly increased until the target bond pressure is obtained. With a four micron cured layer of HD-3007, bonding can be accomplished at 350°C with >10 psi pressure and a 10 min. bond time.

Required bonding temperature, pressure, and time may vary depending on the thickness of adhesive coated and the substrate topography and are subject to test and adjustment. In general, lower bonding temperatures and pressures will require longer bonding times to get adequate flow and adhesion. Thicker films of HD-3007 can be bonded at shorter times or lower temperatures.

5. Wafer De-Bond Process

Preliminary experiments with HD-3007 suggest that wafer de-bonding can be accomplished using laser-release, solvent-release or thermal-release techniques.

Laser release is accomplished by irradiation through a glass carrier with a 248 or 308 nm laser. In a typical process, the wafer is mounted on a CNC controlled stage and is moved beneath the stationary laser beam. The process details will depend on the capabilities of the laser and of the moving stage. For example, a 248 nm laser with maximum pulse energy of 800 mJ was run at 30 Hz pulse repetition rate and defocused to deliver 200 mJ/cm^2 over a 1.01 mm x 1.01 mm target size. The glass/silicon bonded wafer pair was moved beneath the pulsed beam at 30 mm/sec., so that pulses overlapped by 10µm. Under these conditions, the glass carrier was cleanly de-bonded from the silicon wafer at the rate of 20 cm^2/min.

Note that a single laser pulse is sufficient to cause de-bonding. Throughput can be increased by using a higher power laser for increased spot size and by simultaneously increasing the pulse repetition rate and the stage translation speed.

Solvent release requires the use of perforated carrier wafers and is best accomplished with N-methyl pyrrolidinone solvent.

Thermal release requires appropriate de-bonding equipment and is accomplished at temperatures comparable to bonding temperature. We found that at 250°C, the lap shear strength of HD-3007 was approximately 20 pli. Experiments are in progress to better define the de-bond process conditions.

Residue removal after the carrier has been de-bonded from the wafer can be accomplished either by dissolution or by dry etching. N-methyl pyrrolidinone solvent can be used to remove HD-3007 after de-bonding. A four micron thick film can be removed with NMP using a solvent developer track by forming a puddle on the surface of the film with NMP, holding for 90 – 120 s, rinsing off the surface while spinning the part, and repeating with a second puddle step. Residual NMP is removed with a lower boiling solvent (e.g. PGMEA), followed by a high speed spin.

Specific dry etch conditions depend on the etch tool (plasma or RIE) and the amount of residue to be removed. An etch gas composition of 75–80% oxygen and 15–20% CF_4 is typical for polyimides. Power density is usually 200 – 500 watts and vacuum pressure in the range of 100 – 500 mTorr.

6. Die Bond Process

Die to wafer bonding can be accomplished with HD-3007 using standard die bonding equipment. The HD-3007 adhesive can be applied either to the wafer surface to which the bond will be made, or can be applied to a wafer prior to die singulation. Recommended bonding conditions are: temperature ≥ 275°C, pressure = 14 kg/cm^2 and time = 3 s. Under these conditions, die shear testing results in cracking of the die rather than adhesive or cohesive failure of the HD-3007.

Solution Properties (Typical Data)

	HD-3007
Solids content (%)	24 – 26%
Viscosity (cPs)	1100 - 1300
Water (%)	1.0 max.
Solvent Composition	BLO/PGMEA 88/12
Chloride Content	1.0 ppm max.
Sodium Content	1.0 ppm max.
Potassium Content	1.0 ppm max.
Copper Content	1.0 ppm max.
Iron Content	1.0 ppm max.
Total Metals	10.0 ppm max.

Cured Film Properties (Typical Data)

	HD-3007
Cure Condition	250°C, 60 min.
Modulus (GPa)	3.3
Tensile Strength (MPa)	130
Break Elongation (%)	5 - 10
Residual Stress (MPa)	34
CTE (ppm/°C)	65
Tg (°C)	180
Weight Loss (%)	
450°C, 1 hr	1.95
350°C, 1 hr	1.3

United States

HD MicroSystems
250 Cheesequake Road
Parlin, NJ 08859-1241
800-346-5656 ext. 13, 14 (Phone)
732-613-2502 (Fax)

10080 North Wolfe Road, SW3-200
Cupertino, CA 95014
800-346-5656 ext. 11 (Phone)
408-996-0508 (Fax)

Japan

HD MicroSystems, Ltd.
Nikkyohan Building 3F
4-25 Koraku 1-Chome, Bunkyo-ku
Tokyo 112-0004, Japan
81-3-3868-8124 (Phone)
81-3-3868-8126 (Fax)

Europe

HD MicroSystems GmbH
Hugenottenallee 173-175
63263 Neu-Isenburg
Germany
49-6102-18-1823 (Phone)
49-6102-18-1824 (Fax)

Internet

www.hdmicrosystems.com