SU-8 Photolithography Process

1. Sample Cleaning

Depending on the substrate material and application, there are many sample cleaning processes you can choose, such as solvent cleaning, plasma cleaning, RCA cleaning, and etc. Solvent cleaning is commonly used for removing most of organic residue and particles.

1.1 Clean the substrate for 5 minutes in acetone in an ultrasonic bath.

1.2 Soak the substrate in methanol for 1 minute.

1.3 Rinse the substrate with isopropyl alcohol (IPA).

1.4 Dry the substrate under nitrogen.

2. Dehydration and Surface Plasma Cleaning

2.1 After solvent cleaning or other wet cleaning process, bake the substrate at 200 ºC for 5 minutes on a hot plate. Cool with nitrogen.

2.2 Optional: Perform O_2 plasma cleaning using Plasma Stripper/Cleaner.

3. Photoresist Coating

3.1 Use assigned SU-8 spinner bench only.

3.2 Select appropriate chuck which must be smaller than the sample, so that no chuck area is exposed to resist.

3.3 Line the bowl of the spin-coater with aluminum foil, and place the cleaned substrate on the chuck.

3.4 Static dispense: carefully pour a blob of SU-8 (~1 ml of SU-8 per inch of wafer diameter) in the center of the substrate; avoid trapping bubbles of air in the SU-8.

3.5 Spreading Cycle: ramp up to 500 rpm at 100 rpm/s acceleration. Hold for 5 seconds.

3.6 Spin Cycle: ramp up to 3000 rpm at 300 rpm/s. Hold for ~ 30-60 seconds.

IMPORTANT POINTS:

- **SU-8 film thickness control is critical for subsequent processing.**
- **3000 rpm spin speed gives the best reproducibility in terms of film thickness.**
- **To produce features of a different thickness, refer to the data in Table 1.**

4. Soft Baking

4.1 Right after photoresist coating, pre-bake the substrate at 65 °C on a hot plate. The pre-bake times for different thicknesses are shown in Table 1.

4.2 Ramp the hot plate to 95 °C for soft-baking. Refer to Table 1 for the soft-bake time.

4.3 After soft bake complete, turn off the hot plate and let the substrates cool slowly to room temperature.

NOTES

- The hot plate needs to be leveled carefully so that the layer of SU-8 is of uniform thickness.
- Any air bubbles can be removed during the bake at 95 °C by gently tapping the air bubbles with a 24-gauge needle.

5. Edge Bead Removal (EBR) (optional)

NOTE: For thicker SU-8 (>20um) or high aspect ratio feature (height size:feaure size > 2:1) process, it is strongly recommended to remove the edge bead in order to get better contact between the photomask and the photoresist layer.

5.1 Place the substrate back on the chuck of the spin coater. Ramp up to 500 rpm at 100 rpm/s acceleration. Hold for 20-30 seconds.

5.2 While the substrate is spinning at 500 rpm, inject about 3-5 ml of PGMEA (Propylene Glycol Monomethyl Ether Acetate) or SU-8 Developer in a steady stream through a 24-gauge needle to the outer rim of the substrate in order to dissolve the edge bead.

5.3 Ramp up to 1000 rpm at 300 rpm/s. Hold for 20 seconds.

5.4 Bake the substrate at 65 °C on a hot plate for 2 minutes to dry off the residual solvent (developer).

Table1. Process Conditions for SU-8 photolithography

Required SU8 Thickness (um)	SU-8 type	(*1) Spin speed (rpm)/ramp-time/hold-time	Pre-baking time (65C, min)	Soft-baking time (95C, min)	Exposure Energy (mJ/cm^2)	(*2) Suggest Exposure Energy (mJ/cm^2) (+/-10%)	(*3) Suggest Exposure time (AB-M) (sec)	Post-Exp Baking 1 PEB1 (65C,min)	Post-Exp Baking 2 PEB2 (95C,min)	PGMEA Develop time (min)	Comment (*4)	Verified Thickness (um) -CR1 (*5)
1.5	2	3000/ 8s /60s	1	1	70-**100**	85	3.5	1	1	1		
2	2002	3000/ 8s /60s	1	2	70-**100**	85	3.5	1	1	1	CNS	
5	2005	3000/ 8s /60s	1	2	80-**120**	100	4.2	1	1	1		
5	5	3000/ 8s /60s	1	3	80--**110**	100	4.2	1	1	1		
7	2007	3000/ 8s /60s	1	2	90-**140**	115	4.5	1	1.5	1		
10	2010	3000/ 8s /60s	1	2	110-**170**	140	5.5	1	2.5	2	CNS	
10	10	3000/ 8s /60s	2	5	100-**170**	140	5.5	1	2.5	2		
15	2015	3000 / 8s /60s	1	2	120-**190**	160	6.5	1	2+1	3	CNS	14 (+/-0.5)
20	2015	2000 / 5s /60s	1	3	140-**230**	190	7.4	1	2+1	3	CNS	
25	2025	3000 / 8s /60s	1	3	150--**250**	200	8	1	3+1	4	CNS	24 (+/-1)
35	2035	3000 / 8s /60s	2	5	180-**300**	240	9.5	1	3+1	5		
40	50	3000 / 8s /60s	5	15	250-**300**	280	11	1	4+1	6	CNS	
50	2050	3000 / 8s /45s	3	6	230-**380**	310	12	1	7+1	6	CNS	56 (+/- 4)
75	2075	3000 / 8s /45s	3	9	280-**470**	380	15	1	7+1	7		
100	2100	3000 / 8s /45s	5	20	320--**540**	430	17.5	1	10+1	10	CNS	

3000 rpm of spin speed is recommended for the better repeabability of film thickness
Suggest exposure energy is given under follwing conditions: Plastic film pattern mask, a 360nm LP filter to hold the mask and Si substrate
Suggest exposure time is based on the intensity of AB-M at 365nm ~25mW/cm^2
Some of SU8 are provided by CNS, as marked in the Comment column,
3 types of SU-8 (2015,2025, 2050) have been verified in LISE clean-room of CNS (SU-8 banch, rightside spinner, which are highlighted.

6. Exposure

6.1 Two mask aligners in CNS can be used for SU-8 exposure: AB-M mask aligner and SUSS MJB4 mask aligner.

6.2 To operate the mask aligner, follow the standard operating procedure for AB-M aligner (CNS SOP017) or SUSS MJB4 (CNS SOP0XX).

6.3 Set the exposure time as recommended in Table 1 and perform the exposure.

Important Note for SU-8 UV Exposure:

- For a film (transparency) photomask: place the photomask on top of the substrate with the printed side of the mask facing the photoresist layer on the substrate. Mount a blank glass plate on the mask holder.
- Place a 360nm long-pass (LP) filter on the glass plate (or the chrome mask) to reduce the short wavelength effect and improve the feature profile. Add 20%-40% more exposure time to compensate for the intensity loss due to the filter.

7. **Post Expose Bake (PEB)**

7.1 Place the substrate on a hot plate and post exposure bake (PEB) at 65 °C. The recommended baking times (PEB 1) are outlined in Table 1 for different SU-8 thicknesses.

7.2 Ramp the hot plate to 95 °C for the second step post exposure bake (PEB 2). Refer to Table 1 for the baking time for PEB 2.

7.3 Let the hot plate and substrates cool slowly to room temperature.

Note: Rapidly cooling the substrate may cause thermal stress built in the SU-8 film, and results in film crack.

8. **Development**

8.1 Immerse the substrate in a bath of PGMEA or SU-8 Developer and gently rock the dish for agitation. Refer to Table 1 for the developing time for features of SU-8 of varying thickness.

8.2 Soak the substrate in an IPA bath for ~30 seconds.

Note: A whitish residue on the surface of the substrate is an indication of under-development. Repeat the previous step 1-2 minutes at a time until no whitish residue is observed in the IPA bath,

8.3 Dry the front and back of the substrate under a stream of N_2.

9. **Pattern Characterization**

9.1 Observe the substrate under the microscope with the red filter in place to determine the quality of the developed features.

9.2 Use the Veeco Dektak 6M profilometer to measure the height of the features. Refer to the standard operating procedure of Dektak 6M.

Version History

Revision	**Date**	**Author**	**Changes**
2.0	03/18/08	JD	Initial draft
2.1	05/28/08	EM	Minor clerical updates.
2.2	05/30/08	FK	Minor changes, content additions, and comments.
2.3	08/05/08	EM	Merged comments from FK, LX.
2.4	08/06/08	FK	Minor corrections.
2.5	08/07/08	JD	Modify the process table 1, modify the process steps and conditions.
2.6	08/18/08	LX, JD	Minor changes

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