SSIM
AUTOETCH PLASMA ETCHING SYSTEM
OPERATING PROCEDURES
Lam Poly-Nitride Etch System 490

Introduction

The basic function of the Auto Etch is to etch wafers using a plasma dry etch process. Two systems available to perform this function are the Model 490 for poly-nitrides and the Model 590 for oxides.

The Auto Etch is designed to operate automatically once a cassette of wafers is placed on the send indexer, an empty cassette is placed on the receive indexer, process recipe and parameters information is loaded into memory, and the start button is pressed. When the Auto Etch isn't processing wafers, the machine will be in idle status. In idle status the reactor chamber vacuum is maintained so wafers can again be processed without delay.

This section will provide information on the idle and power-up routines, the three modes of operation: Production, Recipe, and Service, general information about automatic and manual operation of the system, and a description of the Bulkhead system.

1. Turning on the Auto Etch

The Auto Etch is designed to remain on at all times except when shut down for maintenance. When not processing wafers the Auto Etch will go to idle status. In idle status chamber pressure is checked every 1/4 second to determine if chamber pressure is greater than 250 m Torr (see Figure 1). If pressure rises above this level, the chamber isolation valve will open for 30 seconds to bring chamber pressure down. (The chamber isolation valves is normally closed to prevent back streaming of mechanical pump oil from the "stack" to the process chamber.)

At normal power-up (see Figure 2) a software check will determine if power has been off for more than ten seconds; if not, and the system has been processing wafers, wafers will continue to be processed. If the power has been off for more than ten seconds; a determination will be made as to whether or not a cold start is required. A cold start will only be required if power has been off for extended periods of time, causing the battery in the memory board to lose its charge and hence the format information for the CRT display. If a cold start is required when power is turned on, the CRT will display "Cold Start, Insert Master Module, Press Load." With the Master Module loaded into memory, system initialization will take place resetting all of the alarms and bringing the system to idle status.

When the system initializes during power-on or a system reset, "INITIALIZE AC2" will display for five seconds in the lower right hand side of the Status page. If after five seconds the AC2 and the computer are not communicating properly, "AC2 FAILURE" will display in the lower right hand corner of the page until communication is established.

A disruption in power to the Auto Etch (see Figure 2, page 197) will trigger two timer circuits in the controller drawer. The two second timer circuit is designed to protect the system from rapidly fluctuating facilities power. When power is interrupted, the two second timer circuit will hold the system low voltage power off for a minimum of two seconds.

A ten second timer circuit will also be triggered with a power interrupt and will determine whether or not the system continues processing wafers when facilities power is restored. If power is restored in ten seconds, the system will continue processing wafers. If power has been off for more than ten seconds, the system will go through an initialization routine erasing recipe and parameters programmed information and asking that a wafer cleanout be activated to remove wafers left in the system.

2. Modes of Operation

The Auto Etch may be operated in three distinct modes:

1. PRODUCTION Mode
2. RECIPE Mode
3. SERVICE Mode

These modes are arranged in an ascending order of capabilities, with the PRODUCTION mode having the least capability and the SERVICE mode having the greatest capability (see Section 3, Figure 1, page 196).

The settings of the key lock switches determine the machine operating modes.

NOTE: The key lock switches restrict access to the machine by disabling certain functions and pushbuttons (keys) on the front panel and restricting the display pages the respective user can control.

In the **PRODUCTION mode** both key switch box keys are turned off and should be removed. Production operators may then load cassettes, load recipes, verify recipe identification numbers, start the wafer processing sequence, and view the Status display.

The **RECIPE mode** (Recipe key turned on) includes the PRODUCTION mode and, in addition, process engineers may edit Recipes and Parameters pages information and operate the manual endpoint override on the Status page.

In the **SERVICE mode** (Service key turned on) service and maintenance technicians are allowed access to all production and process controls and, in addition, have access to the direct machine control areas of the Auto Etch. The 24 volt toggle switch may be used to remove system low voltage only in the SERVICE mode. When the 24 volt switch is turned off, the pneumatic system is disabled.

3. Automatic Operation

The Auto Etch will operate automatically when the start button is pressed cycling wafers through the system from the send cassette to the receive cassette until all wafers have been processed. Note that after the processing recipe has ended and before any of the main chamber doors are opened, the main chamber isolation valve and AC□2 valve are left open for two seconds to lower chamber pressure during wafer transfer.

During processing (see Figure 3, page 196) the recipe step in process, as well as time remaining for that particular step, will be displayed at the top of any CRT display page except the Macro page, which is not accessible during automatic operation. A flashing "W" indicates where a wafer should be located during the processing sequence. A simulation of doors opening and closing, vacuum pumps pumping, and gases flowing will also be represented on the Status page. During any etch step, the amount of reflected power will also be displayed to the upper right of the representation of the process chamber on the Status page. Note, in Figure 3, that the operator interface message indicating that endpoint parameters information has not been programmed for step #2 on the "endpoint" Parameters page.

If the stop button is pressed and wafers are still present in the send cassette, these wafers will not be processed. However, those that had already been sent from the send cassette will continue through the system and will be processed. When the last wafer sent (before the stop key was pressed) has reached the receive cassette, the system will go to idle status.

Figure 4 indicates the Status page configuration during the "dead time" when a processed wafer is about to be taken out of the chamber and another wafer is to be placed in the chamber. Note that the gas flow pre-charge option has been selected on the machine Parameters page as indicated by the representation of the gases flowing into the manifold and hence into the main chamber pumping "stack."

As noted previously, the "macro" Options page is not accessible during automatic processing. This is also true of the upper (outputs) section of the "signal" Options page. Likewise, when manually operating the system using the digital or analog outputs on the "signal" page or the outputs associated with the "macro" page, the start key will be disabled preventing a conflict of control between operator and automation.

If the red/green light option is operational (see digital output Port 10), the red light will be "on" if any one of the following conditions exist.

1. The system is in Idle status.
2. The system is holding for alarm.
3. The system is in Process Complete status.
4. The system is processing the last wafer.
5. The system is loading the last wafer.
6. The system is in any type of audible alarm.

When the system is processing wafers and none of the above conditions exist, the green light will be "on."

4. Manual Operation

Manual operation of the system necessitates activation of the service key switch so that the Options (Direct Machine Control) pages may be accessed.

Signal Options Page

With access to the "signal" Options page (see Section Three, Figure 3□9 of the manual), maintenance personnel may provide digital and analog commands to the system and may read the digital and analog system responses.

The "signal" page is divided into four sections:

1. Digital outputs section.
2. Display of any three digital input or output ports.
3. Analog outputs section.
4. Display of all analog input channels.

From the "signal" page, trained maintenance personnel may set up machine conditions manually. The user may access desired machine digital outputs by selecting [BIT] or [WORD] control. In order to control the elements of the machine using [BIT] control, the user must enter the desired port and change individual bits using the field select key. To control the machine using the [WORD] control, enter the port number desired, enter the desired combination of bits with the numeric keys, and then close the control port (move cursor out of the field) to execute the command. The 10 analog output fields are displayed below the digital output section. From here the user is allowed to manually control the gas flows and the RF forward power by entering the desired counts corresponding to analog output voltages. Below the analog output area are three fields which may display any desired digital input or output ports.

At the bottom of the page there are 16 numbers which correspond to 16 of the 32 available analog input channels. Channels 1 through 16 are displayed when block [1] is selected and channels 1? through 32 are displayed when block [2] is selected. The "PORT MAP" lists the digital port numbers and bits by which each sub-system is connected to the Input/Output ports. In the back of Section 8 is a list of all the analog input and output channels, their functions, and their value ranges.

CAUTION: When the Auto Etch System is operating under Direct Machine Control the regular software interlocks are disabled. For example, it is now possible to inappropriately move the wafer arm into contact with a load lock door. Therefore, when operating from the Direct Machine Control pages, users must use caution not to send improper commands. When leaving Direct Machine Control, software control is resumed, i.e., the chamber isolation valve will open for two minutes, position of wafer transport

components are checked and returned to their initialized positions, and the gap between the anode and cathode is driven to a minimum of approximately 1.35 cm.

On all displays except the two Options pages, the cursor will remain in its last position until a system reset occurs. Whenever the options key is pressed, the CRT will display the "signal" Options page with the cursor at the first digital input port. Note that the guard seal pressure display on both Options pages will disappear when guard seal pressure drops below 20 m Torr.

Macro Options Page

The "macro" Options page (see Section 3, Figure 3□10 of the manual) allows the user to operate the wafer transport system in a manual mode using the field select key to perform specific functions. Figure 5 provides an index to indicate which field performs which functions. Note that when moving an airlock arm, the field select key must be toggled twice to determine the direction it will move next. Otherwise, there is a risk of moving an arm into an airlock door. Also note that before the indexer will index down to send a wafer, the wafer belt track must be turned on.

5. LRC Auto Etch Bulkhead System

The Auto Etch Bulkhead system is designed to be installed through a wall with the front of the machine in a Fab clean room and the rear of the machine in a service area (see Figure 6). This allows for processing of wafers to be done in a clean room environment and system maintenance to be done "outside" that environment.

A remote CRT and operator interface has been provided in the service area to permit operation and diagnostic maintenance of the system. A master control switch on a remote console allows service personnel to take control of the system or return control to the Fab operator. In addition, a special large power switch panel with an emergency stop button, a normal power-on lighted green button and a normal power-off button has been provided in both front and rear locations. The remote console also has a Recipe key switch, a Service key switch, and a 24 volt toggle switch. On the front there also is a Recipe switch, a Service switch and a 24 volt switch. System control is indicated by an amber light located next to the Recipe switch in front and next to the master control switch on the remote console in the rear. When control is shifted to the remote console in the service area, both amber lights are turned "on."

For normal Fab operation, the master control key switch will be in the vertical position pointing to the label "Front" for Fab control. The amber lights will be off and the Fab operator will have control of the system. If the Recipe and Service keys are inserted in the Fab clean room and turned on, the operator can write recipes, set parameters and endpoint criteria, and load or save recipes. The system may also be operated in the operated in the Direct Machine Control mode.

Remote operation from the rear service area requires that the master control switch be turned to the horizontal position pointing to "Remote." In remote, the amber light will be on at the front and rear of the machine. When the lights are on, the Fab operator interface key board will be locked-out or disabled. The Auto Etch can then be operated only from the service area.

The Emergency Stop button is functional from either location regardless of the position of the master control switch. When this button is pushed, all power is turned off. a key must be inserted into this button and turned in order to reset it for powering back up.

The green "On" button is functional only on the side that has control. For example, when service personnel are performing maintenance, they will turn the master control switch to the remote position to take control. The green "On" button in the rear will be activated, but the one in the front will be locked-out to prevent accidental "power up" by Fab personnel. When maintenance is completed, system control is returned to the Fab area by turning the master control to the vertical position.