

UNIVERSITY OF CALIFORNIA, MERCED

SCIF CLEANROOM FACILITY

STANDARD OPERATING PROCEDURE (SOP)

Photolithography & Mask Aligner Operation (Shibley S1813 | NXQ4006 or Equivalent)

1. PURPOSE

To provide a detailed, standardized, and safe procedure for photolithography using Shibley S1813 positive photoresist and mask aligner operation, ensuring reproducible pattern transfer, equipment protection, and user safety.

2. SCOPE

Applicable to all trained users performing photolithography and mask alignment in the SCIF Cleanroom using mask aligners such as the NXQ4006.

3. RESPONSIBILITIES

- **Users:** Follow SOP and ensure correct process parameters
 - **Core Staff:** Maintain equipment and provide training
 - **Facility:** Ensure utilities, safety, and compliance
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4. REQUIRED SYSTEM CONDITIONS

4.1 Utilities

- UV lamp operational and calibrated (~365 nm, i-line)
 - Vacuum supply for wafer chuck and mask contact
 - Clean compressed air
 - Temperature-controlled hotplates
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4.2 Materials

- Shipley S1813 photoresist
 - Developer: MF-319
 - Solvents: Acetone, IPA
 - DI water
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5. SAFETY REQUIREMENTS

5.1 Hazards

- UV radiation (eye/skin damage)
 - Chemical exposure (photoresist, developer, solvents)
 - Thermal hazards (hotplates)
 - Mechanical pinch/contact hazards (mask aligner)
 - Vacuum suction hazards
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5.2 PPE

- Cleanroom gloves (nitrile)
 - Safety glasses (UV-rated recommended)
 - Lab coat
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6. PHOTOLITHOGRAPHY PROCESS (S1813)

STEP 1: SUBSTRATE PREPARATION

- Clean substrate:
 - Acetone → IPA → DI rinse
- Optional:
 - Oxygen plasma clean (improves adhesion)
- Dehydration bake:

- 110–120 °C for 5–10 min
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STEP 2: SPIN COATING (S1813)

Typical Parameters

- Dispense resist at wafer center
- Spin:
 - 500 rpm (5 sec spread)
 - 3000 rpm (30 sec)

Expected Thickness

- ~1.2–1.5 μm
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STEP 3: SOFT BAKE (PRE-BAKE)

- 95–100 °C for 60–90 sec

Note: Avoid over-baking (reduces sensitivity)

7. MASK ALIGNER OPERATION SOP

STEP 1: SYSTEM STARTUP

- Turn ON:
 - Main system power
 - Controller/interface
 - UV lamp power supply
- Allow lamp warm-up (10–15 min)

Verify:

- Vacuum system active
- No alarms

- Exposure system ready
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STEP 2: LOAD WAFER

- Place wafer on chuck
 - Activate vacuum:
 - Confirm firm holding
 - Ensure:
 - Wafer centered
 - No particles
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STEP 3: LOAD MASK

- Place mask onto mask holder
 - Secure (vacuum or clamp)
 - Ensure:
 - Clean surface
 - Correct orientation (chrome side down typically)
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STEP 4: ALIGNMENT

- Use microscope:
 - Focus on wafer alignment marks
 - Align mask pattern

Adjust:

- X-axis
- Y-axis
- Theta (rotation)

Procedure:

- Perform coarse alignment
 - Perform fine alignment
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STEP 5: CONTACT MODE SELECTION

Mode	Gap	Application
Soft Contact	~few μm	Standard lithography
Hard Contact	~0 μm	Higher resolution
Vacuum Contact	0 μm + vacuum	Highest resolution
Proximity	10–50 μm	Fragile substrates

STEP 6: CONTACT / GAP CONTROL

- Lower mask toward wafer
 - Engage selected contact mode
 - Confirm uniform contact
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STEP 7: EXPOSURE SETUP

- Set exposure dose:

Typical for S1813:

- 80–120 mJ/cm^2
 - Adjust time based on lamp intensity
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STEP 8: UV EXPOSURE

- Ensure:
 - Alignment locked
 - Contact stable

- Close shield
 - Start exposure
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STEP 9: SEPARATION

- Release contact slowly
 - Raise mask carefully
 - Avoid resist sticking
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STEP 10: UNLOAD

- Turn OFF vacuum chuck
 - Remove wafer carefully
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8. DEVELOPMENT PROCESS

STEP 1: DEVELOP

- Immerse wafer in MF-319:
 - 45–75 seconds
 - Gentle agitation
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STEP 2: RINSE

- DI water rinse immediately
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STEP 3: DRY

- N₂ blow dry
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STEP 4: INSPECTION

- Optical microscope inspection:
 - Pattern resolution
 - Edge definition
 - Residue
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STEP 5: HARD BAKE (OPTIONAL)

- 110–120 °C for 1–2 minutes
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9. POST-OPERATION

- Clean:
 - Chuck surface
 - Mask holder
 - Dispose chemicals properly
 - Log usage
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10. TROUBLESHOOTING GUIDE

Issue	Cause	Action
Poor adhesion	Dirty wafer	Improve cleaning
Misalignment	Stage drift	Re-align
Mask sticking	Excess pressure	Reduce contact force
Blurred features	Gap too large	Use hard contact
Residue	Underdevelopment	Increase dev time
Pattern loss	Overdevelopment	Reduce dev time

11. CRITICAL DOs & DON'Ts

DO

- Clean wafer and mask thoroughly
 - Use correct exposure dose
 - Allow lamp warm-up
 - Verify vacuum before operation
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DON'T

- Touch resist surface
 - Force contact
 - Skip alignment steps
 - Delay development excessively
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12. ACKNOWLEDGMENT & APPROVAL**Director Name:** _____**Director Signature:** _____**Date:** _____**User Name:** _____**User Signature:** _____**Date:** _____