



## SU-8 3000 Series

### Permanent Negative Epoxy Photoresist

#### Description

SU-8 3000 is a high contrast, epoxy-based negative photoresist designed for micromachining and other microelectronic applications requiring thick, chemical, and thermally stable image. As an improved formulation of the original SU-8, which has been widely adopted in MEMS fabrication, SU-8 3000 offers enhanced adhesion and reduced coating stress. The viscosity range of SU-8 3000 allows for film thicknesses of 2 to 50  $\mu\text{m}$  in a single coat. For film thickness greater than 50  $\mu\text{m}$ , please consider our SU-8 Dry Film Resist Product. SU-8 3000 has excellent imaging characteristics and can produce 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.

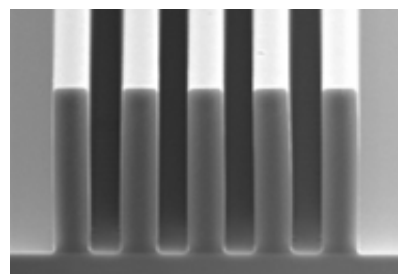
#### Features

- Improved adhesion compared to SU-8
- Reduced coating stress compared to SU-8
- High aspect ratio > 5:1 imaging
- Vertical sidewalls
- Excellent dry etch resistance
- Solvent-based development

#### PROCESSING GUIDLINES

SU-8 3000 is typically exposed with conventional i-Line and broadband UV (350-400 nm) radiation, with i-Line exposure recommended for optimal performance. 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 standard process

flow includes spin coat, soft bake, expose, PEB and development. Process conditions may require optimization based on specific equipment, substrate materials, and application requirements.



Contact aligner exposure  
10  $\mu\text{m}$  features, 50  $\mu\text{m}$  SU-8 3000 coating

#### Substrate Preparation

For maximum process reliability, substrates must be clean and dry before applying SU-8 3000 resist. To get best results, substrates should be cleaned with a piranha wet etch using  $\text{H}_2\text{SO}_4$  &  $\text{H}_2\text{O}_2$  followed by a de-ionized water rinse. Substrates may also be cleaned using reactive ion etching (RIE) or any oxygen-based barrel asher. SU-8 3000 typically provides excellent adhesion without the use of adhesion promoters. However, for applications involving electroplating, it is recommended to pre-treat the substrate with HMDS.

#### Coat

SU-8 3000 resists are available in five standard viscosities, as 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.



| 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

## Recommended Program

- (1) Dispense 1 ml of resist for each inch (25 mm) of substrate diameter.
- (2) Spin at 500 rpm for 5–10 seconds with acceleration of 100 rpm/second.
- (3) Spin at 3000 rpm for 30 seconds with acceleration of 1000 rpm/second.

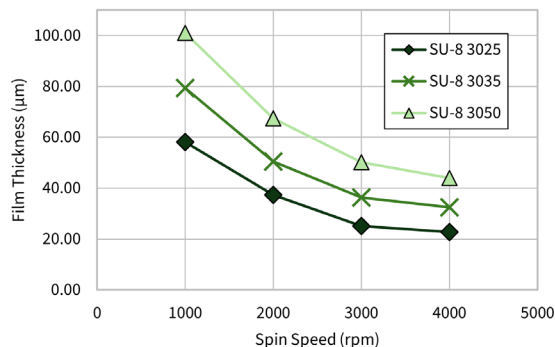
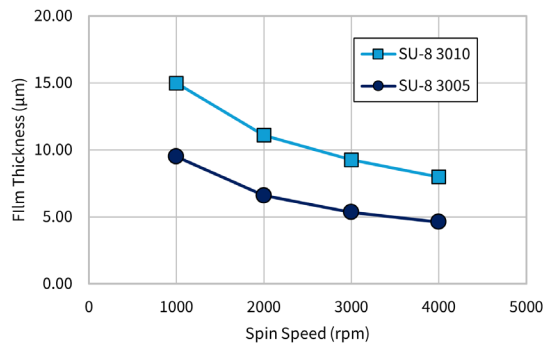


Figure 1. SU-8 3000 Series Thickness vs. Spin Speed

## Edge Bead Removal (EBR)

During the spin coating process, a photoresist build-up may occur on the edge of the substrate. To minimize contamination of the hotplate, it is recommended to remove this thick edge bead. 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.

By removing any edge bead, the photomask can make close contact with the wafer surface, resulting in improved resolution and aspect ratio during exposure.

## Soft Bake

A level hotplate with good thermal control and uniformity is recommended for the soft bake step. Convection ovens are not recommended, as they can cause the formation of a surface skin on the resist. This skin can trap solvent within the film, 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 | Soft Bake Time |
|-----------|----------------|
| microns   | minutes @ 95°C |
| 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 2. This information is useful for film thickness measurements based on ellipsometry and other optical measurements.

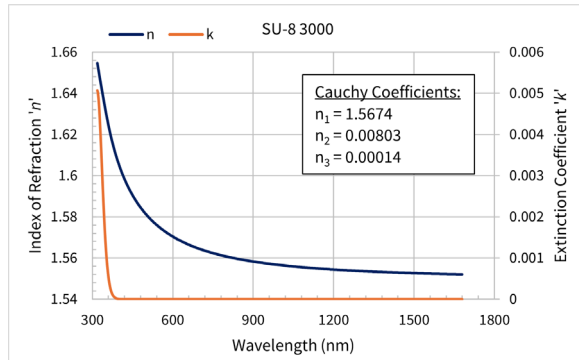


Figure 2. Cauchy Coefficients

## Exposure

To obtain vertical sidewalls in the SU-8 3000 resist, the use of a long pass filter is recommended to eliminate UV wavelengths below 350 nm.

We recommend using the PL-360LP filter from Omega Optical (<https://omega-optical.com/filters-dichroics/>) or an equivalent 365 nm cut off filter. When using a filter, verify the intensity output at the wafer plane, as exposure times may need to be adjusted.

| Thickness | Exposure Energy    |
|-----------|--------------------|
| microns   | mJ/cm <sup>2</sup> |
| 4-10      | 100-200            |
| 8-15      | 125-200            |
| 20-50     | 150-250            |
| 30-80     | 150-250            |
| 40-100    | 150-250            |

Table 3. Exposure Dose

## Post Exposure Bake (PEB)

PEB should take place directly after exposure, Table 4 shows the recommended temperatures and times.

| Thickness | PEB Time       |                |
|-----------|----------------|----------------|
|           | minutes @ 65°C | minutes @ 95°C |
| microns   |                |                |
| 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            |

Table 4. Post Exposure Bake Times

*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.*

## Development

SU-8 3000 resists are formulated for use with immersion, spray or spray-puddle development processes with Kayaku Advanced Materials' SU-8 developer. Alternative solvent-based developers, such as ethyl lactate and diacetone alcohol, may also be used. For high aspect ratio and/or thick film structures, strong agitation is recommended. Approximate development times for immersion processes are provided in Table 5; actual times may 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 | Development Time |
|-----------|------------------|
| microns   | Minutes          |
| 4-10      | 1-3              |
| 8-15      | 4-6              |
| 20-50     | 5-8              |
| 30-80     | 6-12             |
| 40-100    | 7-15             |

Table 5. Development Time for SU-8 Developer

## Rinse and Dry

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

## PHYSICAL PROPERTIES

(Values for Hard Bake at 150°C for 30 min)

|                                                         |       |
|---------------------------------------------------------|-------|
| Glass Transition Temperature (T <sub>g</sub> , °C)      | 198   |
| Thermal Stability (°C @ 5% wt. loss in N <sub>2</sub> ) | 335   |
| Coefficient of Thermal Expansion (CTE, ppm)             | 70    |
| Tensile Strength (MPa)                                  | 89    |
| % Elongation                                            | 7.9   |
| Young's Modulus (GPa)                                   | 2.25  |
| Dielectric Constant @ 28GHz                             | 3.0   |
| Dielectric Loss @ 28GHz                                 | 0.026 |
| Water Absorption (% 85°C/85 RH, 24h)                    | 0.83  |

## Adhesion Properties

| Substrate        | Adhesion Strength (MPa) |
|------------------|-------------------------|
| Si               | 56                      |
| SiN              | 59                      |
| SiO <sub>2</sub> | 48                      |
| Cu               | 56                      |
| Glass            | 35                      |

*Note: Adhesion properties were collected on 100 x 100 μm features with 20 μm film thickness. Adhesion will differ based on feature size, dilution, and thickness.*

## 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 crosslink the material. Bake times should be adjusted based on film thickness and the specific bake method.

## Removal

SU-8 3000 is a highly crosslinked, permanent epoxy material and is extremely resistant to removal by conventional solvent-based resist strippers. Kayaku Advanced Materials' Remover PG will swell and lift off minimally crosslinked SU-8 3000. However, if OmniCoat (30-100 nm) is used beneath the resist layer, immersion in Remover PG can result in 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.

Removal Procedure (Minimally Crosslinked SU-8 3000 or with OmniCoat): Heat the Remover PG bath to 50-80°C and immerse the substrates for 30-90 minutes. Strip time depends on film thickness and degree of crosslink.



Re-work of 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.

For more information on Kayaku Advanced Materials' Omnicoat and Remover PG, please see the relevant product data sheets.

## Storage

Store SU-8 3000 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). Keep the material away from light, acids, heat and other sources of ignition. When properly stored, SU-8 3000 resists have a shelf life of thirteen (13) months from the date of manufacture.

## Handling

Consult the Safety Data Sheet (SDS) for details on the handling procedures and product hazards prior to use. For any questions regarding safety precautions or product hazards, contact Kayaku Advanced Materials.

## Disposal

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

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