

Operating Instructions for the SAMCO RIE200iP

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Introduction

The SAMCO International RIE200iP is a state of the art inductively coupled plasma etcher (Figure 1). The tool specifications were fixed to enable users to etch a dielectric hardmask, strip photoresist, and etch III-V materials such as GaAs and InP and related alloys with either a resist or a dielectric mask.

The tool is plumbed with Cl₂, BCl₃, SiCl₄, Ar, O₂, CF₄, and CHF₃. It possesses a He backside cooled electrostatic chuck that is temperature controlled with an oil circulator capable of maintaining the chuck temperature in the range of 40C to 250C. Specimens are loaded into the process chamber by a robot arm through a load lock to minimize the amount of oxygen entering the process chamber and to protect users from hazardous etch byproducts.

Wafers of 50mm, 100mm, or 150mm diameter can be processed in the system with an appropriate change of parts in the process chamber. Samples that are not of the standard wafer sizes listed must be mounted on a carrier wafer.

There are 2 RF power sources to control the properties of the plasma. The first is a 1000W supply inductively coupled to the gas in the process chamber. It generates a high density of radicals and ions with only a small potential between the plasma and the wafer surface. An additional 300W source induces a potential between the chuck and the plasma just like a traditional RIE system. The advantage of this combination is that the plasma density and the substrate bias can be independently controlled.

The system is controlled by an on-board computer and operated with a touch screen and a very simple “jog dial”. Users must log in to use the tool. A separate laptop computer acts as a data logger and may also be used for recipe editing and transfer.



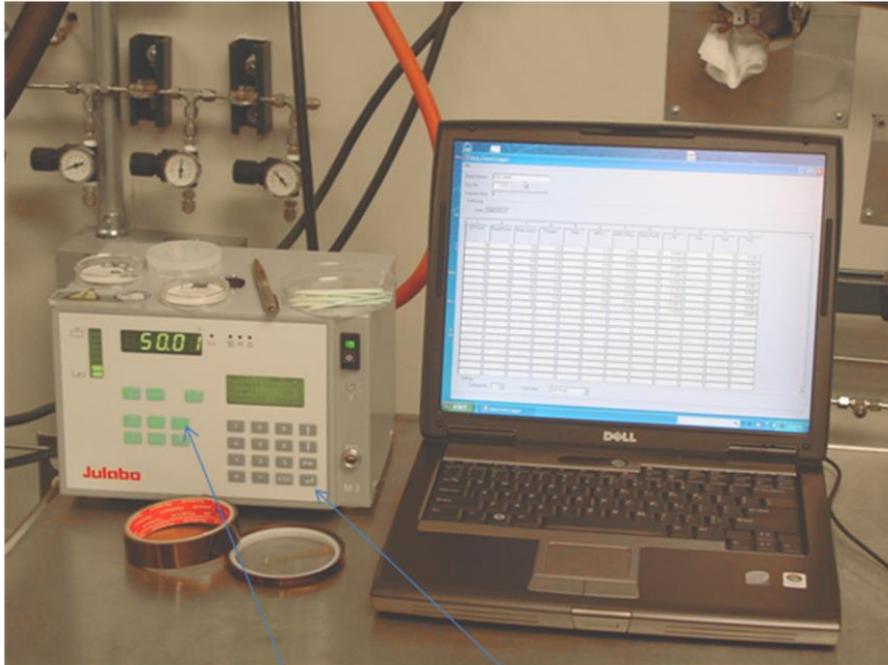
Figure 1. The main unit of the PRISM MNFL Samco RIE200iP etcher.

Overview of the System

The etcher consists of the:

- main unit, which houses all of the turbopumps, electronics, RF sources and chambers (Fig. 1);
- circulator control, located on the table next to the main unit (Fig. 2);
- data log laptop, located on the table (Fig. 2);
- process dry pump and mechanical load lock vacuum pump, located in the J417 service chase;
- high temperature circulator, also in the chase.

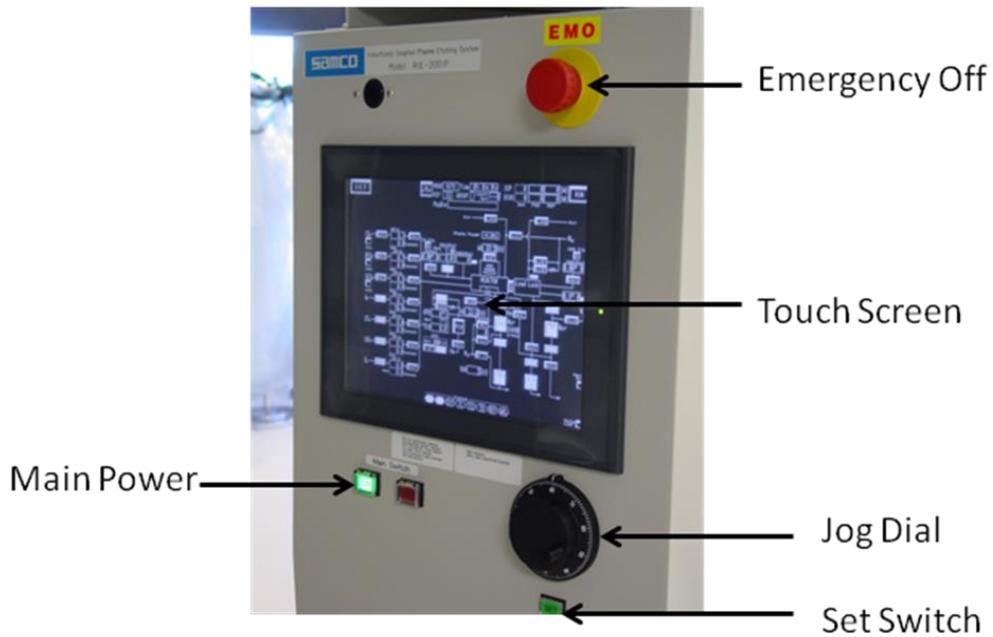
The main unit touch screen and jog dial control all of the tool operations except the chuck temperature (Fig. 3). The circulator temperature controller operates independently of the main unit and must be set manually. All of the other components, such as the pumps, are controlled through the main unit.



Enter Key

Temperature "T" key

Figure 2. The circulator controller box and the data logging laptop.



Emergency Off

Touch Screen

Main Power

Jog Dial

Set Switch

Figure 3. The SAMCO 200iP computer interface with touch screen, jog dial, set switch, emergency off switch, and main power switch.

There are 3 screen displays that are regularly used:

- The Main screen, showing the status of the sub-systems (Fig. 4) at the bottom. In the normal state, the status indicators at the bottom of the screen, PS and FS, should be highlighted.
- The Mode screen, where the user logs in and sets up process runs (Fig. 5). Normally, the tool is in “Auto” operation mode (region on lower right). The user logs in at the “Login Menu” region. Automatic recipes are set up in the “Auto Sequence” region.
- The Edit Screen, where the user edits recipes (Fig. 6). Normally, only the step times are modified.

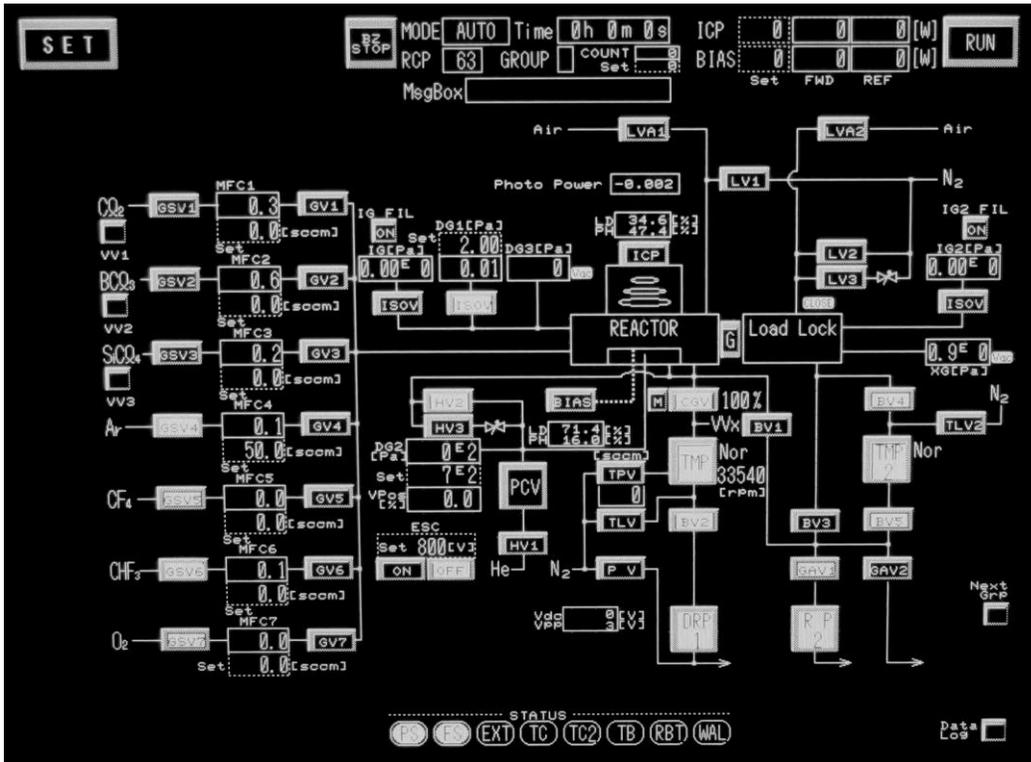


Figure 4. The main screen. The status indicators at the bottom, PS and FS, should be the only ones lit.

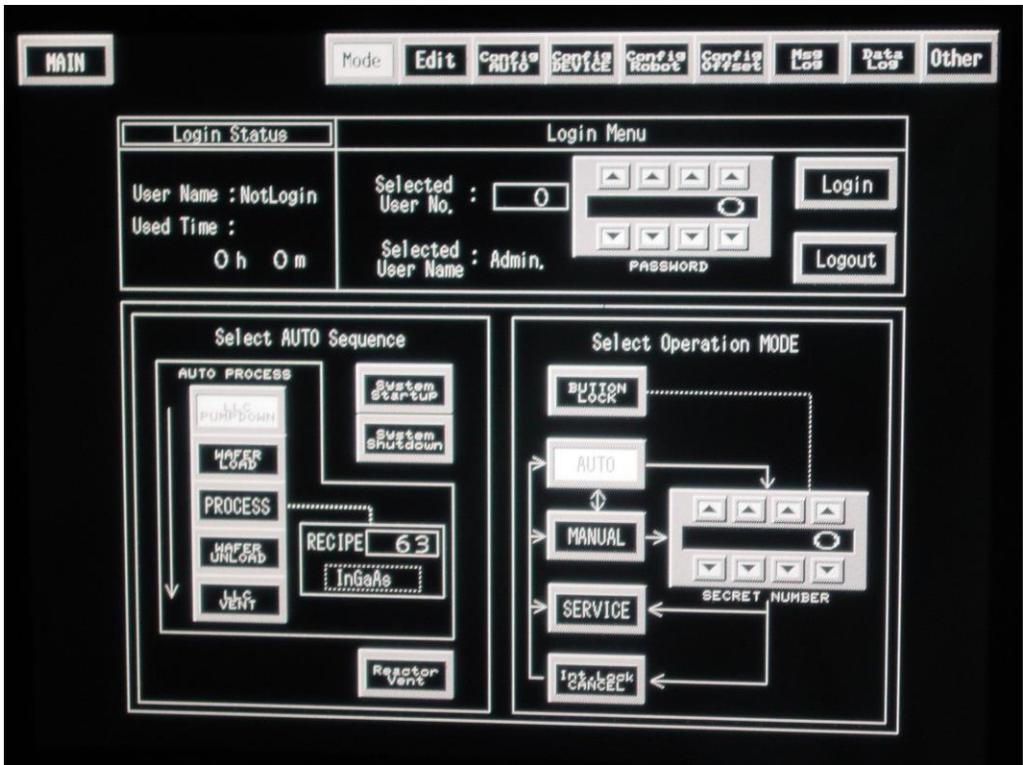


Figure 5. The Set/Mode screen. There are 3 main sections, the login Menu, the Auto Sequence, and the Operation section. Normally, the operation mode should be “Auto”.

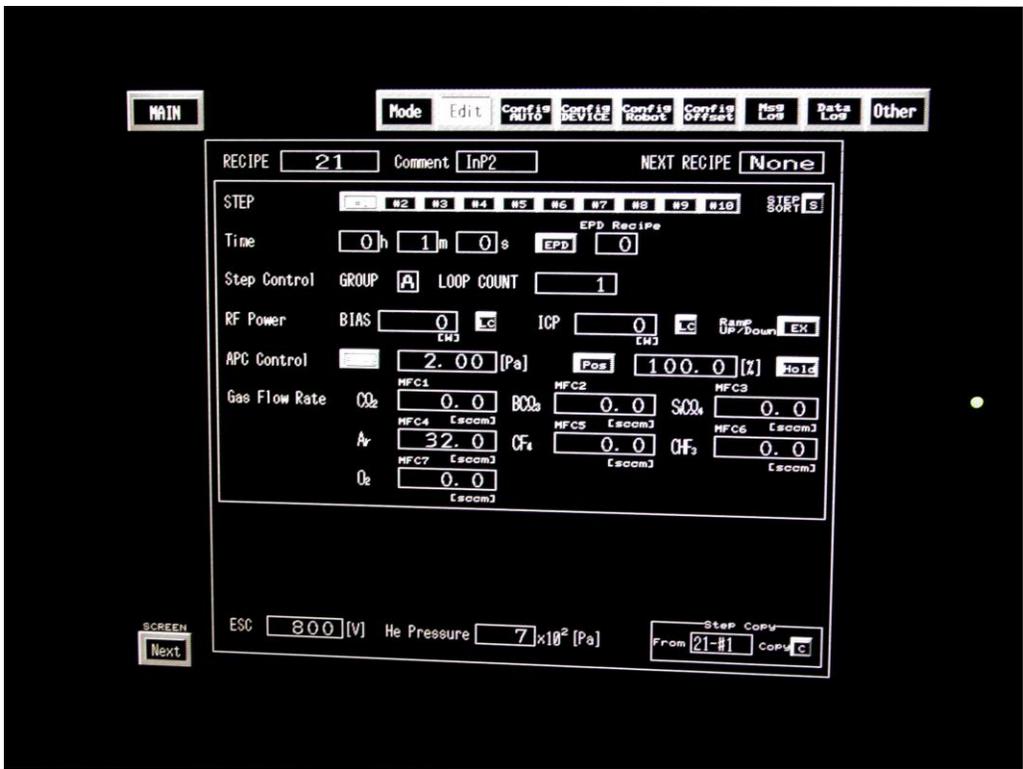


Figure 6. The Set/Edit screen. Users should only modify the “Time” boxes in established recipes.

Start up and Login

- 1) The user should first set the circulator to the temperature called for in the recipe.
 - a) Press “T” on the circulator control pad (Figure 2),
 - b) enter the appropriate temperature, and then
 - c) press enter (↵) on the circulator control unit.

It may take 20 minutes or more for the circulator to reach the proper temperature.

- 2) To operate the etcher, the user must first **log in**:
 - a) First log in to the tool through the on-line **reservation system**, then
 - b) Select the Set/Mode screen (Fig. 5). You should be already logged in as “USER”.
If not:
 - i) Press the “Select User No.” box on the touchscreen and, using the jog dial and set button, select the user ID number “1”.
 - ii) Use the touch screen password digit selector up/down keys to enter the user password “1111” and press “Login”.
- 3) The system should normally be left with the load lock pumped down. To bring the load lock **to atmosphere**,
 - a) use the “Select Auto Sequence” section of the SET/MODE screen (Fig. 5) and deselect all of the auto process steps except “LLC Vent”, which should be highlighted.
 - b) Press the MAIN screen button, which displays a schematic of the system (Fig. 4) and then
 - c) *press and hold* RUN for a few seconds to start the venting process. The system beeps when the process starts and when it is complete.
- 4) Sign in the logbook with user ID, start time, and recipe conditions.

Mounting and Loading a Sample

Since the electrostatic chuck must be protected at all times from the plasma, specimens that are not 50 mm, 100 mm, or 150 mm diameter wafers must be bonded to a carrier wafer. The default wafer size is 50mm (2”). ***Please see the staff if the sample is larger than 50mm, since parts in the process chamber must be changed to accommodate it.***

- 1) A small sample (less than a 50mm wafer) must be mounted to a special carrier wafer. A 50 mm sapphire wafer that has been sputter coated with Cr on the back is typically used as the carrier. The metal coating is required so that the wafer can be electrostatically held to the chuck. Other carrier wafers, such as Si, InP, or GaAs do not require a metal backside layer.

- 2) Clean and blow-off the carrier wafer with 2-propanol to remove any residue. Check the back of the carrier to ensure it is free of any contaminants that could compromise the seal between the carrier and the He backside cooled chuck.
- 3) Using a small cleanroom swab, coat the carrier (or the back of the specimen) with a thin layer of a thermally conductive silicone grease. Make sure that as little grease is exposed as possible. Press the sample gently against the insulating side of the carrier to ensure good contact.
- 4) Open the load lock chamber door (the chamber should now be at atmosphere) and place the carrier on the robot arm. Make sure it is properly centered. Place a cover ring, ceramic or quartz, over the carrier and center it as well. The cover ring will protect the small region of the chuck that is not covered by the carrier or the surrounding protective covering in the process chamber. ***Do not operate the etcher without a cover ring.*** Check to make sure that there are no obstructions or particles on the door o-ring and complementary surface, then close the load lock door.

Etching

The user will generally use established etch recipes. ***Users may only modify the time of the main etch in the standard recipes*** (with ID numbers from 0 to 19).

If other modifications are required, see the PRISM cleanroom staff so that they may copy the recipe of interest to another location for user modification. Please notify the staff of any major new recipe changes to prevent hazardous or damaging situations. For instance, some combinations of gases, such as SiCl₄ and O₂, can be dangerous and should not be used in the same recipe. Also, using O₂ and F₂ containing gases can ruin subsequent Cl₂ based processes unless the chamber is properly prepared.

Do not turn off the electrostatic chuck or He backside cooling components of the recipes.

- 1) To edit a recipe, go to the **edit** subscreen in the **set** screen. Press the **recipe** box and select the recipe of interest with the jog dial/set button (Fig. 6).
- 2) Press the step number of interest and highlight (press) the **hour**, **minute**, and **second** parameter boxes to modify them. Use the jog dial/set button to change the parameter values.
- 3) Check to make sure the data logging program is operating on the laptop computer.
- 4) Press the SET button on the touchscreen and then to the mode subscreen. Highlight all of the auto mode functions so that the device/carrier wafer is pumped down in the load lock, loaded into the process chamber, etched, removed from the chamber, and brought back to atmosphere (Fig. 5).

- 5) Select the recipe box on the touch screen and use the jog dial and set button to select the desired etch recipe.
- 6) Press the **Main** button on the touchscreen and then press **Run**. The tool will load etch and return the sample to the load lock. When the process is complete, the system will signal with a loud pair of beeps.

Finishing Up

- 1) Unload the cover ring and store it in the proper container. Unload the carrier, remove the sample and wipe the carrier with 2-propanol to remove the silicone grease. The grease may be removed from the specimen with warm 2-propanol, followed by a clean 2-propanol rinse and blowoff.
- 2) Close the loadlock door.
- 3) In the Set, Mode screen, deselect all of the auto operations except LLC pump down (the last one). Press “Main” and “Run” to pump down the load lock chamber.
- 4) **Fill in the logbook** with end time, recipe, data log file number, and any comments, results, chuck temperature, etc.
- 5) Set the circulator temperature to 50C and then turn it off.
- 6) To increase the lifetime of the corrosive gas mass flow controllers, (mfcs) use the following procedure to evacuate the Cl₂, BCl₃, and SiCl₄ mfcs:
 - a. Select the **Set/Mode** screen and use the arrow keys to select the “secret number” 1234 in the Operation Mode box. Then press “Service” to enter service mode.
 - b. On the Main screen highlight the “TPV” valve to start purge nitrogen in the turbomolecular pump.
 - c. Deselect the GVS1 (Cl₂) valve to turn it off, then turn on the GV1 valve. Cl₂ should flow from the mfc. When it slows to about 0.1 sccm, turn off GV1.
 - d. Repeat the process for GVS2 (BCl₃) and GVS3 (SiCl₄).
 - e. When the flow controller are evacuated, turn of the purge gas (TPV), then return to the **Set/Mode** screen to select “Auto” in the Operation Mode box to get out of service mode.
- 7) Log out of the tool through the on-line reservation system.

Appendix A: Startup

To start up the system from a power off condition, simply press the green **Main On** switch on the front of the unit. Once the computer boots up, login, select **System Startup** in the auto sequence box on the **set/mode** screen, then select **Main**, and press and hold **Run**. The system will automatically turn on each of the pumps.

If an error occurs, press and hold **Run** again to continue the process.

When complete (pair of beeps), the system vacuum system is ready. Turn on and set the circulator.

Wait for 30 minutes for the chamber heaters to reach temperature.

Appendix B: Shutdown

Log in, goto **Set/Mode**, press System Shutdown on the auto sequence box, press Main and then press and hold Run. The system will safely turn off all pumps and isolate the chambers.

When the sequence is complete (double beeps), turn off the main power with the red **Main Off** switch located on the front of the tool.

Appendix C: Recovering after forgetting to log in to reservation system

If you attempt to vent the load lock chamber without first logging in to the reservation system, the etcher will isolate the process chamber and remain in an error state. To recover, log in to the reservation system and to the tool and then from the main screen, select "Buzz Off" to turn off the alarm. Then follow the Startup instructions in Appendix A. The system should be ready in about 2 minutes.

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