Usage Policies Notebook for STS DRIE System

Revision date

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INRF UCIrvine

Emergency Plan for STS DRIE System

Standard Operating Procedures for Emergencies

Contact information

Person	Phone number
Lab Manager	Jake Hes, 949-824-8239 (day), 562-522-8328 (alternate)
Director	G.P. Li: 949-824-4194 (day), 949-824-2047 (alternate)
Staff	Mo Kebaili: 949-824-8239 (day), 949-494-5892 (alternate)
Super User	Carlos Ruiz (818) 527-6349 (Anytime, voicemail or text only)

Hazardous chemicals, gases, and conditions

Hazard name	Description of hazard
Vacuum	Implosion
High temperature	Burn or ignition source
High voltage	Electrical shock, ignition source
Isopropyl alcohol	Flammable solvent
C_4F_8	Toxic fumes
SF_6	Toxic fumes
O_2 (oxygen) gas	Oxidizer gas
He (helium) gas	Inert gas
N_2 (nitrogen) gas	Asphyxiant

Alarms or indications of danger

Alarm type	Condition and response
Alarm on the scrubber in the utility room	Problem with scrubber. Halt any running process. Correct the problem or notify the staff or the lab manager before continuing.
Alarm on the console	Problem with process state. Halt the process. Correct the problem or notify the staff or the lab manager before continuing.
Pungent or foul smell	Gas leak. Shutdown the machine at once and evacuate the area. Contact the staff and the lab manager.

Emergency shutdown plan #1

In the event of an emergency, when there is very little time, *press the large red emergency shut-off button at the front of the machine*. This will shutdown the system and will stop the gas flow into the system. Leave the facility at once. Then contact the lab manager or the staff.

Emergency shutdown plan #2

In the event of an emergency, when there are a few minutes available, *press the large red emergency shut-off button at the front of the machine*. This will shutdown the system, and stop gas flow into the system. Next, check the gases in the utility room w2331, adjacent to the Plasma-therm room. If there is no fire, and no smell of gases, enter the room and shut off all gas cylinders valves by turning them fully clockwise. Check the oxygen tank in room w2336, feel the door for possible fire, and if safe, close the oxygen tank by turning fully clockwise. Leave the facility at once, then, contact the staff and the lab manager.

Usage Policies for STS DRIE System

Standard policies for usage

The STS DRIE System performs deep reactive ion etching of silicon material. It uses inductively coupled RF plasma (ICP), with Advanced Silicon Etch (ASE), licensed Bosch Process.

Contact information

The INRF staff or the lab manager may be reached at 824-8239 or 824-9831.

Authorized users

Only INRF registered users who have completed the training and passed the certification may use this equipment. Users may only use the portion of the system for which they have been trained.

Training

Users must have received direct training from the staff in order to use this equipment. Users are expected to understand the nature of the system, as well as the proper control and use of the gases. Training varies slightly, depending on the process to be performed. Contact the staff for details and to arrange for a training session.

Usage logs

Users are required to log all activity in the log sheets provided. All users must log in when they used the STS DRIE (date and time), which gases they used and quantity, and when they completed their process in the user log sheets. If users notice anything unusual, they should record it in the user log sheets, and add details in the maintenance log sheets. Any maintenance to the machine must be logged in the maintenance log sheets (maintenance staff only).

Safety equipment

There is no specific safety equipment for use on this tool, however, cleanroom gloves and tweezers should be used when handling pieces in the chamber.

Standard equipment and materials

The laboratory provides the following gases: SF_6, C_4F_8, O_2, N_2, and He. Other gases must be cleared with the lab manager.

User maintenance

Users are requested to clean the load chamber after use by first, wiping them down with the isopropanol, then run the required cleaning process. Spray the isopropanol into a lint-free cloth and wipe the inside of the load chamber. Dispose of the cloth in a waste container marked for flammable solid waste.

Pollution Control

Turn on the scrubber when using the following gases: C_4F_8, and SF_6. Dispose of the alcohol soaked wipes in a waste container marked for flammable solid waste. Purge the gas lines after using corrosive gases.

Scheduling

Reservations can be done online, also, the system can be used on a first come, first served usage if no reservation was made.

Other issues

Users should remain physically present in the cleanroom facility during the entire use of the STS DRIE System.

Gases should be turned off at the cylinders valves when finished.

Users should not modify any standard recipe in the software. New recipes can be created by approved users, but once created, they should stay unedited. A modified recipe should be given a new name. This allows us to track down the history of a problem later, if necessary.

At no time should a user adjust a pressure regulator on a gas line. Gas control should be “on” or “off” only, using only the valves appropriate. For most gases, this is usually the valve at the cylinder head.

Non-standard use

Users may not modify any hardware on this equipment. For use of non-standard processes, gases or materials, contact the staff or the lab manager.

Usage Notes for STS DRIE System

Guide for using the STS DRIE System correctly

Gas cylinders

All gas cylinders should be turned on or off at the cylinders valves. At no time should a user adjust a pressure regulator. Clockwise for all valves, means CLOSED. The standard off configuration for the system is to close the cylinders valves, but leave all other valves alone.

STS DRIE System

The STS (Surface Technology System) Deep Reactive Ion Etching (DRIE) is designed to provide high aspect ratio etching (~20:1) of single crystal silicon using inductive coupled plasma (ICP) reactive ion etching (RIE). By alternating SF_6 (etch) and C_4F_8 (passivate) process cycles with ICP RIE, high etch rate and high directional silicon etch is realized.

The system consists of a process chamber, a double carousel load lock chamber, a power distribution/electronics rack, an RF stack, chillers and a computer control station.

The system has the following gases for processing:

- SF_6
- C_4F_8
- O_2
- Ar
- He (for back side cooling)

NOTE:

Due to the toxic nature of the process gases, the supply cylinders are turned on in the morning (~7AM) by the INRF staff and turned off by the last user or the INRF staff (~6PM).

The following substrate(s) and materials are allowed in the system:

- Silicon, polysilicon
- SiO_2, Si_3N_4
- SC1800 series and SPR220 photoresist from Shipley
- AZ P4000 series photoresist from Clarian

NOTE:

- If you want to process another material, you must get approval from the INRF Lab Manager.
- **SU8, ANY TYPE OF POLYMER, POLYIMIDE, RESIN AND ANY TYPE OF METAL ARE ABSOLUTELY FORBIDDEN TO BE USED AS A MASK.**
- Only whole wafers (4 inch) are allowed at this time.
- If you want to use partial wafers, you must mount the partial wafer on top of a full size (4 inch) wafer. See staff and annex for additional instructions.
- Photoresist must be baked for at least 20 minutes for thin resist (1 to 3 um) and 30 to 45 minutes for thick resist (6 to 12 um) at 90C to 100C before loading it into the system.
- All wafers must be structurally sound, be free of contaminates and photoresists on the back side.
- Failure to follow these rules will lead to loss of access to the STS DRIE System, and may also result in the loss of the cleanroom access.

SAFETY:

1. All maintenance and repair procedures must be performed by qualified person(s) who are fully aware of all relevant safety precaution associated with processing, operating and maintenance of the equipment.
2. If any chemical fume is detected from the process chamber, STOP the process and contact the INRF staff immediately.
3. Potentially lethal voltages (in excess of 30 volts AC and 50 volts DC) are present on the equipment. If you see any open and broken wire or exposed electrical parts, DO NOT TRY TO FIX IT, contact the INRF staff immediately.
4. Do not try to defeat any interlocks on the system. Keep hands away from all moving parts and be sure that all covers are in place before starting a process.

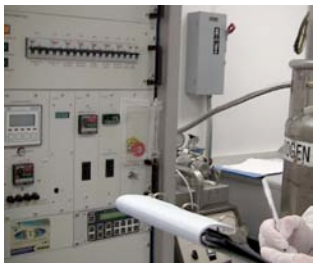
OPERATING PROCEDURE:

A. Loading the sample:

STEP 1a
Check tag to see if CDO is ON and machine is running normally.

STEP 1b
Log in to the system

STEP 1c
Check equipment chase. CDO is running normally and gases are flowing. Also make sure that the process gases are in the on state. If not contact staff.

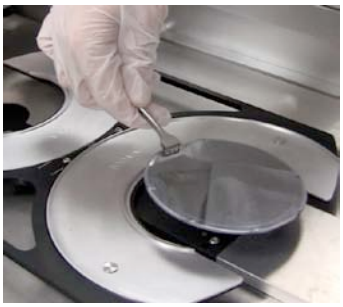


STEP 1d
Record pressures and temperatures on the logbook.

STEP 2 - The system should be in the monitor mode, change to development mode.
STEP 3 - Go to **edit** and select **operator mode**.
STEP 4 - Select **development**.
STEP 5 - Select **change**, enter password and press **enter**.
STEP 6 - Select **change** and verify that the system is in development mode.

STEP 7
Make sure there is no wafer already in the chamber, if there is, you'll have to unload it using the unload button in the transfer window located at the bottom right of the display.

STEP 8
Click on **vent** and wait until the load lock is completely vented.

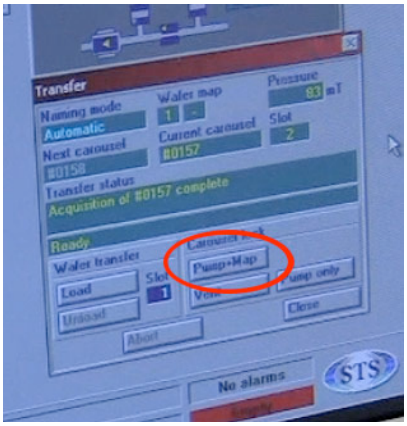


STEP 9
Load the wafer with the flat facing the line marked on the carousel.

STEP 10
The wafer can be loaded to any one of the wafer handlers (each handler is marked with a number on the upper right hand corner).

STEP 11
Load Verification.

STEP 11a
After loading the wafer, close the load lock lid (making sure that it is straight) and close the handle (make sure you hear click sound when the handle is snapped into the closed position).



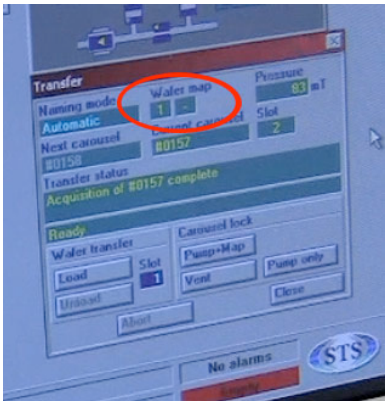
STEP 12
Press **Pump + Map button**. This option pumps down the load lock and maps the carousel to check if a wafer has been placed in either one of the wafer handler. Once the program has finished the mapping process, the wafer with the handler number will be displayed in the wafer diagram or slot box (either number 1 or 2).

STEP 13
Click on **Load** to load the wafer in to the process chamber.

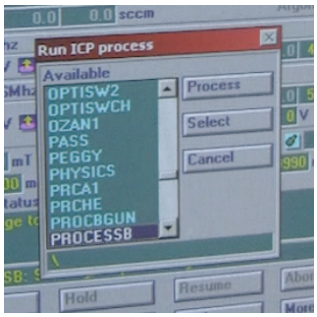
Note:

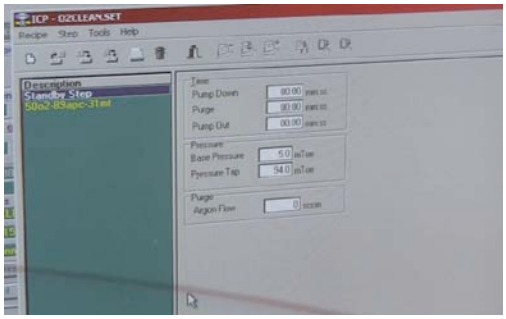
Make sure that the wafer handler number displayed in the slot box next to the load button in the transfer window is correct. If it is not correct then left click on the slot box and type in the correct number of the wafer handler and then press **Enter** on the keyboard. Press the **Load** button in the transfer window to load the wafer into the chamber.

B. Operating:



STEP 1
Select a recipe



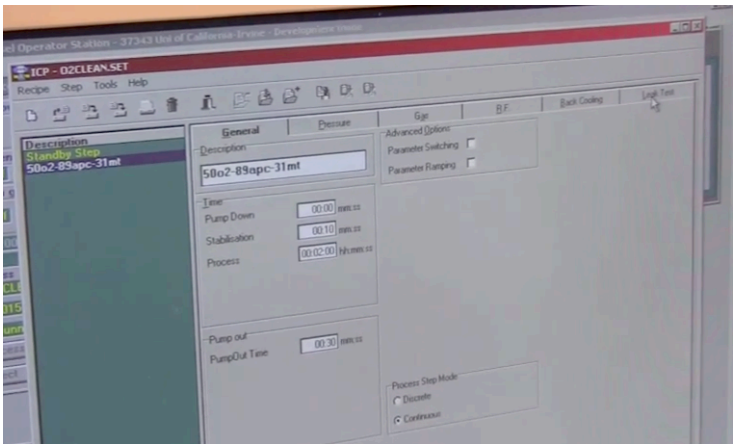


STEP 2
Execute a process recipe:

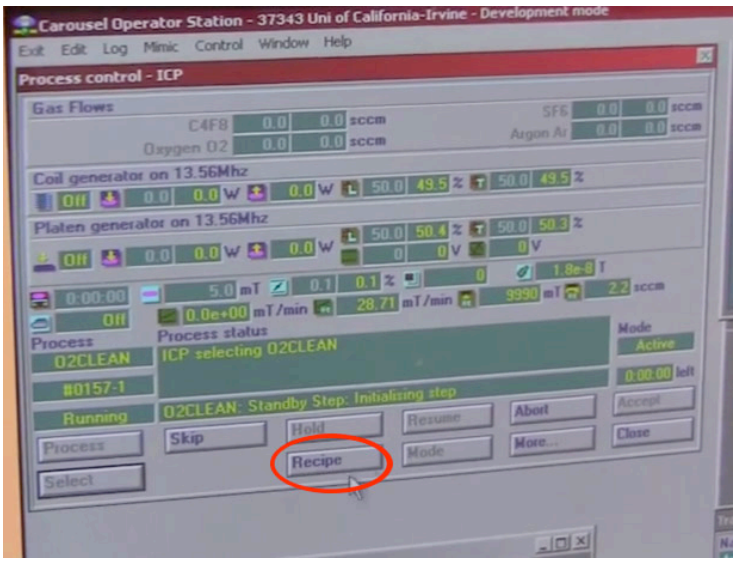
STEP 2a
If a recipe is available for the process, press the **Select** button in the process window.

STEP 2b
A new window will pop up displaying various recipes that are available. Highlight the desired recipe.

STEP 2c
If the wafer has been loaded into the process chamber, then one can go ahead and press process to start processing. **DO NOT START A PROCESS IF THERE ARE NO WAFERS LOADED IN THE PROCESS CHAMBER**.



STEP 3
Usually before the process, a helium leak up test will be performed with a loaded wafer. If the reading is not below the set value (10mTorr/min) then there may be a leak. You should check on the back of your wafer to make sure it is clean and free of scratches and contaminates. Contact the staff if problem persists.



STEP 4
To write or modify a recipe:

STEP 4a
If you need to write or modify a recipe, then press the **Recipe** button in the process window.

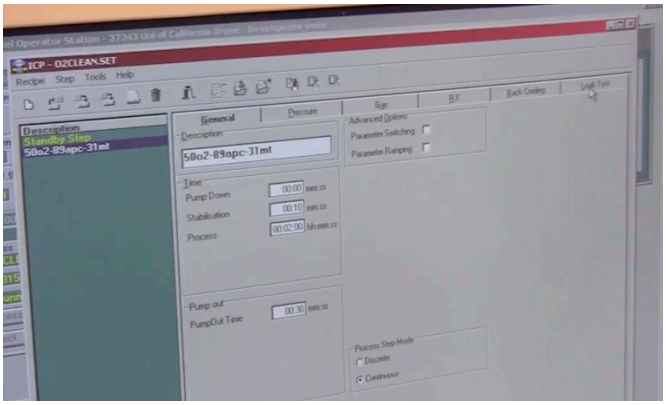
A new window will pop up showing the recipe for the current process.

Press **Open a recipe** button on the top of the new window.

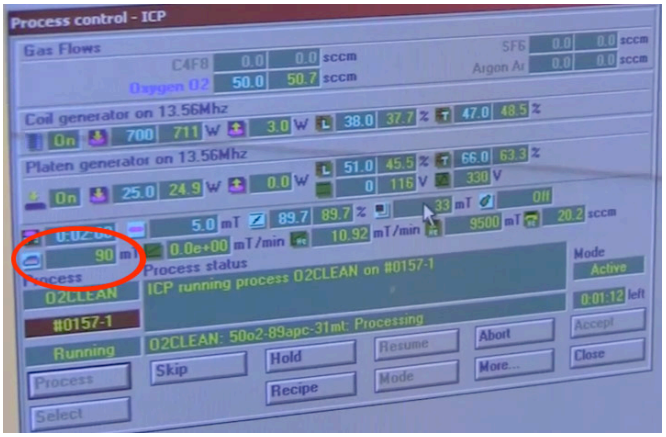
STEP 4b
Each recipe contains 2 steps, a standby step and a process step. The process step is built in processes that the system goes through whenever a recipe is run. One should only modify the process step.

STEP 4c
Click on the name of the recipe that you have selected.

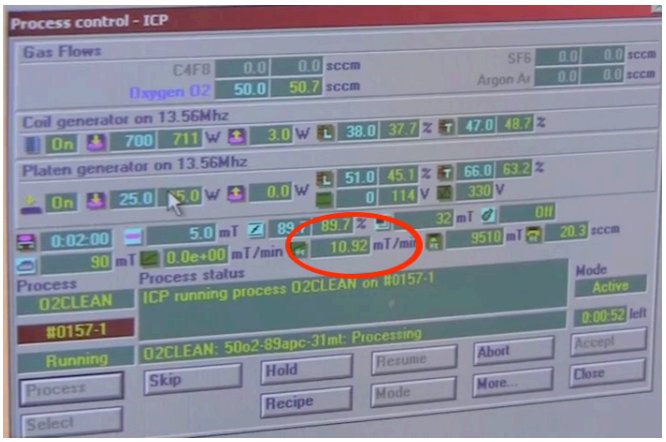
The following options are displayed that are set by the manufacturer for standard recipes:



i) General: Description of the process, type of process and the process times can be modified. Process times are specified by the number of total cycles. Switching parameters will enable the passivation/etching process. Discrete and continuous option is used when 2 or more process recipes are used one after one. By choosing the discrete option, the RF and the gases are stopped before continuing with the next process. The continuous option enables for the processes to run right after the other. The default setting is discrete.



ii) Pressure: Pressure is controlled either by setting the automatic pressure control (APC) to open up at certain percentage or adjust so that a constant pressure is kept.



iii) Gases: Gas flow is set here.

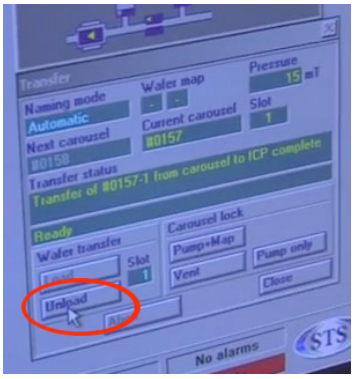
iv) He LUR: Before each process, the helium leak up rate is checked with a loaded wafer. The value with a clean wafer should not exceed 10mtorr/min. One minute is the default time for checking the helium leak up rate. If the leak up rate is more than the set point, then the process will hold until further notice.

STEP 5 - Save and exit the window after modifying the recipe.

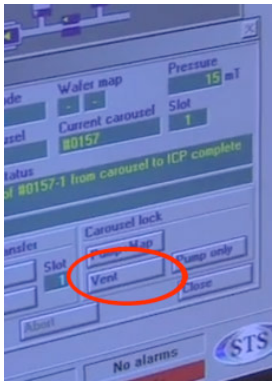
NOTE:

- During the process, check if the parameters are within the specifications. All windows with light blue letters (e.g. Process times) can be modified during the process; it will be rounded to the next process cycle. This will not change the recipe. If one needs to abort the process, then press **abort** and confirm it.
- Fill in processing run data parameters in the log book.
- Do not change the settings of **Pressure**, **Gases**, **HBC** and **He LUR**. If you need to do so, contact INRF staff.
- Do not increase the platen power above 20 watts.

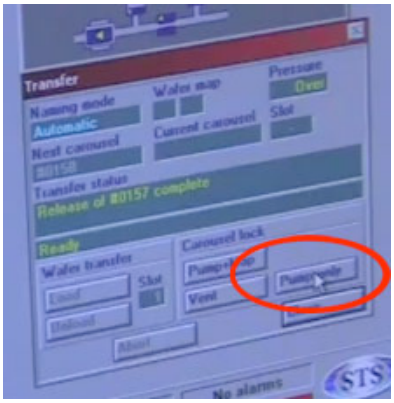
C. Unloading the sample:



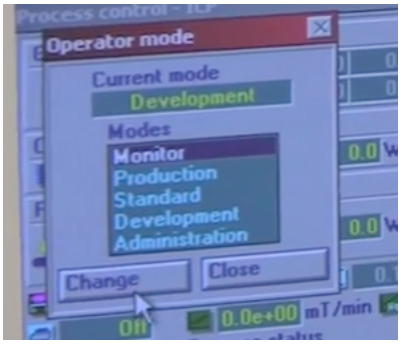
STEP 1
At the end of the process, the unload button will be highlighted.



STEP 2
Unload the wafer and then vent the load lock chamber to retrieve the wafer.



STEP 3
Close and pump down the load lock chamber.



STEP 4
Return the system back to the monitor mode.

STEP 5
Go to **edit** and select **operator mode**.

STEP 6
Select **monitor**.

STEP 7
Select **change**.

STEP 8 - Clean up the area and log out.

WARNING: If any one of the following conditions occurs, immediately stop the process and contact the INRF staff.

- If the wafer is broken or chipped inside the process chamber.
- If the wafer handler is unable to retrieve the wafer.
- Any alarms and errors came up during a process run.
- When in doubt, ask.

Do's and Don'ts:

- Do not attempt to open the load lock while a process is running.
- Do not proceed with processing in the face of an unknown error.
- Do not use the system if there is a tag out sign on it.
- Do not operate the system if you are not a qualified user.
- Do not share computer log-in and password with other users.
- Do report anything unusual with the STS to the staff.

ANNEX: How to bond wafers and pieces

There are several recommended processes of how to bond wafers (for through wafer etches, thinned delicate wafers etc.)

Using Cool Grease:

Cool grease can be purchased from AI Technology Inc, 9 Princess Road, Lawrenceville, NJ 08648. The procedure is as follows:

Heat the carrier wafer on a hot plate to ~50 degrees. Mark out shape on wafer with cool grease and leave for a few minutes for the cool grease to flow, then evenly fill out shape with cool grease with a spatula. Place wafer piece on cool grease and move piece gently in different directions so as to ensure that the wafer piece properly bonds and there are no air bubbles underneath the wafer. Press gently to expel excess cool grease. Remove wafer from hot plate allow it to cool down and then remove any excess cool grease which may be around the wafer edge. This can be done quite easily by scraping off with a spatula. You can then further bake in an oven or hot plate (90 degrees) if you wish for 10 minutes or so to further ensure that the cool grease is in contact at all places of the bonded piece.
The same procedure can be followed for a whole wafer.

Using Photoresist:

- Use an eyedropper or Q-tip to deposit a small drop of approved photoresist (Shippley or AZ) or silicone free heat sink compound on the backside of your piece.
- Then carefully center the backside of your piece onto the front-side of the carrier wafer and press down firmly. Do NOT use too much resist as this will be squeezed out from the back when you press down and can cause problems.
- If you use resist and you need bake your sample on a hot plate at 120°C for at least 5 minutes. This hardens the resist. Do not allow the backside of the carrier wafer to become contaminated (eg. from the hot plate).
- Let your sample cool before loading it onto the STS

There are different techniques that might be also valid to bond wafers and pieces to a carrier wafer but in case of doubt ask staff.