TECHNICAL DATA SHEET

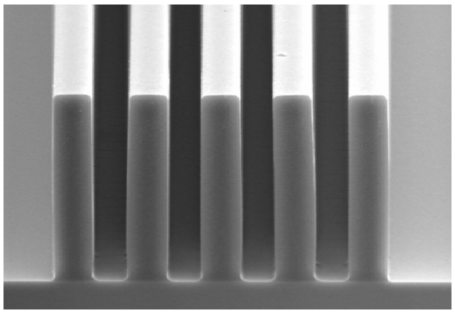
SU-8 3000 Permanent Negative Epoxy Photoresist

Description

SU-8 3000 is a high contrast, epoxy based photoresist designed for micromachining and other microelectronic applications, where a thick, chemically and thermally stable image is desired. SU-8 3000 is an improved formulation of SU-8 and SU-8 2000, which has been widely used by MEMS producers for many years. SU-8 3000 has been formulated for improved adhesion and reduced coating stress. The viscosity range of SU-8 3000 allows for film thicknesses of 4 to 100 μm in a single coat. SU-8 3000 has excellent imaging characteristics and is capable of producing very high, over 5:1 aspect ratio structures. SU-8 3000 has very high optical transmission above 360 nm, which makes it ideally suited for imaging near vertical sidewalls in very thick films. SU-8 3000 is best suited for permanent applications where it is imaged, cured and left on the device.

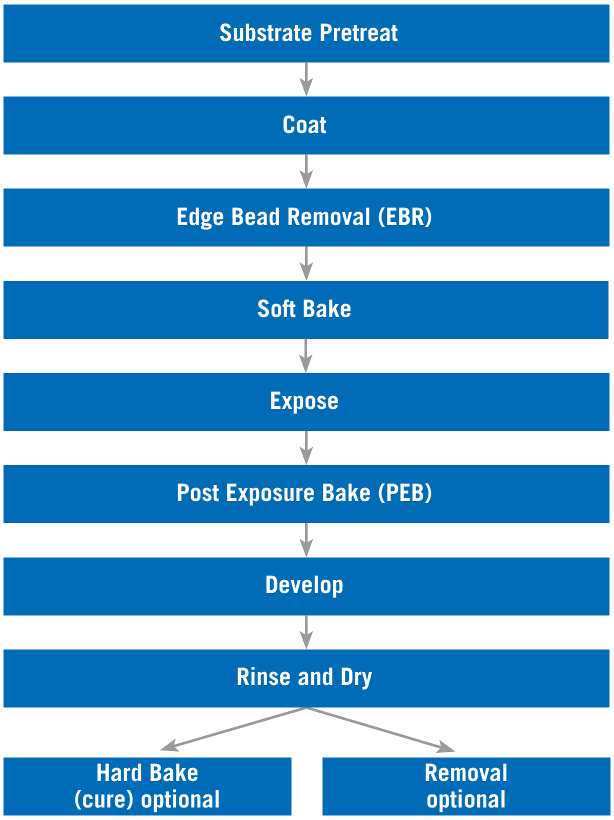
Features

- Improved adhesion
- Reduced coating stress
- High aspect ratio imaging
- Vertical sidewalls
- Up to 100 μm film thickness in a single coat
- Excellent dry etch resistance



Contact aligner exposure
10 μm features, 50 μm SU-8 3000 coating

Process Flow



PROCESSING GUIDELINES

SU-8 3000 is most commonly exposed with conventional i-Line and broadband UV (350-400 nm) radiation, although i-Line (365 nm) is recommended. It may also be exposed with e-beam or x-ray radiation. Upon exposure, cross-linking proceeds in two steps: (1) formation of a strong acid during the exposure step, followed by (2) acid-catalyzed, thermally driven epoxy cross-linking during the post exposure bake (PEB) step. A normal process is: spin coat, soft bake, expose, PEB, followed by develop.

Substrate Preparation

To obtain maximum process reliability, substrates should be clean and dry prior to applying SU-8 3000 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 O_2. Adhesion promoters are typically not required. For applications that require electroplating, it is recommended to pre-treat the substrate with HMDS.

Coat

SU-8 3000 resists are available in five standard viscosities, shown in Table 1. Figure 1 provides the information required to select the appropriate SU-8 3000 resist and spin conditions to achieve the desired film thickness.

Recommended Program

(1) Dispense 1 ml of resist for each inch (25 mm) of substrate diameter

(2) Spin at 500 rpm for 5-10 sec with acceleration of 100 rpm/second

(3) Spin at 3000 rpm for 30 sec with acceleration of 300 rpm/second

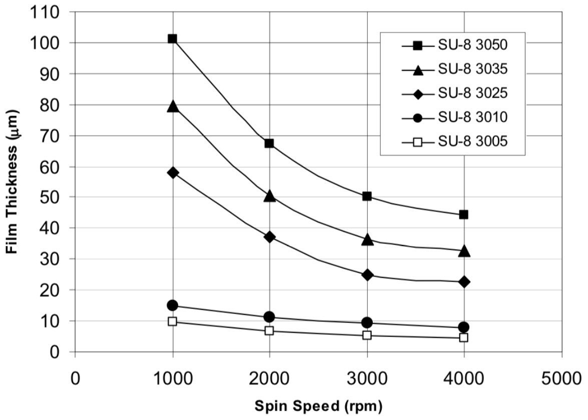


Figure 1. SU-8 3000 Thickness vs. Spin Speed (21ºC US & EU)

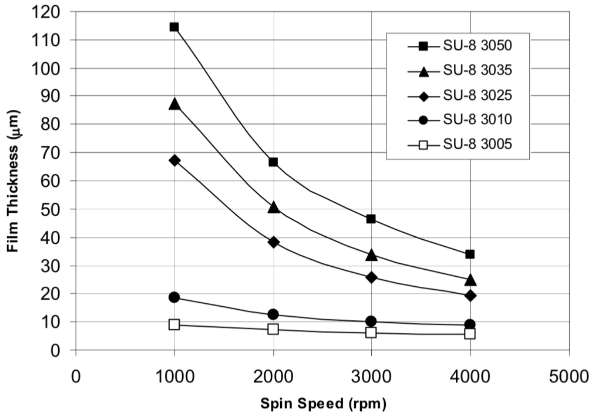


Figure 2. SU-8 3000 Thickness vs. Spin Speed (23ºC Japan & Asia)

SU-8 3000	% Solids	Viscosity (cSt)	Density (g/ml)
3005	50	65	1.075
3010	60.4	340	1.106
3025	72.3	4400	1.143
3035	74.4	7400	1.147
3050	75.5	12000	1.153

Table 1. SU-8 3000 Viscosity

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 (Kayaku Advanced Materials' 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 3000 products at selected film thicknesses.

THICKNESS microns	**SOFT BAKE TIMES** minutes @ 95ºC
4 –10	2–3
8–15	5–10
20–50	10–15
30–80	10–30
40–100	15–45

Table 2. Soft Bake Times

Note: *To optimize the baking times/conditions, remove the wafer from the hotplate after the prescribed time and allow 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 after placing the wafer on the hotplate.*

Optical Parameters

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

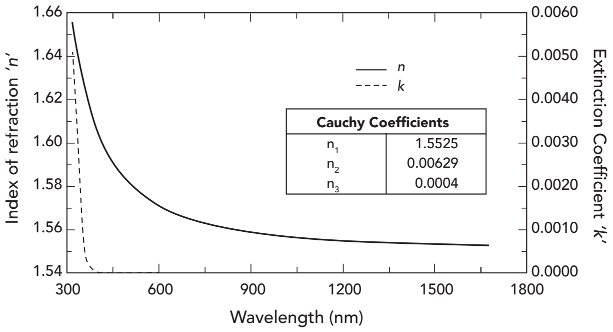


Figure 3. Cauchy Coefficients

Exposure

To obtain vertical sidewalls in the SU-8 3000 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 a 365 nm cut off filter, an increase in exposure time of approximately 40% is required to reach the optimum exposure dose.

Note: *Optimal exposure will produce a visible latent image within 5-15 seconds after being placed on the PEB hotplate and not before. An exposure matrix experiment should be performed to optimize the exposure dose.*

THICKNESS microns	**EXPOSURE ENERGY** mJ/cm^2
4–10	100–200
8–15	125–200
20–50	150–250
30–80	150–250
40–100	150–250

Table 3. Exposure Dose

SUBSTRATE	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 3000 photoresist coating. No visible latent image during or after PEB means that there was insufficient exposure, temperature or both.

THICKNESS microns	PEB TIME minutes @ 65°C*	PEB TIME minutes @ 95°C
4–10	1	1–2
8–15	1	2–4
20–50	1	3–5
30–80	1	3–5
40–100	1	3–5

*Optional step for stress reduction

Table 5. Post Exposure Bake Times

Develop

SU-8 3000 resist has been designed for use in immersion, spray or spray-puddle processes with Kayaku Advanced Materials' SU-8 developer. Other solvent based developers, such as ethyl lactate and diacetone alcohol, may also be used. Strong agitation is also recommended for high aspect ratio and/or thick film structures. The recommended develop times for immersion processes are given in Table 6. These develop times are approximate, since actual dissolution rates can vary widely as a function of agitation.

Note: The use of an ultrasonic or megasonic bath is helpful for developing out photoresist vias or holes.

THICKNESS microns	DEVELOPMENT TIME minutes
4–10	1–3
8–15	4–6
20–50	5–8
30–80	6–12
40–100	7–15

Table 6. Development Times for SU-8 Developer

Rinse and Dry

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

Physical Properties
(Approximate values)

Adhesion Strength (MPa) Silicon/Glass/Glass & HMDS	69/35/59
Glass Transition Temperature (Tg °C), tan δ peak	200
Thermal Stability (°C @ 5% wt. loss)	300
Thermal Conductivity (W/(m.K))	0.2
Coefficient of Thermal Expansion (CTE ppm)	52
Tensile Strength (MPa)	73
Elongation at break (ξb %)	4.8
Young's Modulus (GPa)	2.0
Dielectric Constant @ 1GHz	3.28
Bulk Resistivity (Ω cm)	7.8×10^{14}
Water Absorption (% 85°C/85 RH)	0.55

Table 7. Physical Properties

Optical Properties

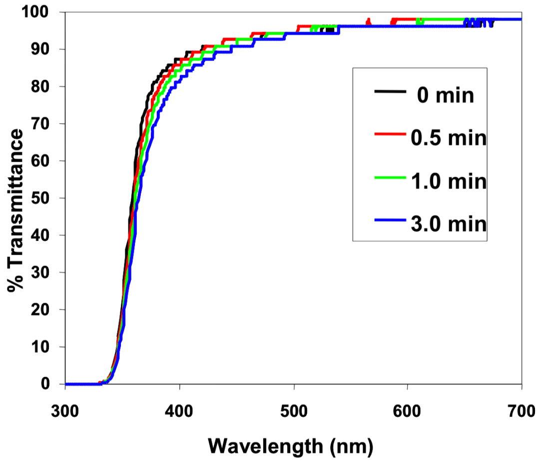


Figure 4. Optical Transmittance after 300ºC Hard Bake

Hard Bake (cure)

SU-8 3000 has good mechanical properties. However, for applications where the imaged resist is to be left as part of the final device, the resist may be ramp/step hard baked between 150–200°C on a hot plate or in a convection oven to further cross-link the material. Bake times vary based on type of bake process and film thickness.

Removal

SU-8 3000 has been designed as a permanent, highly cross-linked epoxy material, which makes it extremely difficult to remove with conventional solvent-based resist strippers. Kayaku Advanced Materials' Remover PG will swell and lift off minimally cross- linked SU-8 3000. 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 3000 material. It will not remove fully cured or hard baked SU-8 3000 without the use of OmniCoat.

To remove minimally cross-linked SU-8 3000, 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 Kayaku Advanced Materials' Omnicoat and Remover PG, please see the relevant product data sheets.

To re-work fully cross-linked SU-8 3000: 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, 100 mTorr, 10°C. For more information, refer to the SU-8 / KMPR® Removal applications note on the website www.kayakuAM.com. Also see www.r3t.de or www.pvatepla.com for microwave plasma tools for high throughput without damaging other microstructures.

Storage

Store SU-8 3000 resists upright 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 thirteen months from date of manufacture.

Disposal

The material and its container must be disposed in accordance with all local, state, federal and/or international regulations.

Handling

Consult Safety Data Sheet (SDS) for details on the handling procedures and product hazards prior to use. If you have any questions regarding handling precautions or product hazards, please email productsafety@kayakuAM.com.

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