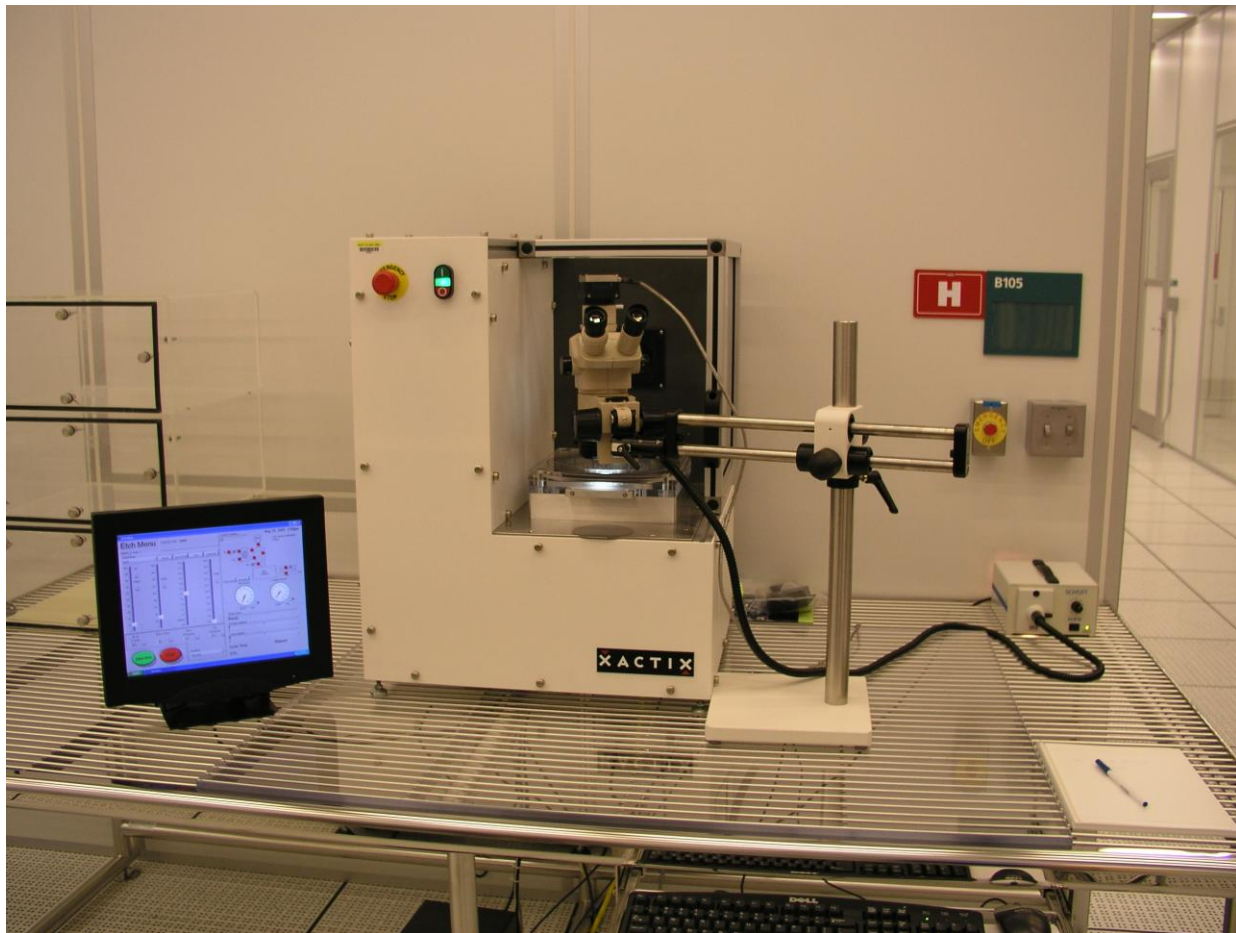


Xetch® e1 Series™ Bulk Silicon Etch System Users Manual



Coral Name: XeF2 Silicon Etcher
Model : Xetch e1 Series
Location: NanoFab, Building 215
Contact: nanofab_dryetch@nist.gov
Version: 1.0

INTRODUCTION:

The Xetch e1 Series tool is an isotropic silicon etcher. It uses Xenon Difluoride (XeF₂) gas as an etchant. XeF₂ vapor phase etching exhibits nearly infinite selectivity of silicon to photo-resist, silicon dioxide, silicon nitride and aluminum.

The overall concept to operate this tool is very simple. There are three chambers in the system:

1. XeF₂ source chamber (bottle)
2. Expansion chamber
3. Etch chamber (Main chamber)

The system is designed to expose samples to XeF₂ gas in a cyclic (pulsed) mode in which the **etch chamber** is repeatedly filled with XeF₂ gas and pumped out again.

Using computer controlled valves, XeF₂ from the **source chamber** gets expanded in the **expansion chamber** and then brought to the **etch chamber** to begin the etch process. After a certain time (usually 10 seconds), the etch chamber is evacuated and the entire process repeats. Figure 1 depicts simplified schematic of the XeF₂ etch system.

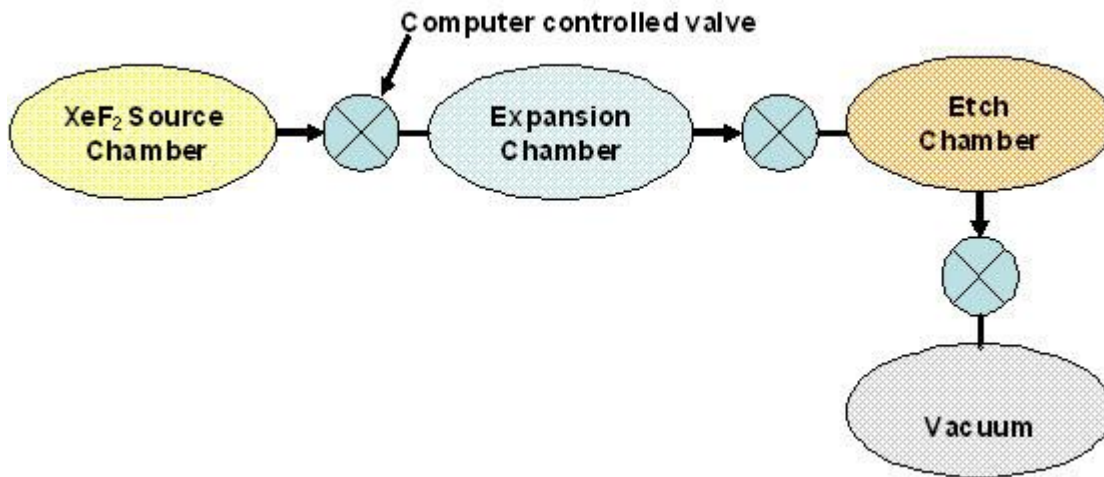


Fig. 1 Simplified schematic of the XeF₂ etch system

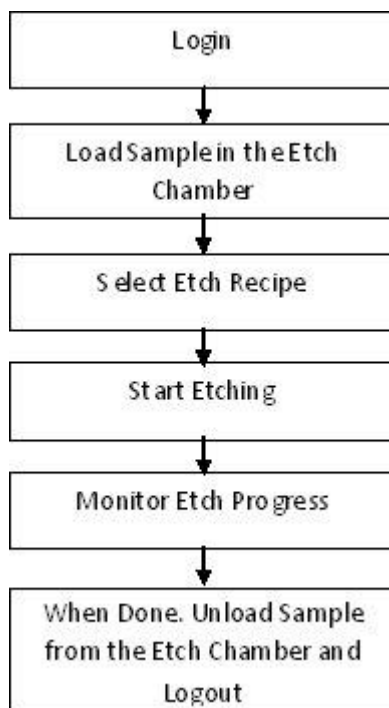
Safety:

XeF₂ forms Hydrofluoric (HF) acid fumes when exposed to moisture in the air. Inhalation of these fumes is a serious threat to human health. Fluorine gas is also produced during the silicon etch process, which is both toxic and corrosive.

- Always observe NanoFab safety procedures.
- Do not attempt to defeat system interlocks.
- Do not attempt to change XeF₂ source bottle.
- Do not expose etch chamber to excess humidity.
- Do not leave the etch chamber open for long time.
- Do not put wet samples in the etch chamber.

Procedure:

Following is a flow chart describing the procedure for etching silicon MEMS devices.

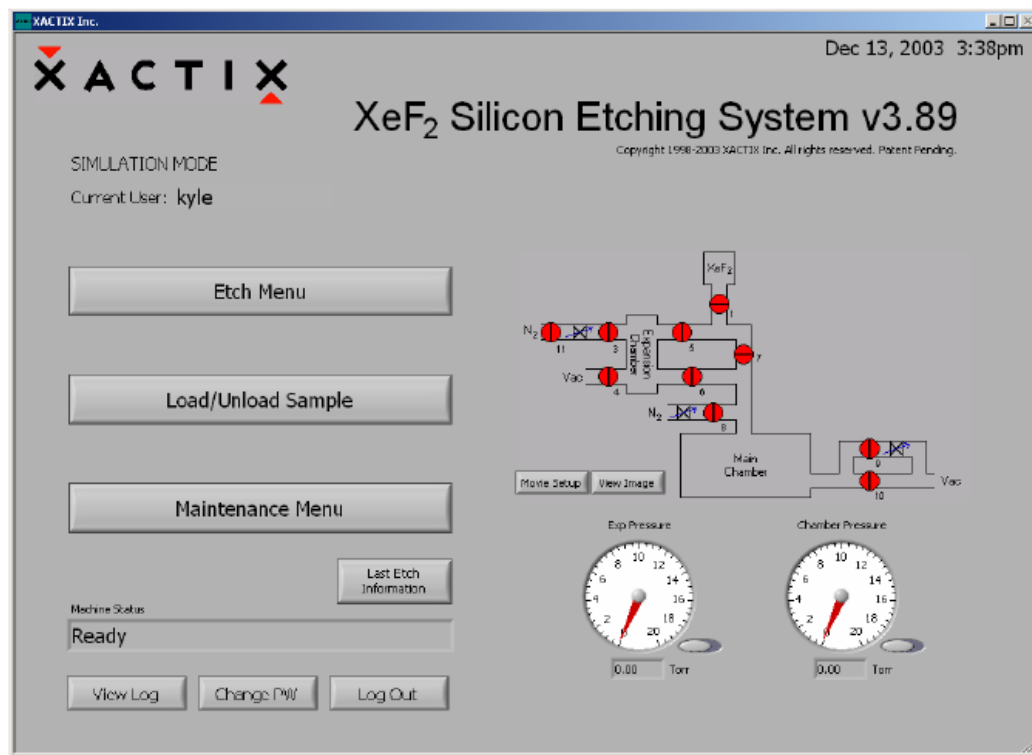


Login:

Login procedure requires a username and password. The user name is “user” and password is also “user”. If you do not see the login screen, please contact technical support.



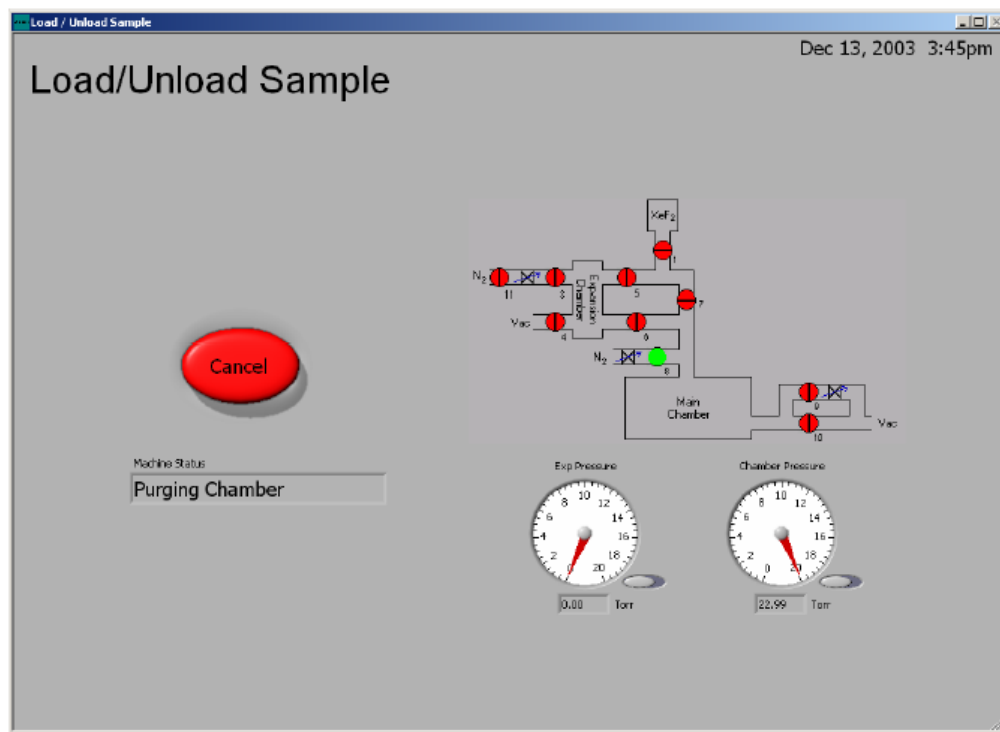
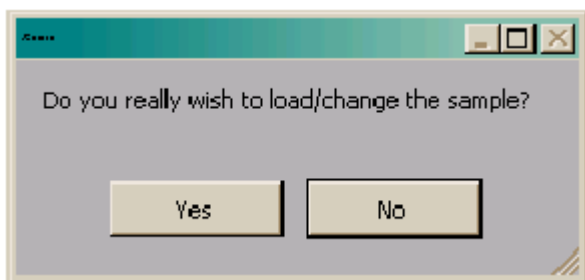
Once logged into the Xetch system. A main menu is displayed as shown below.



When the main menu is displayed, the chamber is under vacuum and ready for use. A schematic for the machine is shown on the right. 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.

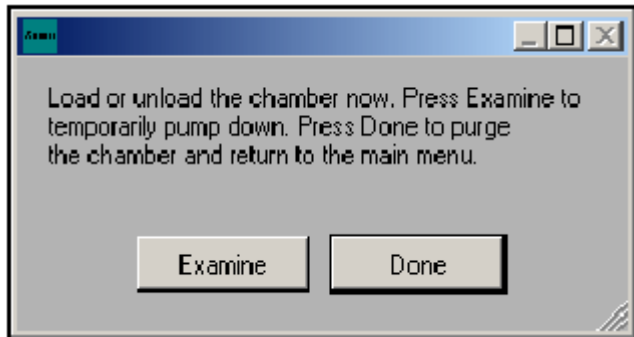
Load Sample in the Etch Chamber:

From the main menu, click on **Load/Unload Sample**. The system will go through prompts to ensure a correct decision: Are you sure? Press YES if you're sure, NO if you're not. This prompt is provided since the load/unload process can be time consuming and is inconvenient if accidentally started. The system begins chamber purges and flushing cycles to evacuate the chamber, shown below.



Swing the microscope (if its there) out of the way of the chamber. If the chamber ventilation shroud covering the chamber is not pulled fully forward (see Fig. 2 (left)), a

request to close the shroud will be displayed before venting the chamber. Move the shroud forward (see Fig. 2 (right)) and acknowledge the prompt. When the chamber is vented, the dialog box below will appear and you can open the chamber lid. The lid will rest open on the stop behind chamber.



Load a sample in the etch chamber and close the lid. Press "Done". The system will go through a purging cycle prior to chamber pump-down. As a side note, the Examine button only pumps the chamber down, without purges, so that the system can be quickly vented to load the sample. This is very useful when examining a sample away from the system to prevent moisture from accumulating in the chamber. However, it is always necessary to press "**Done**" before etching the sample. During the pumping cycle, a "click" sound will be heard that indicates that the ventilation shroud can be moved back to see the sample through the microscope. After pressing "**Done**", main menu will be displayed.

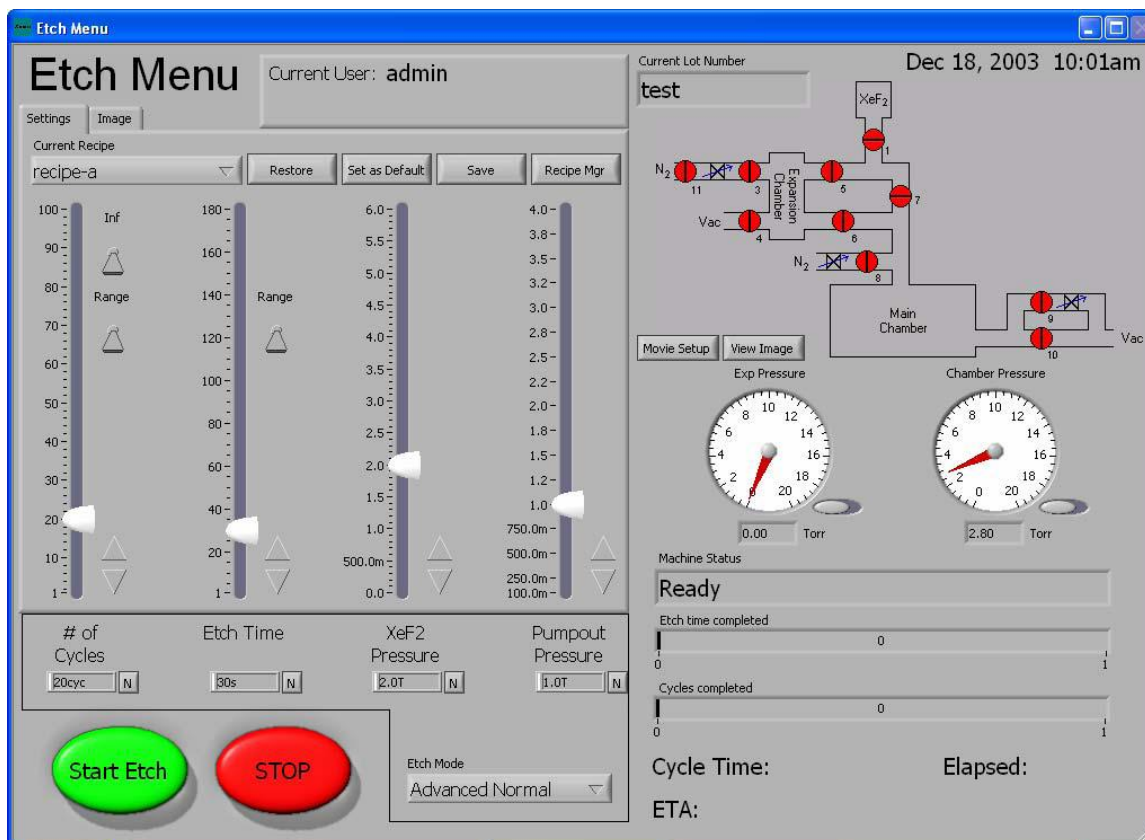


Fig. 2 (left) Chamber ventilation shroud pulled forward. (right) Chamber ventilation shroud moved to back.

Select an Etch Recipe:

From the main menu, select **Etch Menu**. **Etch Menu** allows you to select an etch recipe and to perform an etch.

The Xetch will prompt you to enter the lot number of the sample being etched. Press done once lot number is entered. The “Etch Menu” screen is shown below with lot number, “test” in this case; the screen pictured is for the advanced normal etch mode. It is important to note that in the “perform etch” screen, some options may not be available to certain users depending on the privileges which were given during the creation of their account.



The e1 Series software may be run in one of three operating modes. For default we will be using advanced normal etch mode (optional upgrade). This mode allows the user to set the expansion chamber pump-out pressure between cycles.

Click on “Current Recipe” pull-down menu where the default “recipe-a” is displayed to select a recipe other than the default. For etching in advance normal mode the following etch variables needs to be set:

1. # of Cycles
2. Etch Time
3. XeF2 Pressure
4. Pumpout Pressure

of cycles

Since the e1 Series is primarily a pulsed xenon difluoride etching system, the duration of the etch is controlled by the number of cycles. A cycle consists of the xenon difluoride sublimating 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 xenon difluoride into the main chamber a set pressure change of xenon difluoride must be delivered to the expansion chamber. Because xenon difluoride has a vapor pressure of ~4T at room temperature the upper limit for the XeF₂ pressure is approximately 4T. Due to the slightly elevated temperature inside of the etcher cabinet, you may be able to get considerably higher XeF₂ pressures.

Pump-out Pressure

The pump-out pressure allows the user to set the pressure to which the process and expansion chambers are pumped down to during the evacuation portion of the cycle. The above variables can be set either by moving the white slider on the scroll bar or by tapping or depressing on the arrows at the top and bottom of the scroll bar to increment each value exponentially. The “perform etch” screen is shown on the following page for advanced normal mode etching.

Click on **Image** tab at upper left of menu, move the shroud back, and adjust the microscope arm so the sample is visible in the Image window.

Next Click on **Start Etch** (green button).

The Etch Mode Menu is replaced by a Change Cycles Menu, which allows the user to increase or decrease the number of cycles during the etching based on the progress of the etch.

When the etching is completed, you can view the details of that etch by clicking on the Details button. The etch info is saved in the log file under the Lot #.

Unload your sample and then logout.

Do not shutdown the computer.

Turn off the monitor and the microscope lamp power supply.