

Making a Chrome Glass Mask out of a Transparency Mask

Standard Operating Procedure

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Tufts Emergency Medical Services are at x66911.

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Goal:

Make a Chrome Glass mask out of Transparency Mask.

Warnings:

All processing must be done in the fume hood, as the solvent fumes released during processing have long-term health effects. Avoid contact with skin and eyes. Do not ingest. Do not breathe Chromium Etchant vapors. These vapors are highly irritating to the mucous membranes and respiratory track and can cause excessive tearing. Work carefully in the hood with goggles, face shield and both nitrile and trionic gloves.

1. Material Requirements:

1. Equipment and tools: Chromium glass mask from Telic of size 5"x5"x0.09", pre-coated with AZ 1500 photoresist. Clear glass mask 5"x5"x0.090" (Soda lime glass), 6 re-crystallization dishes sized to accept a mask, oven or hotplate. Transparency mask, cut to size (5" x 5").
2. Chemicals: Transene Chromium Etchant Type 1020 (contains 6 wt% Nitric Acid and 16% Ceric Ammonium Nitrate), MF CD26 developer, Remover 1165, acetone, isopropanol
 - 1.2.1 Hazards associated with chemicals:
 - 1.2.1.1 MF CD26 developer is an alkaline (base) corrosive liquid containing tetramethyl ammonium hydroxide (TMAH). It will cause irritation and burns if it contacts the skin. It may react violently with acids. Do not mix with acids!!
 - 1.2.1.2 Chromium Etchant Type 1020 is corrosive to the eyes, skin and mucous membranes and causes irritation and burns. Vapors severely irritate the respiratory track. Do not mix with strong oxidants or organic materials. **Do not heat.**
 - 1.2.1.3 Remover 1165: A solvent mixture including N-methyl-2- pyrrolidine. It is flammable with a flashpoint of 88°C (that is, at and above 88°C the fumes ignite explosively by a spark or open flame.)
 - 1.2.1.4 Acetone is a volatile, flammable solvent. Avoid heat sources. Do not breath fumes. Conduct processing in the fume hood.
 - 1.2.1.5 Isopropanol is a volatile, flammable solvent. Avoid heat sources. Do not breath fumes. Conduct processing in the fume hood.
3. Engineering Controls: Conduct procedures in the fume hood. Store bottles of chemicals (sealed tightly) in cabinets with secondary containment. Work area should contain an eye wash and safety shower. Dispose of chemicals as described at the end of this document.
4. Personal Protective Equipment: Nitrile gloves and eye protection required for all procedures. When working in the fume hood, also wear trionic gloves on top of nitrile gloves, apron, goggles, and face-shield.

2.0 Procedure:

Startup for the OAI Model 204 Aligner:

(Also refer to the SOP “OAI Model 204IR Mask Aligner”)

1. Open the valve on the top of the nitrogen cylinder to the back right of the tool. You should hear some gas flowing, the regulator should read 60 psi on the outlet side, and the vibration isolation table should float up.
2. Turn on the main power switch to the aligner on the front panel.
3. Move the optics module all the way back by using the horizontal black handle to the back right of the tool. Push in the small button to release, and push the optics module all the way back (it will hit a solid hard stop at the back of the machine.)
4. Push “Cycle”. The main module will move to the right, if it is not there already.

Turning on the Lamp:

When you first come in to use the aligner, the lamp may be powered down, particularly if the tool has not been used for a few days. To check if the lamp is powered down, look at the lamp controller under the aligner on the left. If the power switch is off then the lamp is off. You can also look at the back of the lamp housing; if the lamp is on you will see a purple glow. The glow is not subtle.

If the lamp is off:

1. Plug in the blower module (on the floor to the back right of the aligner). It should start blowing out air.
2. Check the settings on the lamp controller. The controller is on the shelf under the aligner.
 - a. Channel: “A” Mode: “C/I” (this means constant intensity mode) Intensity-Power: Power
3. Turn on the power switch on the lamp controller. The power switch is the throw switch on the right hand side.
4. To ignite the lamp, press the “Start” switch on the lamp controller in for about a second, then release. The lamp should ignite; the power level should start to rise, and you should see a purple glow if you look behind the aligner.
5. Wait at least 5 minutes for the lamp to warm up. The power should stabilize around 300 Watts.

Loading the Mask:

1. Inspect the clear glass mask under the microscope and make sure it is clean. You can clean your mask with solvents (acetone then IPA) in the hood and use cleanroom swabs. If the glass mask is very dirty, a Piranha clean may be used.
2. The photoresist coated glass mask should be clean (new out of the box). Blow any particles off with the air gun.
3. Toggle the mask vacuum button to “off” (if it is not already off).
4. Loosen the thumb screws on either side of the mask frame, and lift the mask holder out and flip it over. (Keep the vacuum hose attached.)
5. **Remove all four thumbscrews and completely remove the mask clamps. Set them aside. (You will be exposing a 5” x 5” mask in this procedure; the clamps will not fit!)**
6. Put the clear soda lime glass mask into the holder, using the alignment pins to position the mask. Be careful not to scratch or smudge your mask.
7. Turn on the mask vacuum toggle. The mask should now be stuck to the frame.
8. **Do not replace the mask clamps or the thumbscrews.**
9. Flip the mask frame back over, put it into the mask holder, align the scribe marks (this gets your mask mostly square to the wafer) and tighten the two side set screws.

Loading the substrate:

1. Toggle the mask frame to “open”
2. Place the photoresist coated chrome glass mask and transparency mask on the chuck in such a way that the ink side of the transparency mask touches the chrome side of the photoresist coated glass mask as shown in fig.1 Try to get both masks centered and square on the chuck.

3. Turn ON the substrate vacuum.
4. Turn the black knob on the front of the tool to create maximum separation between the mask and substrate (turn in the direction labeled “move wafer down”).
5. Toggle the mask frame to “Close”

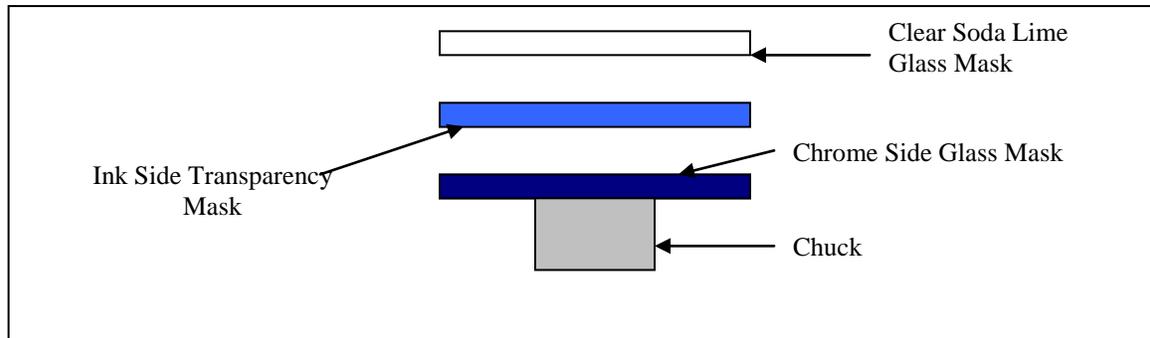


Fig.1 Mask Arrangement in the Aligner

Exposure

1. Unlock the ball vacuum
2. Bring the mask up into soft contact until chuck slides. By rotating the black knob.
3. Lock the ball vacuum
4. Put ON hard contact
5. Set exposure time 1.5sec at an intensity of $20\text{mW}/\text{cm}^2$ at i-line
6. Move the optics forward and press cycle button twice.
7. The substrate will move under the lamp and will be exposed. Do not look at the UV lamp while the shutter is open.

Note: 1.5s seems to be the correct exposure time, but will reproduce the bubbles found in the mylar (in other words, there will be small spots of unexposed resist where there should be none). 3s will “wash out” these unexposed areas giving a better result.

Removing your substrate

1. Toggle the “Hard Contact” switch to the “Off” position.
2. Switch on the “Nitrogen purge” toggle and open the “Nitrogen purge flow valve” to blow some air between wafer and mask. Adjust the flow rate to somewhere mid-range (around “5”) on the N_2 flow meter.
3. Lower the substrate out of contact with the mask using the black knob.
4. Move the optics all the way to the right using the two-button handle. If you do not do this, the IR module may crash into the wafer stage when you try to move the optics back!!!
5. Slide the alignment optics to the back of the tool.
6. Open the mask frame and turn off the substrate vacuum (sub. vac.). You can now remove the substrate.
7. Close the mask frame and turn off the N_2 purge.
8. Separate the chrome glass mask from transparency mask.

Removing the clear mask:

1. Loosen the thumb screws on either side of the mask frame, and lift the mask holder out and flip it over. (Keep the vacuum hose attached.)
2. Turn off the mask vacuum toggle, and remove the clear glass mask.
3. **Replace the mask clamps and the four thumbscrews.** Tighten finger tight.
4. Flip the mask frame back over, put it into the mask holder, align the scribe marks (this gets your mask mostly square to the wafer) and tighten the two side set screws.

Shutting down the system:

1. Turn off the main power to the unit on the front left.

Develop (Chemistry Hood)

Using MF-CD-26 Developer

1. Before beginning take two of the glass recrystallizing dishes into the hood (these are wider and shorter than beakers... they will fit a 5" square mask).
2. Fill one of the dishes with DI water and in the other pour in enough MF CD-26 to submerge the mask. (MF-CD 26 should be available in base storage cabinet).
3. There are a few Teflon (PTFE) flat disk tools with tall threaded handles available in the lab. These will help you lift your masks in and out of the dishes... place one of them in each dish so that one edge of the mask is lifted up from the base of the dish slightly; that way you will be able to get your tweezers under the mask more easily.
4. Place the exposed mask, chrome side up, in the MF CD-26 developer and agitate gentle (swirl the dish) for 30sec.
5. Move the mask from the developer into the DI water rinse using two stainless steel tweezers. Allow it to soak with agitation for 5 minutes.
6. Remove the mask from the rinse and blow the mask dry with the air gun in the hood.
7. Examine the mask under the microscope to make sure the resist is fully developed. If not, develop for additional time until the lithography looks complete.
8. Dump the MF CD-26 developer, and DI water used to rinse the wafers into the MF CD-26 developer waste (HDPE bottle). Rinse the developer container with water and dump this also into the MF CD-26 developer waste.
9. Rinse each dish with water one more time and dump into the dilute acid/base water waste (5 gallon HDPE jug).

Note: The 30s develop time has worked well, also check the log for any new data points

Chromium Etch

(See also "Chromium Etch" SOP)

1. Fill two recrystallizing dishes with deionized.
2. Carefully pour some of the Transene Chromium Etchant Type 1020 into a third recrystallizing dish; pour in enough that the mask will be covered.
3. Put the developed chrome mask in the chromium etchant for 30sec. Careful swirling of the beaker will accelerate etch and improve uniformity.
4. When the etch is complete, transfer the mask carefully to the first DI water rinse beaker for 5mins
5. Transfer the mask to the second DI rinse beaker, and rinse for another 5 mins.
6. Blow the mask dry with the nitrogen gun in the hood.
7. Examine under the microscope. The etched regions should appear completely clear; you should see no reflection from the etched regions at all. If you see a reflection, some Chromium is still remaining, you should etch longer.
8. The etchant may be used for multiple etches. For temporary storage (< 3 days), cover the dish with aluminum foil and store on fab wipes in the back of the hood. Make sure the dish is clearly labeled with your name, the date, and "Chromium Etchant".
9. When you are finished using the etchant, dispose of it in a HDPE or glass bottle, label "Cr Etch Type 1020" with the red hazardous waste tag. The chrome etch waste can be mixed with sulfuric acid and hydrogen peroxide waste (Piranha) or nitric acid waste. Keep the bottle in the satellite accumulation area (under the hood). If a waste bottle already exists, use that one, otherwise start a new one.
10. Also dispose of the first deionized water rinse container in the Cr etch waste bottle.
11. Rinse the Chrome etch container once with DI water, and dump it into the Cr Etch waste bottle.
12. Rinse all the containers a second time with water, and dump into the "dilute acid/base waste" 5 gallon jug.

Mask Photoresist Strip:

1. After the chrome etch is complete, put the mask into the large PTFE 5" mask holder paddle.
2. Using the squirt bottles in the hood, clean the majority of the photoresist off the mask directly into the solvent waste bottle (use a funnel!!). First clean with Acetone and then IPA.
3. After the majority of the resist has been removed using acetone/IPA, put the mask in the tank of Remover 1165 (in the back of the hood) for 10mins (the mask should still be in the large PTFE mask holder).
4. A complete strip may require heated Remover 1165. Please see that SOP for details.
5. Prepare a recrystallizing dish with deionized water for rinsing the mask.
6. Prepare the solvent waste bottle with a funnel.
7. After the 10 min soak is complete, remove the mask from Remover 1165 and rinse with isopropanol and water from squirt bottles directly into the solvent waste bottle. Also rinse off the PTFE mask holder with IPA and deionized water into the solvent waste bottle.
8. Take the mask out of the PTFE mask holder and put it in the deionized water rinse dish. Soak for 3 minutes.
9. Remove the mask from the rinse and dry it with the air gun. Additional drying can be performed in the 120 °C oven if desired.
10. The mask should now be complete. Examine under the microscope.
11. Dispose of the rinse water in the solvent waste bottle.
12. If photoresists remains, an O2 Plasma clean (300W 30s) should help. See the March RIE SOP.

Cleanup:

1. Instructions for chemical disposal appear in each of the sections above and repeated below under "waste disposal".
2. Return glassware to the shelves; stand it upside down on cleanroom wipes. Use enough wipes that it does not drip onto items on lower shelves!
3. Wipe up any drips in the area with chemical wipes and dispose in the acid trash (developer or chrome etch) or solvent trash (acetone, Remover 1165, or IPA).

Storage

1. MF CD-26 developer should be stored in the "base" cabinet.
2. Chromium Etchant Type 1020 should be stored in "Acid" cabinet.
3. Remover 1165, Acetone, and Isopropanol should be stored in the "solvents" cabinet.

Waste Disposal:

1. MF CD-26 developer waste:
Solid waste should go in the acid/base trash.
Liquid waste should go in the MF CD-26 waste bottle. This container should be HDPE.
2. Chromium Etchant 1020 waste:
Solid waste should go in the acid waste bin.
Liquid waste should go in the Cr Etch waste bottle. This container should be HDPE
3. Remover 1165, Acetone and IPA waste:
Solid waste, wipes are disposed of in the solvent trash can.
Remover 1165, Acetone and IPA liquid waste and rinse water is collected in the solvent waste bottle. This container should be HDPE.
4. Rinse water:
First rinses should go into the container for the chemical being rinsed (see above).
Any additional rinses for solvents (Remover 1165, acetone, IPA) should go into the solvent waste bottle.
Any second or third rinses for acids and bases (Cr etchant, MF CD-26 developer) should go into the dilute acid/base water waste jug.

Accident Procedures:

Contact: Read MSDS prior to working with any chemical to familiarize yourself with the symptoms of exposure and recommendations for treatment.

1. Chromium Etchant 1020 and Remover 1165:

- A. Skin contact: Remove contaminated clothing, wash skin with soap and water. **If there is any irritation, get immediate medical attention. Don't be shy. Tufts Emergency Medical Services are at x66911.**
- B. Eye contact: Immediately flush with water for at least 15 minutes while lifting upper and lower eyelids occasionally. **Get immediate medical attention. Call Tufts Emergency Medical Services are at x66911.**
- C. Ingestion: Do not induce vomiting. **Get immediate medical attention. Call Tufts Emergency Medical Services are at x66911.**
- D. Inhalation: Remove to fresh air. Resuscitate if necessary. Take care not to inhale any fumes released from the victim's lungs. **Get immediate medical attention. Call Tufts Emergency Medical Services are at x66911.**

2. Spill:

- A. If a small, contained spill occurs, such as inside the hood, wipe it up with chemical wipes and dispose of in the acid trash container.
- B. If a large spill occurs that you are not comfortable cleaning up:
- C. Evacuate the lab and notify the Tufts emergency services (x66911) immediately. Clean up should only be performed by authorized personnel according to MSDS guidelines. Notify the faculty advisor.

If at any time you feel a situation is dangerous, do not hesitate to call the safety office (x73246, Peter Nowak) or the faculty supervisor (x72210, Robert White). Please inform of the faculty supervisor and/or the health and safety office of any accident or health concern.

Report all accidents (injuries, major spills, fires) to the safety office at x73246 (Peter Nowak) and the faculty supervisor at x72210 (Robert White). For emergencies, call Tufts Emergency Services at x66911.