GM 1075

SU-8-negative tone photo-epoxy
for **thick layers (>100 µm)**

Technical Datasheet

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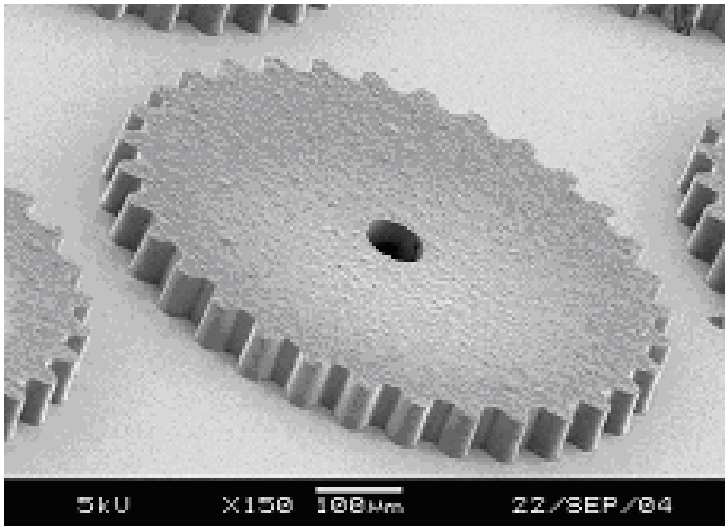
General information

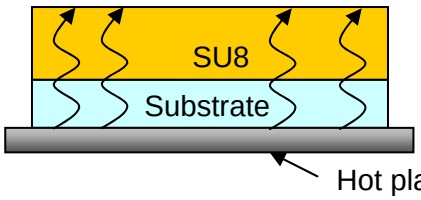


SU-8 is an epoxy based, chemically amplified resist system with excellent sensitivity and high aspect ratios. The primary applications are Micro-fabricated Mechanical Structures (MEMS) and other Microsystems.

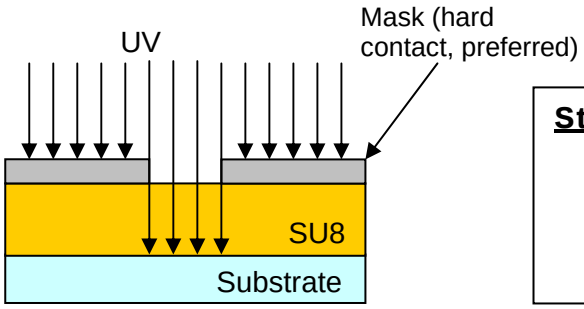
Examples are sensors, micro-fluidic components, electronic coils, inkjet print head nozzles, multi-chip modules, actuators, LCD spacers and moulds for plastic, stamps for hot embossing and electroplating.

Datasheet parts...

1 / Schematics of the process

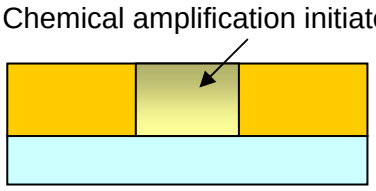


Step 1:
- Spin-coating
- Relaxation time to improve uniformity
- Pre-Bake to evaporate solvent (GBL)

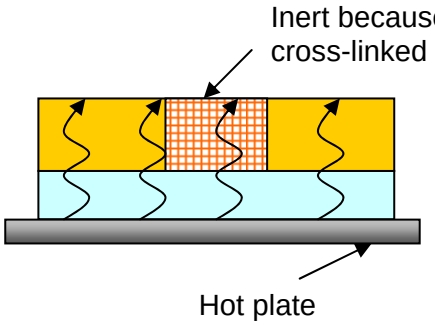


Step 2:
- Exposure

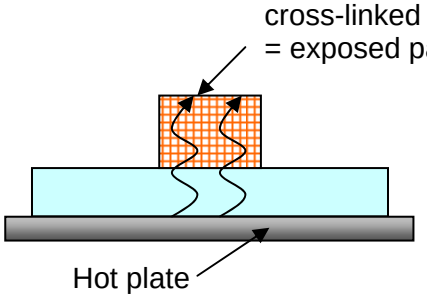
→ with a hard contact preferred to improve exposition homogeneity and side-wall verticality, and keep a clean mask.



Result of Step 1: exposure has only initiated chemical amplification, but the cross-linking reaction is really slow / impossible at room temperature.



Step 3: … this process is enhanced by a thermal treatment, called Post Exposure Bake (PEB).



Step 4:
- Development with PGMEA* + Rinse with Isopropanol
- Possible Hard Bake if any relaxation of the material is required (to eliminate some cracks or unstuck parts).

**PGMEA: Propylene glycol methyl ether acetate*

2 / Process description

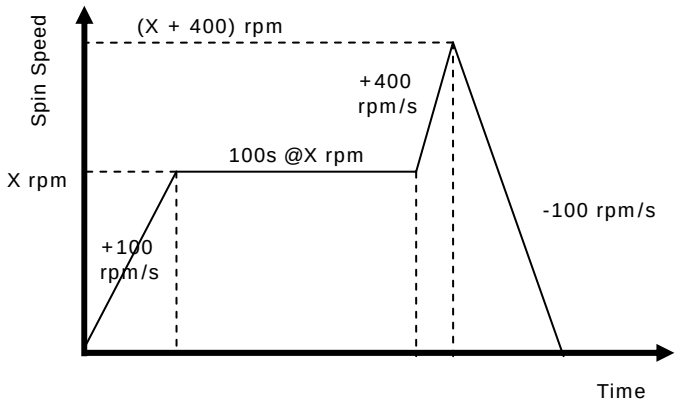
A typical SU-8 process consists of

- Substrate preparation (dehydration, cleaning…)
- Spin-coating
- Relaxation time to improve the surface uniformity
- Soft Bake
- Exposure to initiate the cross-linking
- Post Exposure bake (PEB), to cross-link exposed regions.
- Development
- Rinse & dry
- Hard Bake (or curing-optional)
- Imaged material (optional: in case of moulding)
- Remove (optional: in case of moulding)

(in chronological order)

- Put the **substrate** in an oven at a minimum temperature of 130 °C during at least 20 minutes to remove adsorbed water from the substrate surface.
  Alternatively use an oxygen plasma for 7 min at 500 Watts in a Microwave plasma reactor. This should increase the temperature inside the plasma chamber above 80°C after the 2 first minutes.
  Standard HMDS procedure is not recommended for GM 10series on SiO2 based wafers.

- **Spin-coat** the resist after cooling down the substrates, at the wanted speed (X) level during 100 seconds with a 100 rpm/s acceleration, followed by a 400 rpm/s acceleration up to (X+400) speed during 1s and then a deceleration ramp about 100 rpm/s.



- **Relax (optional)** the resist from 1 hour up to 1 night, depending on the resist thickness and the uniformity wanted. If there are some bubbles just after spin-coating they can be burst using a clean and thin tip. The created hole should be removed during the required time. Finally this relaxation time should improve the uniformity of the layer, and evaporate some portion of solvent.

- **Softbake** the coated substrate. All the temperature ramps should be about 4°C/min. After making an optional relaxation at 40°C, increase the temperature up to 120 °C and let he wafers as much time as necessary that, when holding them at room temperature with some tweezers there are not printed on the SU-8 layer! Then you can switch off the power or decrease temperature until they reach the room temperature.

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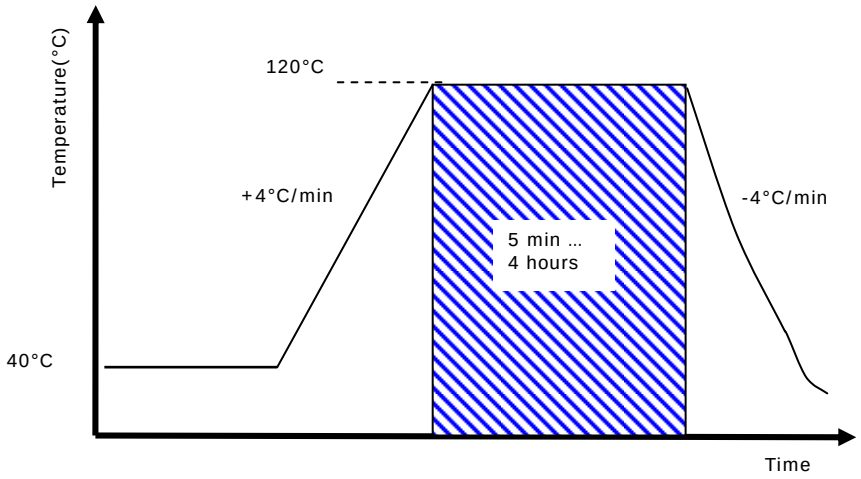


- **Expose** the coated substrate with the mask. This exposure dose adjusts the negative wall profile whom slope is closed to 90°. Have a look on the exposure curve to choose as a function of your thickness the dose that gives not any cracks, un-sticking or "stairs effect".
  Note: Exposure doses refer to i-line (365nm). A standard mask aligner with a 350W Hg light source has approx. 6-15 mW/cm^2 i-line intensity, while in many cases 20-30 mW/cm² are measured meeting the total (g-, h- and i-line) intensity!

  Ideally you should try some multiple exposure around the given exposure dose on the Exposure curve. In fact your results may not be exactly the same because of the UV lamp parameters. So you have to optimise this exposure dose parameter simply because your mask aligner is probably not the same than our.

- **Delay time:** Keep the coated substrate at room temperature after the exposure for at least 10 minutes. In this delay time some chemical species will diffuse on the exposed parts giving more homogeneity on the amplification phenomenon.

- **Post Exposure Bake (PEB):** after the delay bake the coated substrate at the same temperature profile than for the Soft Bake but at 95°C instead of 120°C. Lower temperature will induce a lower internal stress. This step accelerates the cross-linking of the exposed areas making them insoluble in the developer.

- **Develop** in PGMEA. When the structure is through-developed (cleared), add another 10% of the time in a cleaned bath of the total development time to finalize the side wall profile.

Rinse with Isopropanol. Once there is not any more white traces the development is then finished. Unfortunately, if you add even more than a few seconds, the SU-8 layer that should be unsticking from the substrate.

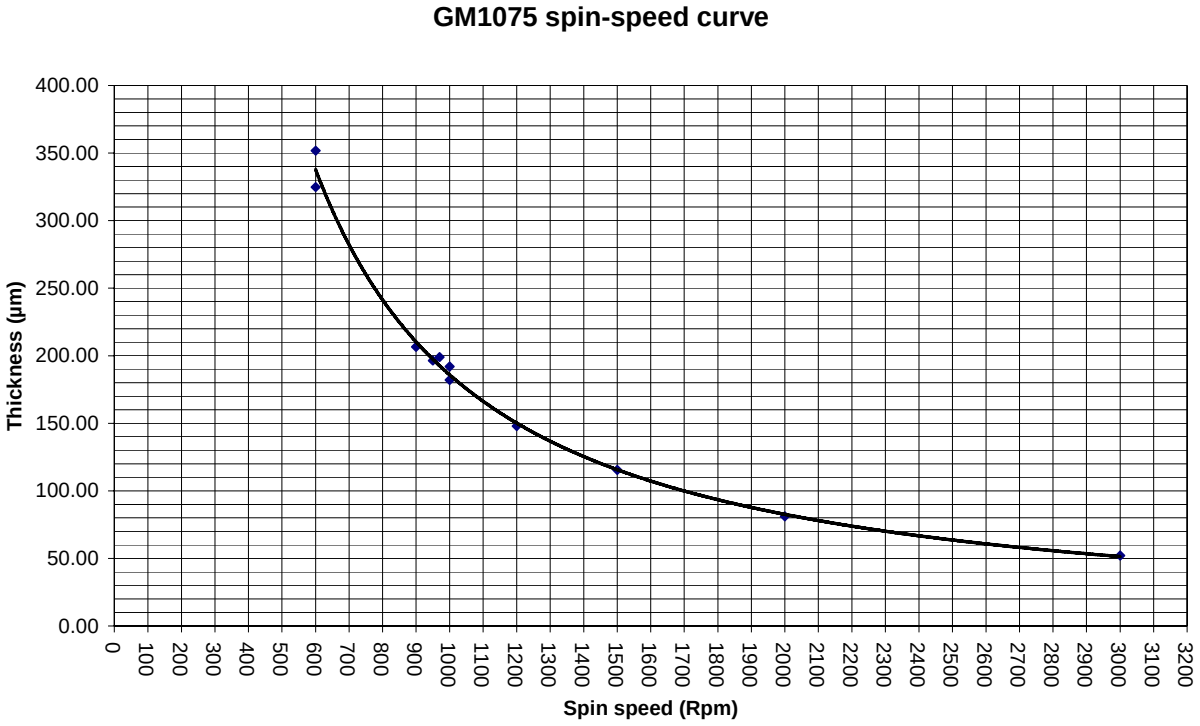
Dry the wafers just letting them at the ambient air, on a wet bench with an appropriate air flow (exhaust).

- **Hard-bake (optional)** the coated substrate if after drying there are some unstuck SU-8 or cracks. Only the smallest cracks (<5 µm) will be totally removed after this step.

Optional…

- **Imaged material** (optional: in case of moulding): deposition of you material by sputtering, electrodepositing…
- **Remove** SU-8: using the Gersteltec SU-8 stripper

3 / Process parameters



4 / Processing GM1075 - Overview

1 / Substrate preparation	Oxygen plasma at 500 W for 7 min (for some new wafers). Otherwise please refer to another method…
2 / Spin coating	Tested from 200 to 5000 rpm with ramps as following… - 0 to X rpm with an acceleration =100 rpm/s - 100 s at X rpm - 0 to (X+400) rpm with an acceleration =400 rpm/s - 1s at (X+400) rpm - X rpm to 0 with a deceleration =100 rpm/s
Resist thickness (µm)	Above 100 µm
3 / Relaxation time	30 min … 1 night
Pre-bake or Soft-bake	Temperature ramps… - From 40 to 120°C at 4°C/min - Stay at 120°C during the needed time - Decrease up to room temp. (about 2°C/min) Time dependent on resist thickness and substrate shape.
4 / Exposure Broadband or g, h, i (mJ/cm^2)	i-line (365 nm) exposure dose
Typical Exposure dose* (mJ/cm^2)	Dose dependent on resist thickness and substrate shape
5 / Post Bake Time (Hot plate Temperature)	Temperature ramps… - 25 to 95 °C at 4°C/min - Stay at 95°C during the needed time - Decrease up to room temp. (about 4°C/min)
6 / Delay time	1 hour
7 / Developer	- PGMEA, used in baths (”old” + “new”) Time in these baths is depending on resist thickness, mask patterns and substrate shape. - + Isopropanol to clean - Evaporation of Isopropanol at the ambient air
8 / Hard Bake (optional)	?°C in an oven for 2 hours ramps should be… - relatively progressive to go up to ?°C (2°C/min) - cooling down up to room temperature “naturally” (without cooling source).
9 / Moulding	Imaged material
Remover (Stripper)	Stripper Gersteltec

* i-line (365 nm) exposure dose. A standard mask aligner with a 350W Hg source has approx. 6-15 mW/cm^2 i-line intensity, in many cases 20-30 mW are measured meeting the total (g-, h- and i-line) intensity!
All our test have been done with a MA6 mask aligner from Karl Suss with a 250W Hg lamp and, with intensity of 10.0 mW at the wafer emplacement.

5 / Typical processes (100, 150, 200, 300, 350 & 400 µm)

Firstly, the wafer preparation should be as mentioned previously (Oxygen plasma at 500W for min 7min (for some cleaned wafers yet)…).

Thickness	100 µm	150 µm	200 µm	300 µm	350 µm	400 µm
Spin coating	100s @ 1700 rpm	100 s @ 1200 rpm	100s @ 950 rpm	100 s @ 650rpm	100s @ 600 rpm	100s @ 500 rpm
Relax. Time*	30 min @40 °C	30 min @40 °C	30 min @40 °C	30 min @40 °C	30 min @40 °C	30 min @40 °C
Pre-bake	2 min @ 120 °C	5 min @120 °C	10 min @120 °C	30 min @120 °C	40 min @120 °C	50 min @120 °C
Typical Exposure dose mJ/cm²	200	350	500	700	850	1000
Post-Bake	30 min @ 95°C	40 min @ 95°C	1 h @ 95°C	1 h 30 @ 95°C	2 h @ 95°C	2 h 30 @ 95°C
Delay time	1 hour	1 hour	1 hour	1 hour	1 hour	1 hour
Develop in PGMEA**	3 min	5 min	7 min	9 min	11 min	15 min

***Note**: our clean room parameters are 20.5°C (± 0.1°C) with 45% (± 1 point) of relative humidity.*

*These relaxation time are as a function of the uniformity required for your process.
**These Development times are an example which depends on resist thickness, shape / geometry of the structures.

6 / Troubleshooting

- **Cracks**: theses drawbacks appear as a function of the exposure dose, temperature ramps taken and Pre-bake time. Try to increase the exposure dose range by some x10 mJ/cm^2, if you want to try multiple exposure. Consequently, you will see the quality of the surface changing.

- **White traces after development**: This is only because there is still some unexposed SU-8 not totally developed. In fact unexposed SU-8+Isopropanol makes a white complex that you can find on your wafers.
  In the other side, just pay attention to not develop to much time. Otherwise you could unstuck the SU-8 layer from the substrate.

Appendix

Our machines…:

- Spin-coating: RC-8 from Karl Suss
- Mask aligner: MA6 mask aligner from Karl Suss with a 250W Hg lamp and, with intensity of 10.0 mW at the wafer emplacement.
- Hotplates from Karl Suss.
- Thickness measurements: AlphaStep 500.