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PRODUCT BULLETIN

HD-7010 Polyimide

HD-7010 is a negative-tone, solvent developed, photodefinable polyimide which is being used commercially as a high temperature adhesive layer between semiconductor chips. The material is a self-priming photodefinable polyimide precursor that can be patternered to cleanly resolve micron scale relief patterns with controlled size and wall profiles without the need for photoresists.

Features offered by HD-7010 include:

- Negative-tone and both Broadband and I-line photodefinable
- Good room temperature (RT) viscosity stability, with wide process latitude
- Sloped sidewall profile with no crown after cure
- Low residual stress and small cure shrinkage
- Wide process latitude between prebake to exposure and exposure to develop
- Good copper migration resistance

Process Details

Coating

HD-7010 can be coated onto a variety of metals, alloys, semiconductor and ceramic substrates. Bonding of the polyimide to the substrate is achieved during the softbake cycle as the priming chemistry is activated by temperature.

Substrates should be clean and dry prior to use. Oxygen plasma cleaning followed by a wet clean-up with an organic stripper solution to remove organic contaminates is recommended.

The polyimide solution is highly viscous. It may be necessary to have a short delay prior to spin to allow the polyimide to flow as far as possible and relax.

The final spin speed and time is determined by the film thickness required (see the spin speed curve on following page). Longer spin times will improve coating uniformity, but will also reduce the film thickness. The recommended spin speed range is 1500–4500 rpms and the recommended spin time is 30–60 seconds.

In semiconductor applications, an Edge Bead Removal (EBR) and Backside Rinse process may be added to the coating cycle to remove polyimide from the edge and back of the wafer prior to baking. NMP (N-methyl-2-pyrrolidone) or NMP/IPA (isopropanol) can be used for this purpose.

Soft Bake

After application of the polyimide, a bake process is required. The purpose is to drive off carrier solvents to produce a tack free surface for exposure and to provide sufficient chemical resistance and adhesion so that the exposed areas of the coating will not be attacked or delaminated by the developer.

With this coating, it is recommended that at least two hot plates be used to increase soft bake temperature in steps. Coated substrates should be soft baked from 70°C–120°C, for 60–240 seconds on each hot plate. Too high or fast a temperature bake can lead to bubble entrapment and a poor coating surface.

Once soft baked, the coated substrates may be stored for up to 48 hours in a wafer cassette box under cleanroom conditions prior to exposure.

Exposure

The amount of exposure energy required for optimum resolution or wall shape depends on the coating thickness, underlying surface reflectivity, structure size and feature uniformity. Most applications use between 150 – 400 mj I-line. Depth of focus will impact resolution, feature size and sidewall shape. Typical settings are from +2.0 to -4.0μm from the top surface. Broadband exposure

can also be used effectively, resulting in shorter exposure times.

Once exposed, the substrates can be stored for up to 48 hours in a wafer cassette box under cleanroom conditions prior to development. However, all substrates should be held a minimum of 30 minutes prior to development for optimal resolution. Post exposure bakes (PEBs) may lower the exposure energy required. This process works especially well on linked stepper/developer tracks. Typical conditions are 70°C–120°C for 30–90 seconds.

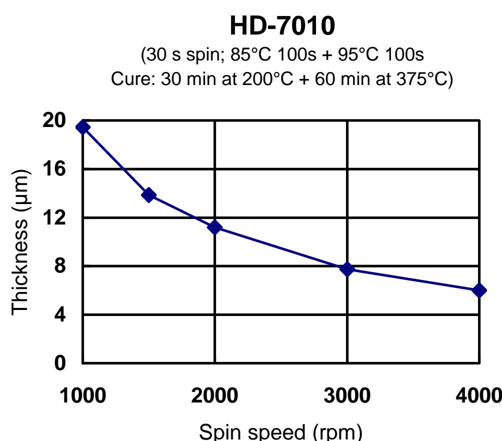
Development

Substrates patterns can be developed using either a spray or puddle process. In the spray process, PA-400D or PA-401D developer is sprayed onto a slowly spinning wafer (1000 rpm) for a set time (10–60 seconds). This is followed by a five to ten second overlap with the rinse and then a complete rinse (5–15 seconds) with PA-400R or PA-401R. The wafer is then spun dry (3000rpm).

In a puddle process, the developer is puddled onto a stationary wafer. After a set time (20-60 seconds), the rinse is applied and the wafer is spun dry. A double puddle may be used on thicker films – the developer is applied, spun off, re-applied and then rinsed.

A post-develop bake (PDB) may be used to modify the wall slope. Conditions vary from 150°C–200°C for 60–300 seconds.

Spin Speed Curves for Cured Polyimide



Example of Typical Process Conditions

Apply Coating
- Dispense on static substrate
- Spread at 500rpm for 5 seconds
- Spin at final speed for 30 seconds
- EBR / Backside rinse, 10 seconds
- Spin Dry, 15 seconds
- Hot plate bake at 70°C for 240 seconds, followed by 120°C for 240 seconds.
- Maximum hold time 48 hours

Expose – 300mj, I-line

Post Exposure
- Hold for 30 minutes minimum
- Optional bake, 110°C for 60 seconds
- Maximum hold time 48 hours

Develop

Developer: PA-400D or PA-401D
Rinse: PA-400R or PA-401R
Spray Development Process:

- Spray (1000rpm) 90 seconds
- Overlap (1000rpm) 10 seconds
- Rinse (1000rpm) 10 seconds
- Spin Dry (3000rpm) 30 seconds

Cure (in Nitrogen)
- Heat from RT to 200°C, ramp rate 5°C/min
- Hold 200°C, 30 minutes
- Heat to 375°C, ramp rate 10°C/min
- Hold at 375°C for 60 minutes
- Gradual cooling to RT

Cure

The objectives of a proper cure schedule are to: 1) remove residual solvents, 2) complete the imidization process, 3) remove photopolymer cross links, and 4) complete the adhesion process. The recommended final cure condition is ranges from 350°C to 400°C. See chart on the next page for the effects of cure temperature and time on final film properties.

The recommended ramp rate is 10°C/minute in a diffusion furnace or programmable oven with a 200°C hold for 30 minutes. Curing is performed under a nitrogen ambient (oxygen concentration <800ppm). The furnace can be cleaned with a 700°C cycle for one hour with an air atmosphere.

Rework

Before curing, HD-7010 can be stripped with commercial cleaners commonly recommended for polyimide removal. Oxygen plasma etching can be used to remove both uncured and cured polyimide. The cured film can also be stripped by 49% HF solution.

Storage/Shelf Life

HD-7010 is extremely stable. It can be kept at clean room temperatures (21°C) for about four weeks with no significant change in properties. When stored at -18°C, shelf-life is two years from date of manufacture. Moisture contamination is detrimental to stability and must be avoided. Containers should be brought to room temperature before opening to avoid moisture condensation inside the bottle.

Solution Properties

	HD-7010
Solids content (%)	R&R
Viscosity (cSt)	R&R
Water (%)	1.0 max.
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)

Cure Condition (Temp/Time)	Tensile Strength (MPa)	Elongation (%)	Modulus (Gpa)	Residual Stress (MPa)	CTE (ppm)	Tg (^oC)	Weight Loss Temperature		
							1%	3%	5%
400°C/60min	175	55	2.9	-	50	285	415	435	465
375°C/60min	175	75	2.6	30.3	50	270	410	425	460
350°C/60min	175	75	2.6	29.8	70	260	370	390	410
320°C/60min	175	80	2.5	27.6	80	235	-	-	345
300°C/60min	170	75	2.5	28.4	90	230	-	-	335

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Caution: Do not use in medical applications involving permanent implantation in the human body