1 Introduction

This tool is a Xactix e1 series XeF2 (Xenon Difluoride) based vapor phase etch system for isotropic and selective silicon etching. The XeF2 reaction with silicon is purely chemical and spontaneous (i.e., plasmaless). The XeF2 vapor phase etching exhibits a very high selectivity of Silicon to Photoresist, Silicon Dioxide (SiO2), Silicon Nitride (Si3N4), and Aluminum. Typically the selectivity to Si3N4 is better than 100:1, and the selectivity to SiO2 is better than 1000:1. Being a vapor phase etchant, XeF2 avoids many of the problems typically associated with wet processing, such as the sticking issues.

Only trained and approved (qualified) users may use this tool.
2 Safety and Precautions

a) This equipment uses sealed XeF2 cylinder as the gas source. Do not open any panels or change any regulator settings. The MSDS of XeF2 is available on the computer desktop.
b) Do not scratch or put any objects on the surfaces where vacuum seals are.
c) Do not use Acetone to wipe the seal rubber ring.
d) Pay attention to safety symbols on the equipment.
e) Press EMO button if there is an immediate danger to personnel or the equipment. Inform the staff.

3 Operating Procedure

Activate the equipment in FOM before you start. Deactivate it when finished.

1. Go to the computer to login the control software (Figure 1). Use username “user” and password “user” to login.

![XeF2 Silicon Etching System v3.89](image)

Figure 1: user Login interface.

2. After logging in, the software main screen will be displayed, as shown in Figure 2. A schematic for the machine is shown on the right side. The red dots denote closed valves, while green dots represent open valves. Pressure gauges for the main chamber and the expansion chamber are at the bottom right. Two options, “Etch Menu” and “Load/Unload Sample”, are available on the main screen for users.
3. Load sample

1) Press the "Load/Unload Sample" button. The system will go through prompts to ensure a correct decision (Figure 3). Press Yes if you’re sure. This prompt is provided since the load/unload process can be time consuming and is inconvenient if accidentally started.

2) After clicking YES, the Load/Unload Sample screen (Figure 4) will show. The system will begin chamber purges and flushing cycles to evacuate the chamber.

![Software Main Screen](image)

Figure 2: software main screen after user logging in.

![Prompt Screen](image)

Figure 3
3) When the chamber is vented, a dialog box as shown in Figure 5 will appear on the computer screen. Now the chamber is ready to open for loading sample.

Figure 5: the prompt shows after venting chamber.

4) Open the lid, and rest the lid on the stop behind the chamber, as shown in Figure 6.
5) Load your wafer/sample into the wafer tray, as shown in Figure 7. If small chips are to be processed, put all the chips inside the tray.

6) Close the chamber lid. Go to the computer and press the “Done” button (Figure 5). The system will go through a purging cycle prior to chamber pump-down.
Note: It is always necessary to press the “Done” button on the dialog box before running any etching recipe. The “Examine” button only allows pumping the chamber down without purges, so that the system can be quickly vented to load samples later. This is used when examining a sample away from the system to prevent moisture from accumulating in the chamber.

4. Run etching recipe

1) After the chamber pump-down, it will go back to the main screen, and the Machine Status information box at bottom left will show “Ready” (Figure 2). Press the “Etch Menu” button. You will be prompted to enter a Lot Number, as shown in Figure 8. Put any number here or just click the “Done” button.

![Figure 8](image)

2) After that, the Etch Menu will show on screen (Figure 9). The name of last used recipe is shown on top left. Four parameters (highlighted in the red box) can be changed to create your recipe. The parameters are explained below.

**# of cycles**

This tool is primarily a pulsed XeF2 etching system. The duration of etching is controlled by the number of cycles. A cycle consists of the XeF2 subliming to the set pressure in the expansion chamber, etching for a set amount of time and evacuation of the main chamber and expansion chamber.

**Etch Time**

When the valve between the main chamber and expansion chamber is opened the pressure equilibrates and the etching process begins. The etch time is the time between the opening of the valve between the expansion chamber and the process chamber and the opening of the valve between the process chamber and the pump.

**XeF2 Pressure**

In order to introduce the proper amount of XeF2 into the main chamber, a set pressure charge of XeF2 must be delivered to the expansion chamber. Because XeF2 has a vapor pressure of ~4T at room temperature the upper limit for the XeF2 pressure is approximately 4T.
N2 Pressure

Nitrogen can be added into a recipe to improve selectivity. The pressure obtained in the expansion chamber likewise controls the amount of nitrogen introduced into the process chamber.

3) Input numbers to all four fields according to your need. After that, you can save your recipe by press the “Save” button on the top of screen. It will then allow you to input your recipe name. Note: The maximum XeF2 pressure is 4 Torr. Do NOT put a number higher than 4 in the XeF2 Pressure field.

4) Start the recipe by press the green “Start Etch” button on the screen. When the etching process is finished, it will return to the main menu. A message “Etch Completed” will flash on screen as shown in Figure 10.

Figure 9: The Etch Menu screen.
5. Unload sample

Follow the Load Sample procedure to unload your sample. After unloading, press the “Done” button on the computer screen. The system will pump the chamber down to the base pressure. When the Machine Status shows “Ready”, press the “Log out” button to log out software.

6. Log out tool on FOM

END OF PROCEDURE.