

Liftoff Procedure SOP

Revised April 2020

INTRODUCTION

Liftoff is a cleanroom process used for applying a patterned thin film on your substrate surface. Liftoff is done by performing photolithography on your wafer before performing a deposition (such as sputtering) and then removing the photoresist with a chemical etch. If everything goes well, the film deposited on the wafer should stay while the film deposited on the photoresist should be washed away. Liftoff involves various photolithography techniques for creating a photoresist profile that ensures separation between the thin film coating in desired and undesired areas of your pattern. Without separation between the two areas, the film may not release in small patterns or may result in rough “tearing” around all of the features as it pulls up film in the desired areas.

Image Reversal is generally considered the best method for consistent image reversal. The big catch with image reversal is that you will need a photomask printed in the opposite polarity than you would with the other liftoff techniques. This means that you will need to plan to use liftoff from the beginning and won't be able to switch back and forth between the other techniques. Exposed photoresist normally has a sloped profile which is exactly what makes liftoff difficult. Image Reversal takes that property and uses it to our advantage. It uses an ammonia oven to lock in exposed photoresist so it isn't removed with developer, then exposing the remaining photoresist to end up with a photoresist profile sloped in the other direction which is perfect for liftoff. Image reversal is generally recommended for relatively small features (<10 microns).



Liftoff using LOR3A is also very commonly performed in the cleanroom. This technique involves pre-coating the wafer with a chemical that etches slightly faster than photoresist in developer. This should result in a photoresist profile that looks “undercut” and allows a gap between the thin film on the wafer with what is on the photoresist.



Liftoff using Toluene is generally the worst performing method of the three outlined here. The big advantage of Toluene is that it does not involve directly exposing another chemical to the surface of your wafer. Toluene is a chemical that coats the top of your exposed photoresist and etches slower, more or less the opposite of LOR3A.



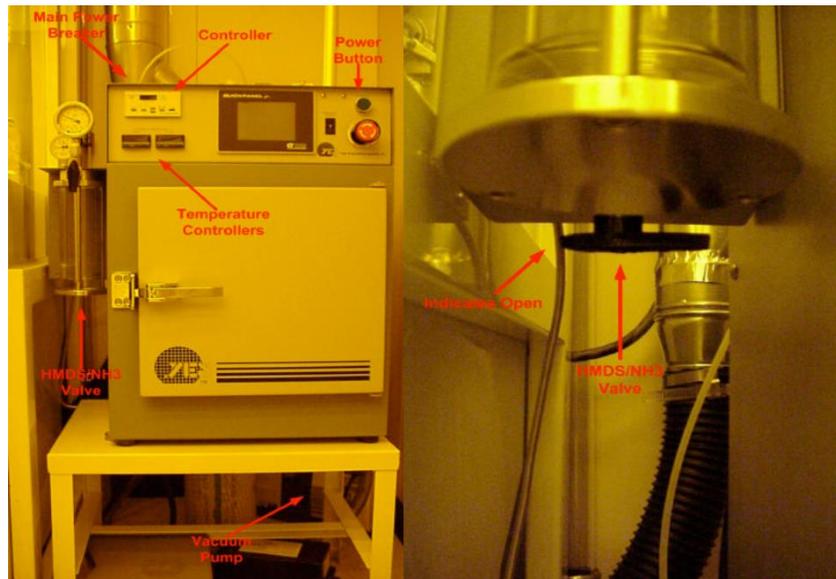
The result should hopefully be that the toluene overhangs over all your features giving you the separation between the thin films. It is worth noting while this method is the most difficult, it also tends to effect the sizes of features since the Toluene overhangs the edge of the photoresist.

LIFTOFF WITH IMAGE REVERSAL

Wafer Preparation

Image reversal is usable for any positive photoresist. It should also be compatible with any adhesion promoters if you wish. Process your wafer using normal parameters, but stop after exposing in the aligner and before development. Here you will move to the YES Image Reversal Oven and run a process before exposing again and then developing.

System Start-Up



1. Don't forget to login into your FOM account and login to the tool
2. Turn **ON** power to the oven using the breaker located on the back, left corner.
3. Press green **Power On** button
4. Turn **ON** vacuum pump located behind oven on the floor.
5. Open N₂ valve located on wall behind oven.

Vapor Prime

1. Turn HMDS/NH₃ valve to NH₃ position (located behind glass cylinder, short end of knob indicates valve selection)
2. Select **2** on the Thumbwheel.
3. Set temperature for front/rear zones. Press and hold **SET BUTTON** (far left), set temperature to desired setting.

NOTE: Oven must be at set temperature before beginning processing.

Front Zone: 90°C

Rear Zone: 90°C

4. Press S.P. on the controller and check each set point

Recommended Settings

Set point 1 (Display Set Point)	600 Torr
Set point 2 (Set Point 2)	100 Torr
Set point 3 (Alarm 3 Low Limit)	1 Torr
Set point 4	500 Torr

- Using the touch screen press:

GOTO Alarms Panel
GOTO Process Variables

- Enter Process Variables

Recommended Process Variables:

Number of dehydration cycle purges:	3
Number of exit cycle purges:	5
IR wafer Warm up Delay:	10
Process duration:	2700 seconds (45 min)

- Press **GOTO OPERATOR PANEL**
- Load Samples
- When oven has stabilized at set temperature, press **START**
- When Process is complete Shutdown oven

NOTE: Total time for the recommended process is approximately 60 minutes.

Additional Wafer Processing - Flood Exposure

- Allow the wafer to cool and return to the SUSS Aligner for a flood exposure.
- Set the exposure time on the SUSS Aligner to your previous time **+50%** (e.g. if your previous exposure time was 14s, expose at 21s).
- To perform flood exposure, load no mask into the system. Instead go to **SELECT PROGRAM** and use the up and down arrows to select flood exposure. It will then expose the system immediately after you load your wafer.

IMPORTANT: WHEN YOU ARE DONE WITH YOUR EXPOSURE, SET THE PROGRAM BACK TO HARD EXPOSURE OR IT WILL RUIN THE WAFER OF THE NEXT PERSON TO USE THE MACHINE.

- Move on to development as you normally would, but it may take an **extra 30 seconds** or so for the development to finish.

Shutdown

- Turn **OFF** breaker on back of oven.
- Turn **OFF** vacuum pump.
- Turn **OFF** N₂.
- Logout from the tool in your FOM account.

LIFTOFF WITH LOR3A

1. Bake your wafer to remove water vapor (Not Required).
2. Spin LOR 3A at 3000 RPM for 10 sec.
3. Soft bake at 150°C for 5min (soft bake process enables precise and reproducible control of undercut to provide maximum process windows), allow wafer to cool.
4. Spin on your 1805, 1813, or 1827 resist at your prescribed speed and bake time, usually 4000 RPM 10 sec and 115°C 60 sec, respectively.
5. Expose according the values of your photoresist given at the contact aligner for your resist.
6. Develop your wafer to in MF-319.
7. Insure that your substrate is completely developed! Inspect under a microscope.
8. Deposit your metal.
9. Use acetone or NMP for metal lift off at the lift off tank.
10. You may need to use old MF-319 or another mild base to remove your LOR 3A.

NOTE: Watch out if you are using Aluminum, MF-319 will dissolve your Aluminum!!!

LIFTOFF WITH TOLUENE

1. Spin on your S1800 series photoresist as normal.
2. Soft bake your wafer at **90°C for 60 sec.**
3. Expose your resist on the contact aligner using the prescribed times given at the machine for your photoresist at 4000 RPM or use your own best time.
4. Soak your wafer in Toluene for 60 sec and dry completely with N₂.
5. Return your wafer to the hotplate at 90°C for 15 sec (be consistent with your time!)
6. Develop photoresist using MF-319.
7. Inspect to insure that your resist is developed. You will see a black boundary around each feature. This is the undercut of the toluene treated resist which is needed for successful lift off.
8. You may need to do some ashing in the March RIE, but you want to avoid that because it will remove the shadow mask lip that you spent all of this time on with the Toluene process.