Primaxx Operating Instructions

The Primaxx uses Hydrogen Fluoride gas to perform isotropic dry etching of silicon oxide selective to silicon. It is a plasma free process, performed at low pressure (125 Torr) using HF, nitrogen, and ethyl alcohol.

Notes:

1. Nitrile gloves only! No vinyl gloves. This is both for personal protection as well as avoiding polymer contamination of the chamber.
2. No PSG, BSG, or BPSG glasses are allowed to be exposed on the wafer. When these materials are etched by gaseous HF, boric and phosphoric acid are produced leading to chamber contamination.
3. Gaseous HF diffuses readily through resist. Therefore resist masking will not work and is not allowed.
4. Gaseous HF will react with many silicon nitrides destroying the film, attacking materials underneath it, and leaving behind a toxic solid material. This solid material will sublimate off at about 200°C but the fumes are toxic so only do this with an exhausted oven or hotplate. Review etch rate data to determine which nitrides available at the CNF will hold up to the HF etch.

1. Log into CORAL.

The tool is interlocked in CORAL and will not operate until you log in. The CORAL interlock is the gas cabinet door sensor, which will show as an exclamation mark on the top of the screen, and as a door alert on the alarms screen.

2. Vent the chamber & load your substrate.

The tool should have been left in the 'Waiting to Vent' status by the previous user. On the Process screen, press the vent button to vent the chamber. Once the chamber has vented, use the plastic tool to pull the wafer holder forward and place your substrate on the pins. Use the carrier wafer for pieces too small to place on the pins. Do not use vacuum grease, tape, or any other method to fix your piece to a carrier. Avoid touching the interior of the chamber by using the plastic tool on the wafer slide and using tweezers on your substrate.

3. Pump the chamber down.

Push the door closed in the middle while pressing the 'Purge' button on the Process page. The tool will pump down and perform a variety of Purge and Leak Check steps before reaching Idle.

4. Select and run your recipe.

On the Recipes screen, use the up and down arrows to select the recipe to run. You can edit the time on the Etch step and the # of cycles. Press the 'Save' button to store any changes you make otherwise they will be lost when you leave the screen. Review the process section of this manual for advice on how to setup your etch process. When you are ready, press the 'Start' button on the Process screen.

The tool will go through a variety of stabilization steps before introducing the HF and running the etch. The countdown timer will tell you how much time is remaining in the process. At the end of the process the tool will run a purge and remain under vacuum. You can then run another recipe or proceed to the next step if you are finished etching.

If you abort a run after it has started, the tool will not let you vent the chamber until a Purge process is run. After the Purge process the Vent button will be enabled to let you vent the chamber.

5. Wait before venting the chamber.

Wait about 5 minutes before venting the chamber. If your device has a particularly deep undercut (>50µm), wait an additional 5 minutes longer. This will give time for any absorbed HF to outgas and pump out of the chamber. On the Process page press ‘Vent’ to vent the chamber and remove your substrate. Avoid touching the interior of the chamber by using the plastic tool and using tweezers on your substrate.

6. Pump the chamber down

Holding the door closed in the middle, press the ‘Purge’ button on the Process page to pump the chamber down. The tool will perform a variety of purge and leak detect steps before reaching the ‘Waiting to Vent’ status.

7. Log out in CORAL

Do not log out of CORAL until the ‘Waiting to Vent’ status is displayed or the interlock will interrupt this important process.

Process Parameters

When gaseous HF reacts with silicon oxide, water is released as a by-product. Proper release etching of suspended structures requires careful management of the water production to avoid stiction of your devices. The water is encouraged to desorb off of the surface and remove from the chamber by the combination of the lower pressure (125 Torr), the chamber temperature, and the ethyl alcohol in the chamber. Additionally, etch rates need to be carefully controlled to avoid overwhelming the chamber with moisture leading to ruined devices.

A typical application for vapor HF etching is the release of MEMS devices on Silicon On Insulator (SOI) wafers. In these applications the device Si layer has been etched, exposing a large area amount of the buried oxide, which is then isotropically etched for the release. During this initial part of the process, a recipe with a lower etch rate is required to avoid producing too much water in the chamber.

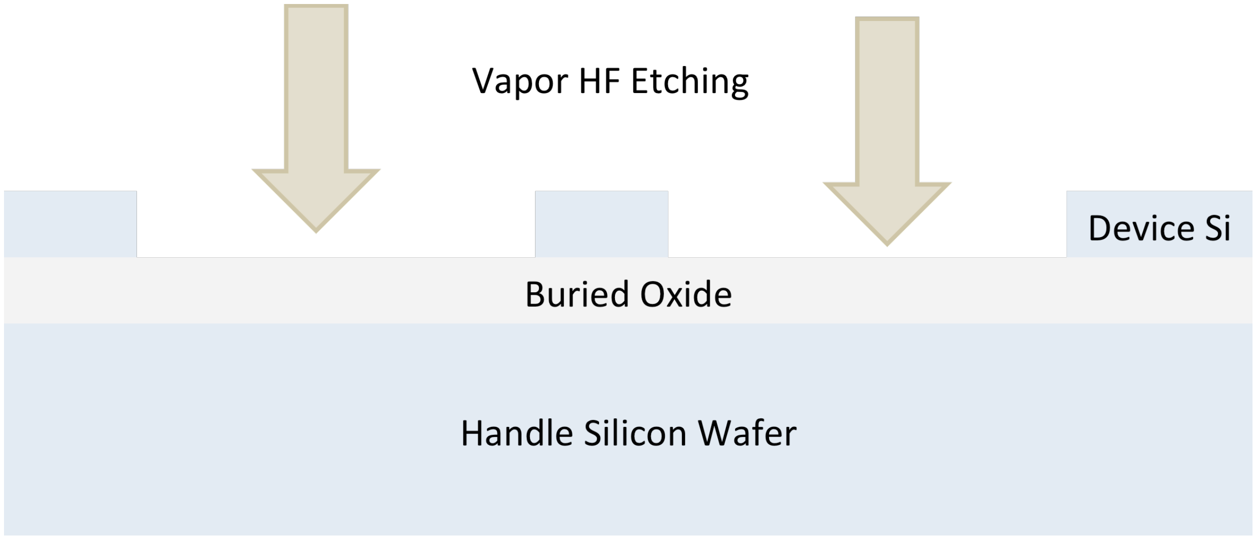

Figure 1 Large exposed area leads to high water production

Once the exposed areas of buried oxide are etched down to the carrier wafer, the amount of etched oxide is much lower, allowing you to run with a higher etch rate recipe without producing too much water. This will speed up the undercut process leading to shorter run times.

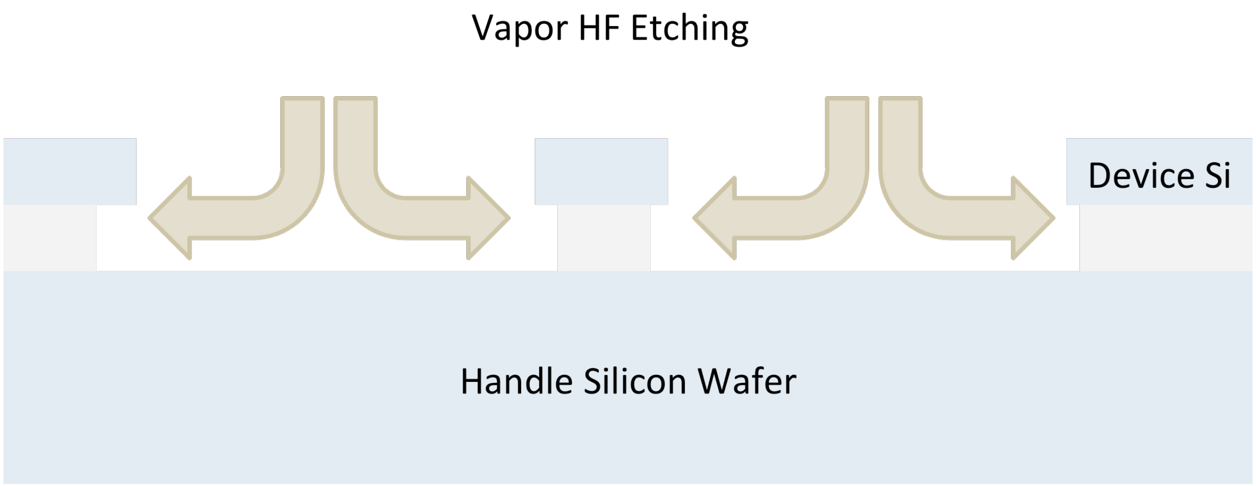

Figure 2 Undercut portion of etch has less exposed oxide area being etched.

To achieve this in your recipe, run a low etch rate recipe long enough to ensure that the surface oxide is fully cleared, including an appropriate amount of over etch to account for nonuniformity. When that process has complete the substrate will still be in the chamber under vacuum. Then select a high etch rate recipe to adequately undercut the devices.

Recipe name	Blanket thermal oxide etch rate
0.01uR7.5	130 A/min
0.05uR7.5	476 A/min
0.10uR7.5	1224 A/min
0.15uR7.5	1518 A/min
0.20uR7.5	1820 A/min

Process Recommendations

- If possible bake all samples at 240C for 1-2 minutes to properly dehydrate them.
- Perform a brief oxygen (1 minute) ash on all samples to remove any fluorocarbon deposits originating from the fluoroware containers, which will inhibit oxide etching. This can be done in the Gasonics downstream asher.
- Slower processes have the highest uniformity.
- For adequate release of microstructures, a process consisting of two recipes should be used. First a clearing etch recipe should be used with a low etch rate (ie, up to 500A/min). This will ensure the greatest uniformity across the wafer. Then select an undercut recipe with a high etch rate (ie.> 1000A/min) for enhanced isotropic etching.
- HF vapor etching of silicon nitride will produce NH4 salts as a residue. The residue should be removed by baking on an exhausted hotplate at 160C for 1-2 minutes. Low stress silicon nitride (ie, silicon rich) is the best choice.
- Good etch masks for HF vapor etching are: Al, TiW, Al2O3, a-silicon, x-silicon, and SiC. Photoresist should be avoided as a mask since the HF vapor will lift the resist, producing trapped moisture and HF.

Recipe name	LPCVD low stress SiN ER(A/min)	LPCVD Si3N4 ER(A/min)	thermal ox.	Selectivity
0.01uR7.5	8	50	16:1	3:1
0.05uR7.5	6	80	79:1	6:1
0.10uR7.5	50	170	25:1	7:1
0.15uR7.5	50	160	30:1	10:1
0.20uR7.5	66	200	28:1	9:1