

Xactix Xenon Difluoride Etcher



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.



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.

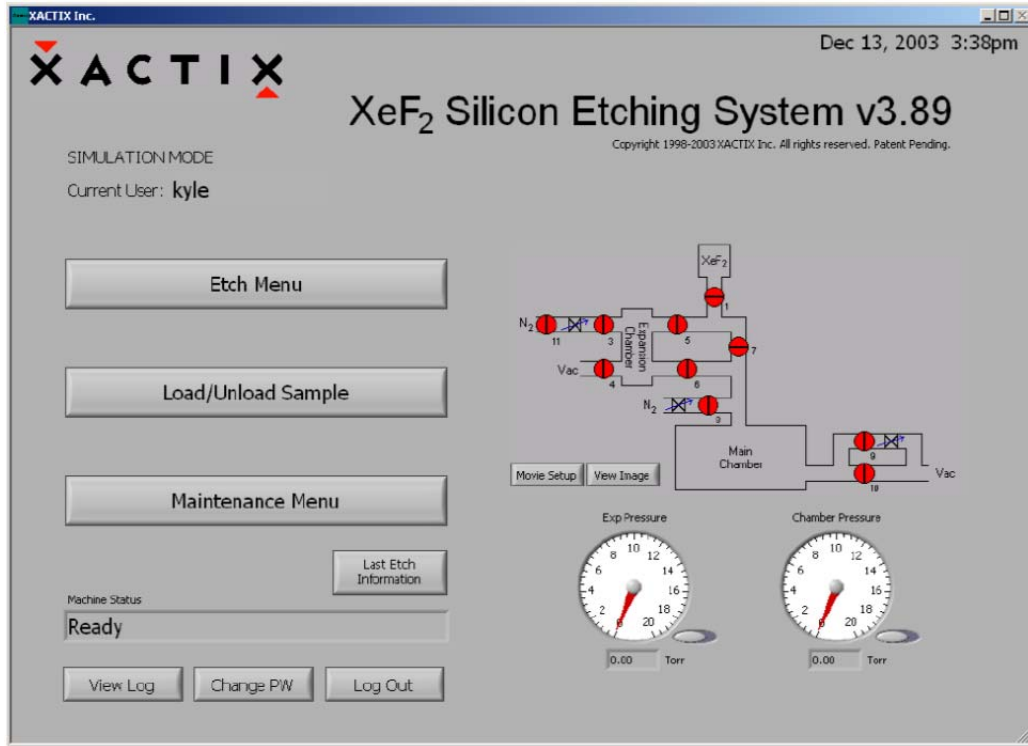


Figure 2: software main screen after user logging in.

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.

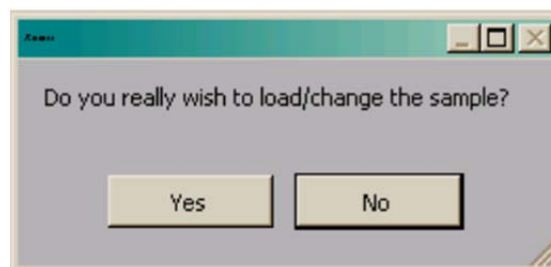


Figure 3

- 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.

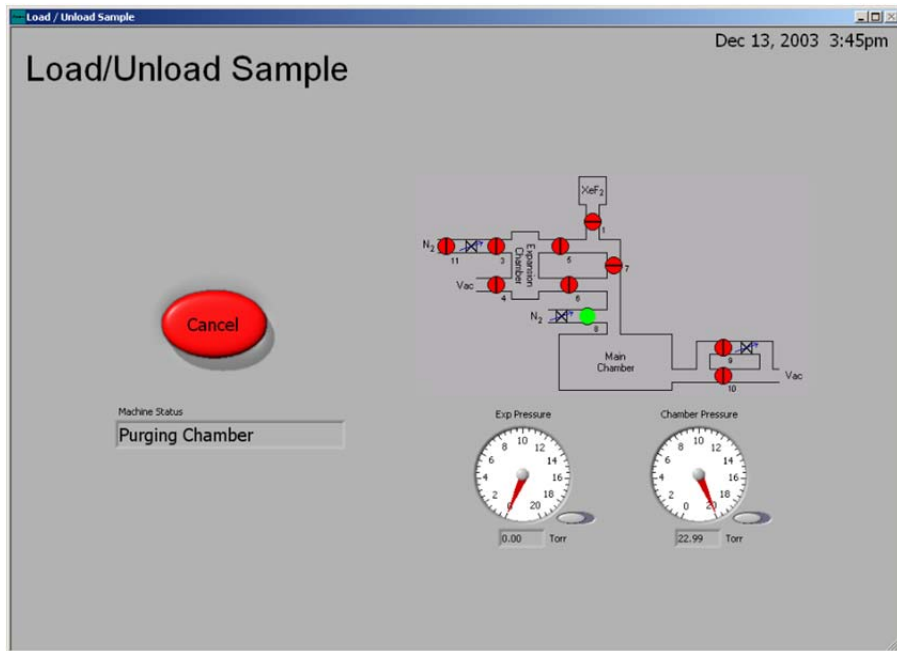


Figure 4: Load/Unload Sample screen.

- 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.

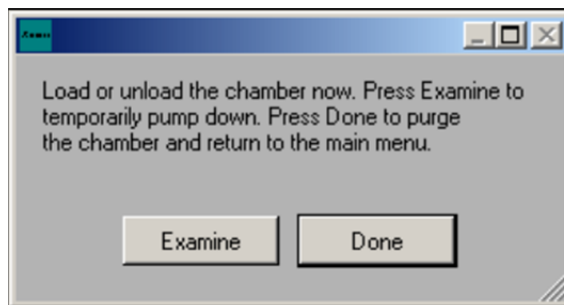


Figure 5: the prompt shows after venting chamber.

- 4) Open the lid, and rest the lid on the stop behind the chamber, as shown in Figure 6.



Figure 6: View of chamber with lid open.

- 5) Load you 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.

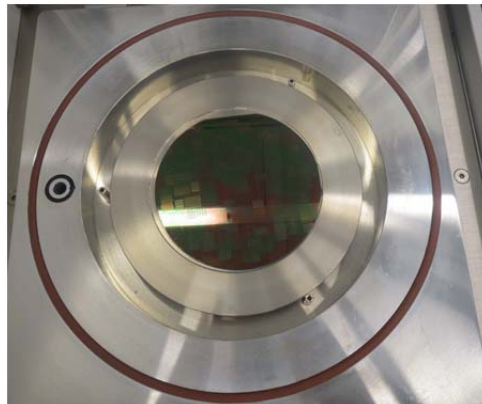


Figure 7: Top view of the chamber with a 4" wafer loaded in the wafer tray.

- 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.

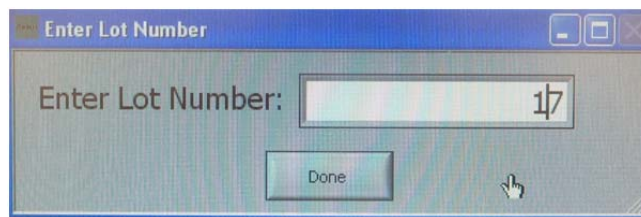


Figure 8

- 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.

The screenshot shows the 'Etch Menu' software interface. At the top, it displays 'Current User: admin' and the date/time 'Dec 13, 2003 5:02pm'. The main area is divided into several sections:

- Recipe Management:** A dropdown menu shows 'Current Recipe: Blank Recipe'. To its right are buttons for 'Restore', 'Set as Default', 'Save', and 'Recipe Mgr'. Red arrows point to the 'Current Recipe' dropdown with the label 'Last used recipe' and to the 'Save' button with the label 'To save a new recipe'.
- Parameter Sliders:** Four vertical sliders are visible, each with a 'Range' label. A red box highlights the bottom-most slider, and a red arrow points to it with the label 'Four parameters for every recipe'.
- Parameter Input Fields:** Below the sliders, four input fields are shown: '# of Cycles' (value: 0), 'Etch Time' (value: 0s), 'XeF2 Pressure' (value: 0.01), and 'N2 Pressure' (value: 0.01). A red box highlights these four fields.
- Machine Status:** A 'Machine Status' section shows 'Ready'. Below it are progress bars for 'Etch time completed' and 'Cycles completed', both at 0. There are also fields for 'Cycle Time:', 'Elapsed:', and 'ETA:'.
- Control Buttons:** A green 'Start Etch' button and a red 'STOP' button are located at the bottom left. An 'Etch Mode' dropdown menu is set to 'Normal'.
- Diagram:** On the right side, there is a schematic diagram of the etching chamber system, showing gas inlets for XeF2, N2, and Vacuum (Vac), and pressure gauges for 'Exp Pressure' and 'Chamber Pressure', both showing 0.30 Torr.

Figure 9: The Etch Menu screen.

- 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.

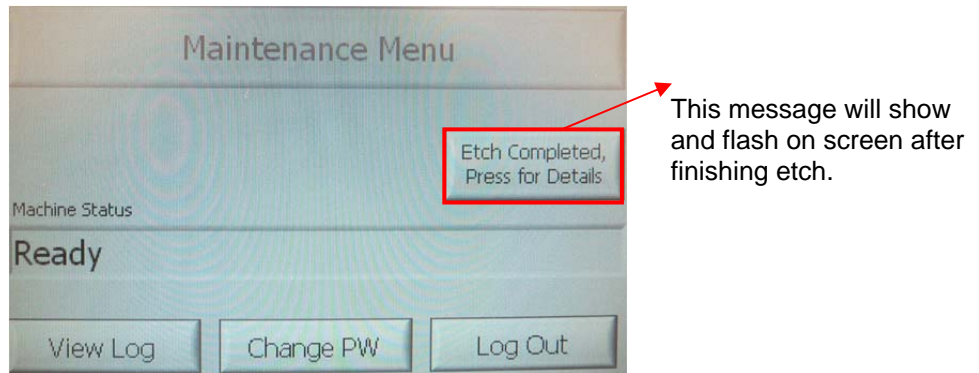


Figure 10: Main screen with the “Etch Completed” message flashing.

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.