



## **Standard Operating Procedure: Reactive Ion Etching**

Samco RIE-10NR

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### **Table of Contents**

1. Lab Safety Information.....	2
2. Samco RIE Safety Information.....	3
3. Software Overview .....	5
3.1. Elements of the Main Screen .....	5
3.2. Elements of the Main Banner.....	6
4. Operation.....	7
4.1. Loading the sample .....	7
4.2. Start a Recipe .....	7
4.3. Unload the sample.....	7

## 1. Lab Safety Information

- ✓ All GMU NFF users are required to complete the Lab Safety Orientation (LSO) before performing any lab work.
- ✓ Proper Personal Protective Equipment (PPE) should always be worn before entering the clean room: safety glasses, hair net, shoe covers, gloves, and lab coat. Additional PPE is available for specialized chemical work as needed.
- ✓ No shorts, sandals, tank tops, or spaghetti-strap shirts are allowed in the clean room!
- ✓ Safety Data Sheets (SDS) are available in a binder in the gowning room.
- ✓ Read the SDS for any chemicals you plan to use before proceeding with your work. Any materials used in the clean room for the first time should be brought in after the approval of NFF staff.
- ✓ A safety buddy is required in the clean room with you when doing chemical work. They must remain in the clean room the entire time you are handling the chemical. Feel free to ask NFF staff if no one qualified is available!
- ✓ Prohibited clean room items: cardboard, pencils, cloth, hats/coats, and contact lenses.
- ✓ Accepted clean room items: plastic, pens, synthetic fabrics, clean room paper.

## 2. Samco RIE Safety Information

- ✓ Any irregular system behavior should be reported to NFF staff promptly. Never attempt to fix the system yourself!
- ✓ Pump down the system once you are finished using it.
- ✓ Do not put wafers with PDMS or any other unapproved materials into the vacuum chamber.
- ✓ When in doubt... ask NFF staff!
- ✓ Gloves can become contaminated when loading wafers or removing wafers. Always check your gloves and replace them when necessary.
- ✓ Failure to use the system safely and properly may result in your access to the system being reviewed and/or revoked.
- ✓ Fill out the logbook before you begin.
- ✓ If a new recipe is required ask for assistance from the NFF staff.

### 3. Principles of RIE

Reactive Ion Etching is a plasma etching technology used to fabricate micro and nanostructures. During RIE etching processes, volatile compounds are formed in interaction of sample surfaces and high-energy ions/radicals generated by low-pressure plasma. The volatile compounds are removed from the sample surfaces, and isotropic or anisotropic profile is achieved. Process gasses in use:  $\text{CF}_4$ ,  $\text{CHF}_3$ ,  $\text{SF}_6$ , Ar,  $\text{O}_2$ . 300W RF power supply. Useful for etching of  $\text{SiO}_2$ ,  $\text{Si}_3\text{N}_4$ , Si, many other materials.



## 4. Software Overview

### 4.1. Elements of the Main Screen

The Main Screen is shown in Figure 1. Elements of the screen are described below.

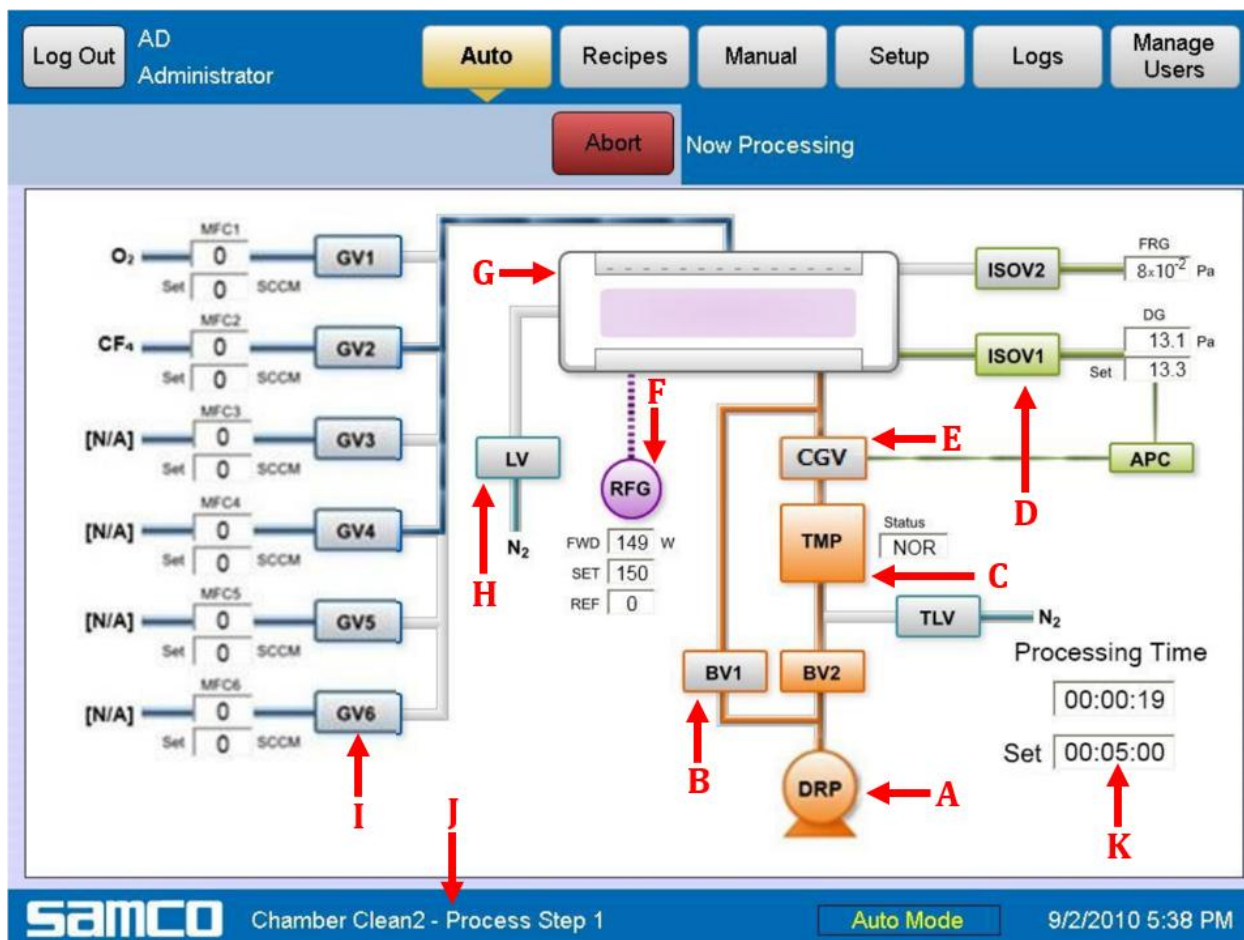


Figure 1

- **A: Dry Roughing Pump.** Used to handle the initial stages of pump down (creating vacuum in the chamber) and to back up the Turbo Pump.
- **B: Breaker Valve.** Used to isolate the Dry Roughing Pump. Switches from BV1 to BV2 in later stages of pump down when the Turbo Pump is utilized.
- **C: Turbo Molecular Pump.** Handles the later, higher-pressure stage of the pump down process.
- **D: Isolation Valve.** Isolates two gauges that allow the user to evaluate the pressure within the RIE chamber.
- **E: Control Gate Valve.** Isolates the Turbo Pump from the RIE chamber during etching, and opens when the Turbo Pump is needed to create a strong vacuum.

- **F: RF Generator.** Creates the required bias within the RIE chamber to allow plasma to be created and etching to occur.
- **G: RIE Chamber.** Main chamber where a carefully maintained ratio of gasses are pressurized, exposed to a RF bias and ionized to allow for a sample to be etched.
- **H: Leak Valve.** Opens to vent the chamber to atmospheric pressure once etching is complete.
- **I: Gate Valve.** Isolates each process gas the system can use when they're not in use, and regulates their flow rate when they are in use.
- **J: Active Process Recipe:** This section shows the active recipe that is loaded into the RIE's computer, which will run once the "Start Process" button is pressed
- **K: Processing Time:** A timer that gives an estimate for how long the system needs to finish the step that it is on.

#### 4.2. Elements of the Main Banner

The Banner at the top of the main screen is shown in Figure 2. Elements of the screen are described below.

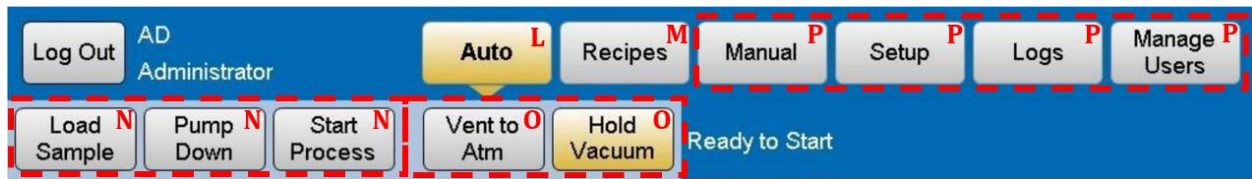


Figure 2

- **L: Auto Mode Screen:** Main screen that lets you initiate an etch, and observe the system as it moves through the stages of the process
- **M: Recipes Screen:** Secondary screen that allows you to view publicly available recipes, and select which you'd like to use.
- **N: Imminent Action Buttons:** These three buttons allow you to select the action you'd like the RIE to imminently take. These include Venting to Atmosphere (*Load Sample*), Pumping the Chamber down to vacuum, and/or Starting the Process that's actively loaded into the system (*Refer to J*).
- **O: Post-etch Action Buttons:** These buttons allow you to dictate what the RIE should do once an etch is complete. You can ask it to either hold its vacuum, or to vent to atmosphere.
- **P: Admin-level buttons:** These buttons facilitate admin-level processes. You should not be able to use them in operator mode!

## 4. Operation

### 4.1. Loading the sample

1. Vent the chamber, if it is not already at atmosphere (*Refer to N, "Load Sample"*)
2. Press both load-lock buttons simultaneously (*do NOT hold them down*) to open the chamber
3. Load your sample into the RIE chamber, centering it as best as possible
4. Press and hold both load-lock buttons simultaneously to close the chamber (*release them when you hear a beep and the warning light flashes*)

### 4.2. Start a Recipe

1. Go to the Recipes screen (*Refer to M*) and click "Open Recipe"
2. Select the publicly available recipe you'd like to use, then click "Select Recipe".
3. Click "Make this the Active Recipe" to load your desired recipe into the RIE computer.
4. Click "Auto" to return to the main screen (*Refer to L*)
5. Tell the RIE what you'd like it to do once the etch finishes (*Refer to O*), then press the "Start Process" button to begin the etch (*Refer to N*)

### 4.3. Unload the sample

1. Vent the chamber, if it is not already at atmosphere (*Refer to N, "Load Sample"*)
2. Press both load-lock buttons simultaneously (*do NOT hold them down*) to open the chamber
3. Remove the wafer.
4. Press and hold both load-lock buttons simultaneously to close the chamber (*release them when you hear a beep and the warning light flashes*)
5. Pump The system Down (*Refer to N*). ALWAYS PUMP SYSTEM DOWN WHEN FINISHED