Substrate Preparation

To obtain maximum process reliability, substrates should be clean and dry prior to applying SU-8 2000 resist. For best results, substrates should be cleaned with a piranha wet etch (using H_2SO_4 & H_2O_2) followed by a de-ionized water rinse. Substrates may also be cleaned using reactive ion etching (RIE) or any barrel asher supplied with oxygen. Adhesion promoters are typically not required. For applications that include electroplating, a pre-treatment of the substrate with MCC Primer 80/20 (HMDS) is recommended.

Coat

SU-8 2000 resists are available in twelve standard viscosities. This processing guideline document addresses six products: SU-8 2000.5, SU-8 2002, SU-8 2005, SU-8 2007, SU-8 2010 and SU-8 2015. Figures 1.a. and 1.b. provide the information required to select the appropriate SU-8 2000 resist and spin conditions to achieve the desired film thickness.

Recommended Program

1.) Dispense 1ml of resist for each inch (25mm) of substrate diameter.
2.) Spin at 500 rpm for 5-10 seconds with acceleration of 100 rpm/second.
3.) Spin at 2000 rpm for 30 seconds with acceleration of 300 rpm/second.

Figure 1.a. SU-8 2000 Spin Speed vs. Thickness

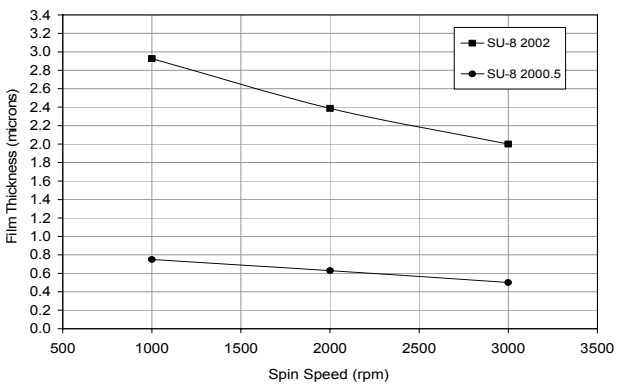


Figure 1.b. SU- 8 2000 Spin Speed vs. Thickness

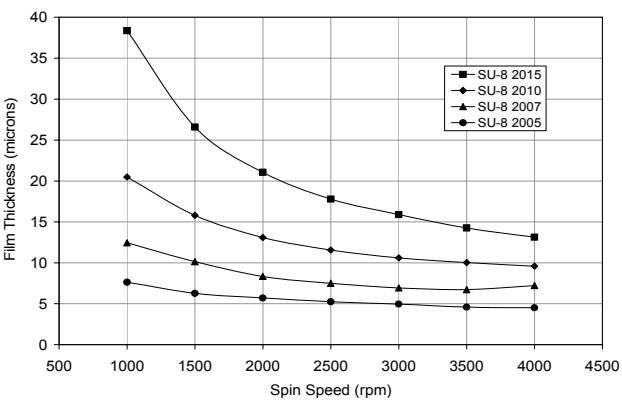


Table 1. SU-8 2000 Viscosity

SU-8 2000	% Solids	Viscosity (cSt)	Density (g/ml)
2000.5	14.3	2.49	1.070
2002	29.00	7.5	1.123
2005	45.00	45	1.164
2007	52.50	140	1.175
2010	58.00	380	1.187
2015	63.45	1250	1.200

Edge Bead Removal (EBR)

During the spin coat process step, a build up of photoresist may occur on the edge of the substrate. In order to minimize contamination of the hotplate, this thick bead should be removed. This can be accomplished by using a small stream of solvent (MicroChem's EBR PG) at the edge of the wafer either at the top or from the bottom. Most automated spin coaters now have this feature and can be programmed to do this automatically.

By removing any edge bead, the photomask can be placed into close contact with the wafer, resulting in improved resolution and aspect ratio.

Soft Bake

A level hotplate with good thermal control and uniformity is recommended for use during the Soft Bake step of the process. Convection ovens are not recommended. During convection oven baking, a skin may form on the resist. This skin can inhibit the evolution of solvent, resulting in incomplete drying of the film and/or extended bake times. Table 2. shows the recommended Soft Bake temperatures and times for the various SU-8 2000 products at selected film thicknesses.

Note: *To optimize the baking times/conditions, remove the wafer from the hotplate after the prescribed time and allow it to cool to room temperature. Then, return the wafer to the hotplate. If the film 'wrinkles', leave the wafer on the hotplate for a few more minutes. Repeat the cool-down and heat-up cycle until 'wrinkles' are no longer seen in the film.*

THICKNESS	SOFT BAKE TIME
microns	minutes @ 95°C
0.5 - 2	1
3 - 5	2
6 - 15	2 - 3
16 - 25	3 - 4
26 - 40	4 - 5

Table 2. Soft Bake Times

Optical Parameters

The dispersion curve and Cauchy coefficients are shown in Figure 3. This information is useful for film thickness measurements based on ellipsomety and other optical measurements.

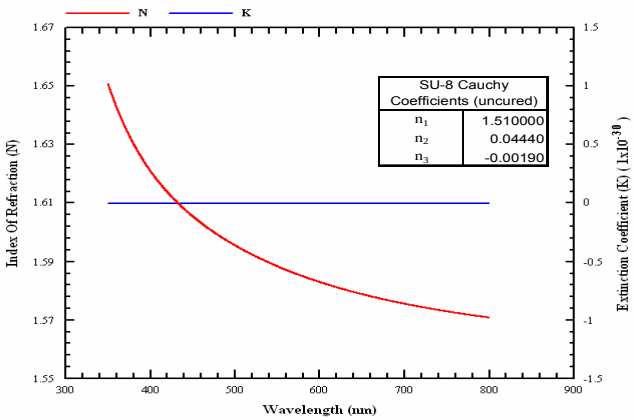


Figure 3. Cauchy Coefficients

Exposure

SU-8 2000 is optimized for near UV (350-400 nm) exposure and i-line tools are recommended. SU-8 2000 is virtually transparent and insensitive above 400 nm and has high actinic absorption below 350 nm.

To obtain vertical sidewalls in the SU-8 2000 resist, we recommend the use of a long pass filter to eliminate UV radiation below 350 nm. With the recommended filter (PL-360-LP) from Omega Optical (www.omegafilters.com) or Asahi Technoglass filters V-42 plus UV-D35 (www.atgc.co.jp), an increase in exposure time of approximately 40% is required to reach the optimum exposure dose.

Note: *With optimal exposure, a visible latent image will be seen in the film within 5-15 seconds after being placed on the PEB hotplate and not before. An exposure matrix experiment should be performed to determine the optimum dosage.*

THICKNESS microns	EXPOSURE ENERGY mJ/cm^2
0.5 - 2	60 - 80
3 - 5	90 - 105
6 - 15	110 - 140
16 - 25	140 - 150
26 - 40	150 - 160

Table 3. Exposure Dose

	RELATIVE DOSE
Silicon	1X
Glass	1.5X
Pyrex	1.5X
Indium Tin Oxide	1.5X
Silicon Nitride	1.5 - 2X
Gold	1.5 - 2X
Aluminum	1.5 - 2X
Nickel Iron	1.5 - 2X
Copper	1.5 - 2X
Nickel	1.5 - 2X
Titanium	1.5 - 2X

Table 4. Exposure Doses for Various Substrates

Post Exposure Bake (PEB)

PEB should take place directly after exposure. Table 5. shows the recommended times and temperatures

Note: *After 1 minute of PEB at 95°C, an image of the mask should be visible in the SU-8 2000 photoresist coating. If no visible latent image is seen during or after PEB this means that there was insufficient exposure, heating or both.*

THICKNESS microns	POST EXPOSURE BAKE TIME minutes @ 95°C
0.5 - 2	1 - 2
3 - 5	2 - 3
6 - 15	3 - 4
16 - 25	4 - 5
26 - 40	5 - 6

Table 5. Post Exposure Bake Times

Development

SU-8 2000 photoresist has been designed for use in immersion, spray or spray-puddle processes with MicroChem's SU-8 developer. Other solvent based developers such as ethyl lactate and diacetone alcohol may also be used. Strong agitation is recommended when developing high aspect ratio and/or thick film structures. The recommended development times for immersion processes are given in Table 6. These development times are approximate, since actual dissolution rates can vary widely as a function of agitation

Note: *The use of an ultrasonic or megasonic bath may be helpful when developing out via or hole patterns or structures with tight pitch.*

THICKNESS microns	DEVELOPMENT TIME minutes
0.5 - 2	1
3 - 5	1
6 - 15	2 - 3
16 - 25	3 - 4
26 - 40	4 - 5

Table 6. Development Times for SU-8 Developer

Rinse and Dry

When using SU-8 developer, spray and wash the developed image with fresh solution for approximately 10 seconds, followed by a second spray/wash with Isopropyl Alcohol (IPA) for another 10 seconds. Air dry with filtered, pressurized air or nitrogen.

Note: *A white film produced during IPA rinse is an indication of underdevelopment of the unexposed photoresist. Simply immerse or spray the substrate with additional SU-8 developer to remove the white film and complete the development process. Repeat the rinse step.*

The use of an ultrasonic or megasonic bath will energize the solvent and allow for more effective development of the unexposed resist.

Physical Properties

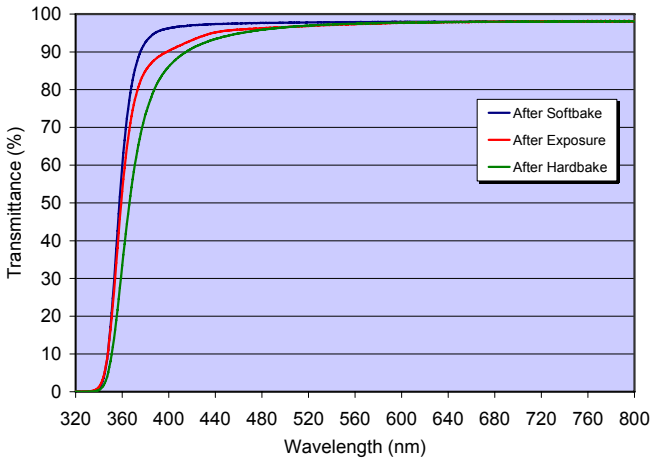
(Approximate values)

Adhesion Strength (mPa) Silicon/Glass/Glass & HMDS	38/35/35
Glass Transition Temperature (Tg °C), tan δ peak	210
Thermal Stability (°C @ 5% wt. loss)	315
Thermal Conductivity (W/mK)	0.3
Coeff. of Thermal Expansion (CTE ppm)	52
Tensile Strength (Mpa)	60
Elongation at break (εb %)	6.5
Young's Modulus (Gpa)	2.0
Dielectric Constant @ 10MHz	3.2
Water Absorption (% 85°C/85 RH)	0.65

Table 7. Physical Propeties

Optical Properties

Figure 4. Optical Transmittance



Process conditions for Figure 4.
Softbake: 5 minutes at 95°C
Exposure: 180 mJ/cm^2
Hardbake: 30 minutes at 300°C

Hard Bake (cure)

SU-8 2000 has good mechanical properties. However, for applications where the imaged resist is to be left as part of the final device, a hard bake can be incorporated into the process. This is generally only required if the final device or part is to be subject to thermal processing during regular operation. A hard bake or final cure step is added to ensure that SU-8 2000 properties do not change in actual use. SU-8 2000 is a thermal resin and as such its properties can continue to change when exposed to a higher temperature than previously encountered. We recommend using a final bake temperature 10°C higher than the maximum expected device operating temperature. Depending on the degree of cure required, a bake temperature in the range of 150°C to 250°C and for a time between 5 and 30 minutes is typically used.

Note: *The hard bake step is also useful for annealing any surface cracks that may be evident after development. The recommended step is to bake at 150°C for a couple of minutes. This applies to all film thicknesses.*

Removal

SU-8 2000 has been designed as a permanent, highly cross-linked epoxy material and it is extremely difficult to remove it with conventional solvent based resist strippers. MicroChem's Remover PG will swell and lift off minimally cross-linked SU-8 2000. However, if OmniCoat (30-100 nm) has been applied, immersion in Remover PG can effect a clean and thorough Lift-Off of the SU-8 2000 material. Fully cured or hard baked SU-8 2000 cannot be removed without the use of OmniCoat.

To remove minimally cross-linked SU-8 2000, or when using Omnicoat: Heat the Remover PG bath to 50-80°C and immerse the substrates for 30-90 minutes. Actual strip time will depend on resist thickness and cross-link density For more information on MicroChem Omnicoat and Remover PG please see the relevant product data sheets.

To re-work fully cross-linked SU-8 2000: Wafers can be stripped using oxidizing acid solutions such as piranha etch, plasma ash, RIE, laser ablation and pyrolysis.

Plasma Removal

RIE 200W, 80 sccm O_2, 8 sccm CF_4, 100mTorr, 10°C

Storage

Store SU-8 2000 resists upright and in tightly closed containers in a cool, dry environment away from direct sunlight at a temperature of 40-70°F (4-21°C). Store away from light, acids, heat and sources of ignition. Shelf life is twelve months from date of manufacture.

Disposal

SU-8 2000 resists may be included with other waste containing similar organic solvents to be discarded for destruction or reclaim in accordance with local state and federal regulations. It is the responsibility of the customer to ensure the disposal of SU-8 2000 resists and residues made in observance all federal, state, and local environmental regulations.

Environmental, Health and Safety

Consult the product Material Safety Data Sheet before working with SU-8 2000 resists. Handle with care. Wear chemical goggles, chemical gloves and suitable protective clothing when handling SU-8 2000 resists. Do not get into eyes, or onto skin or clothing. Use with adequate ventilation to avoid breathing vapors or mist. In case of contact with skin, wash affected area with soap and water. In case of contact with eyes, rinse immediately with water and flush for 15 minutes lifting eyelids frequently. Get emergency medical assistance.

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