# EDGE ISOLATION

## STANDARD OPERATING PROCEDURE (SOPs) 2021 (v.1)

## NCPRE FABRICATION LAB

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# TABLE OF CONTENTS

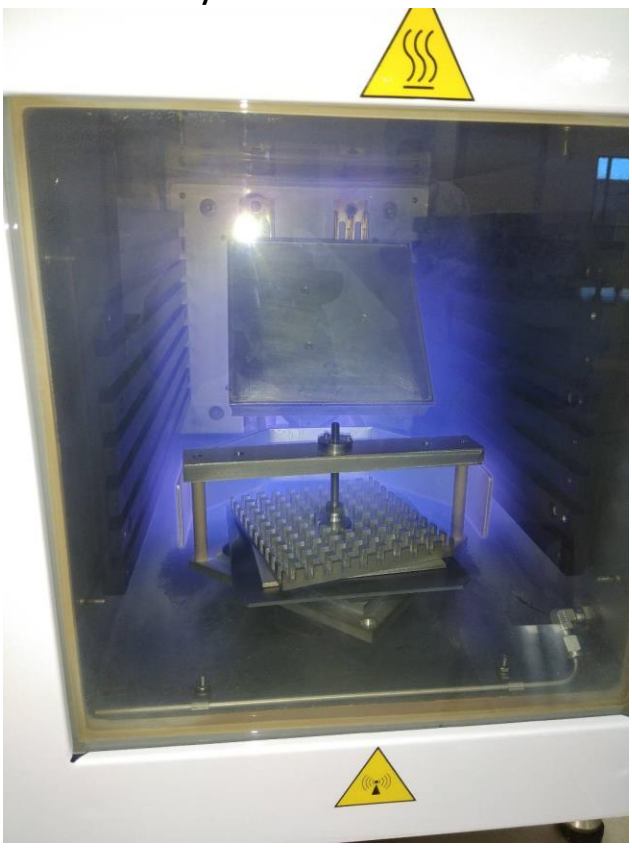
# Introduction:



## Edge Isolation

During diffusion, the entire surface of the wafer is exposed to the dopant source, including the rear of the solar cell and edges. In the case of a phosphorous diffusion, this creates a current path from the front junction to the rear of the device, effectively shunting the solar cell as these recombining carriers do not contribute to the power output. Therefore, following diffusion, an edge isolation process is required to remove the unwanted diffusion around the edges of the solar cell, and electrically isolate the front and rear surfaces.

In Plasma Etching Process, the samples are stacked on top of one another such that only their edges are exposed. They are then loaded into a chamber where they are exposed to plasma formed of SF6 gas, which etches the exposed sides of the wafer, effectively removing the diffused silicon at the edges. A short process results in insufficient isolation and therefore a lower shunt resistance. In contrast, an extended process may result in excessive damage to the edges which damage the diffused junction, which enhances recombination in this region, affecting the diode ideality factor of the solar cell.



# Equipment Configuration:

### Instrument Provider/ Manufacturer:

**BSET EQ Plasma Systems**
2545 W. 10th Street Suite L
Antioch, CA 94509
Ph: (925) 755-2300; (925) 354-7270
Fx: (925) 755-2301
E-mail:sales@bsetplasmas.com;
service@bsetplasmas.com;
accounts@bsetplasmas.com

### Technical Details:

Gases Used: $CF_4$, $SF_6$, $N_2$
RF Power Source: AG 0613NL (T&C Power conversions, Inc.)
RF Power capacity: 13.56MHz, 10-600W RF Power source
Maximum flow rates: $CF_4$ – 200 sccm, $SF_6$ – 27 sccm, and $N_2$ – 50 sccm
Wafer Dimensions Allowed: 125 x 125 mm, and 156 x 156 m
Model: NT-2
Sr.no.: 5012
Electricals: 230 VAC, 50/60HZ, 7 Amps
1 Phase- 3 wire (L1, Neutral, Ground)

# Training Procedure:

1) User must have to receive training from SO/ an Authorized user.
2) Three training sessions and one hands-on session for authorization on the tool.

**Note:**
User must go through the Manual of the Edge Isolation thoroughly while having the training.

# Installed System:





fig.: Power supply to Monitor, Main unit, Chiller and vacuum pump


fig.: RF Power source

<<<<< fig.: Installed system

# SAFETY PRECAUTIONS



To ensure safe installation and operation all persons who are to work with this equipment are to please read the entire manual. There are several safety symbols that will appear in the manual and on the equipment itself. Here are the symbols and their meanings.

### Safety Symbols

| | | | | |
|---|---|---|---|---|
|  |  |  |  |  |
| important notes regarding safety | non ionizing radiation (RF) | hot surface to be encountered | high voltages may be present. | short circuit protection device present |

**WARNING:**

- AS THE SURFACE WILL BE HOT, DO NOT TOUCH SAMPLE HOLDER OR ANY PART OF THE ELECTRODE (INSIDE THE CHAMBER) IMMEDIATE AFTER COMPLITING THE PROCESS.
- DO NOT OPEN THE CHAMBER IMMEDIATE AFTER THE PROCESS TO AVOID INHALATION OF SF6.

# Operation Theory:

Plasma is a partially ionized gas composed of equal numbers of positive and negative charges, as well as some neutral molecules. Plasma can be generated by applying a strong radio frequency (RF) electromagnetic field to a gas, which breaks down gas molecules and generates ions, free radicals, electrons, photons and reaction by-products such as ozone. Since these reactive species have high energy, they create highly active and low temperature plasma which can etch materials precisely and efficiently.

# CLEANING METHOD

- Cleaning procedures should be done only with using Isopropyl alcohol and lint-free cloth.
- Electrodes can be cleaned only during the maintenance of the system.

# STANDARD OPERATIONAL Procedure

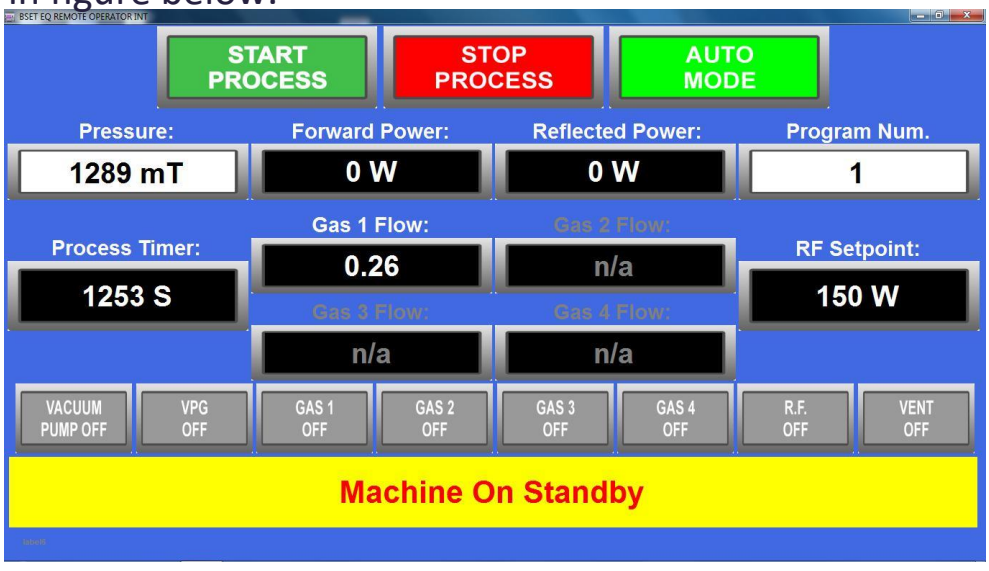
## A) Procedure for Starting the Tool:

### Before entering the clean room:

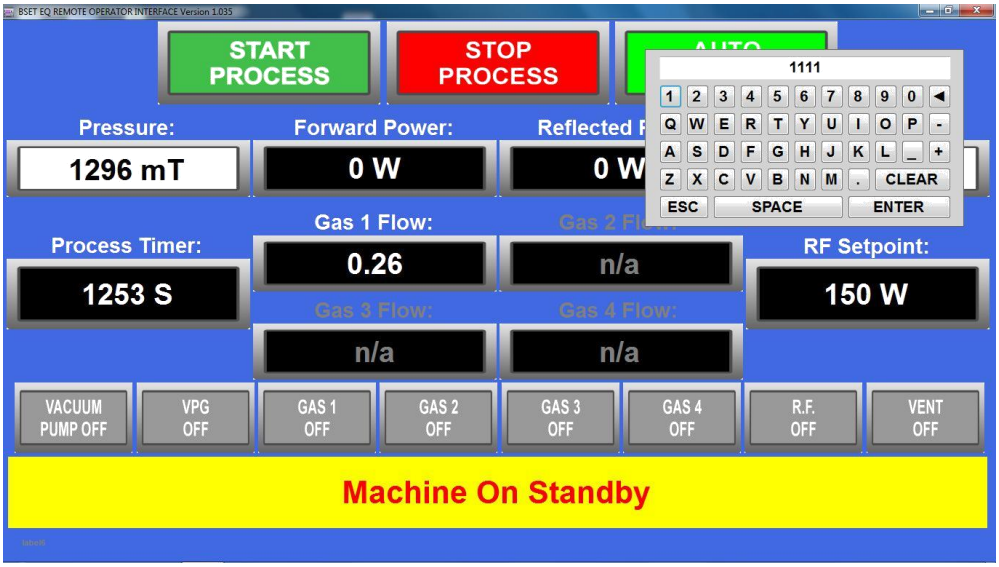
1. Before turning on the instrument check whether the scrubber is turned ON. You should start the tool only after receiving the green signal from the facility in charge, regarding the status of the scrubber.
2. Check with facility in charge, whether the process gases are ON and nitrogen is pressure is at 5 bar.

### Inside the Clean Room:

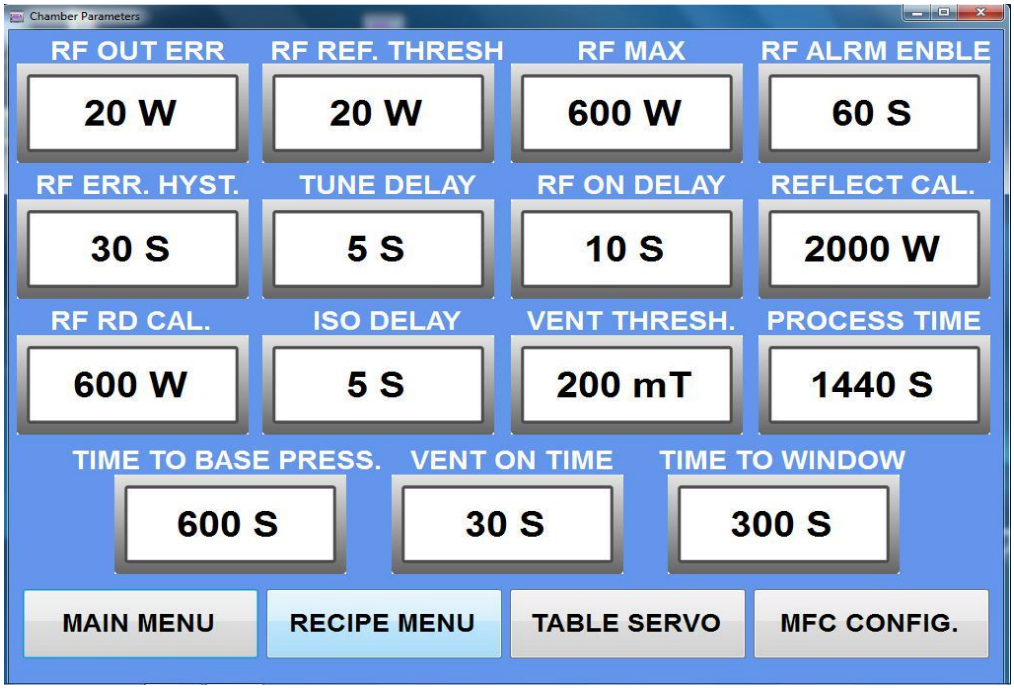
1. Turn ON the main gas regulators for $N_2$, $SF_6$ and $CF_4$ (if using)
2. Turn ON the gas flow switches at the back of the tool.
3. Turn on the main switches for the pump, chiller, PC, and the system.
4. Turn on the PC, and select the REMOTE INTERFACE - 1 on desktop.
5. Turn on the system using the GREEN power button on the front of the tool.
6. Once the tool is ON, and initialized, we can see the following screen as shown in figure below.



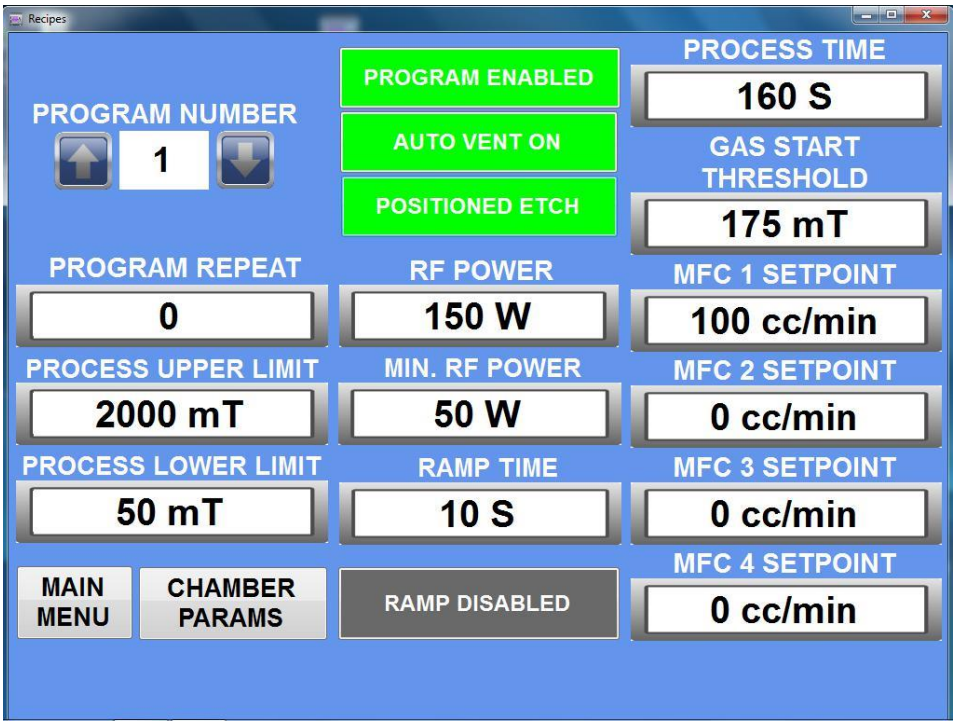
7. Once at the home screen, click on Auto Mode, and change it to Manual Mode. Click on the Vent button, and wait for 30 secs. Open the lid, and load the sample.
8. Click again on Manual mode, and change it to Auto Mode. A default recipe is stored in program eg. Program 1, and in order to make changes to it, we should login to the software.
9. For logging into the software, click on the RF set point, and enter the value 1111, and press enter, as shown in figure below.



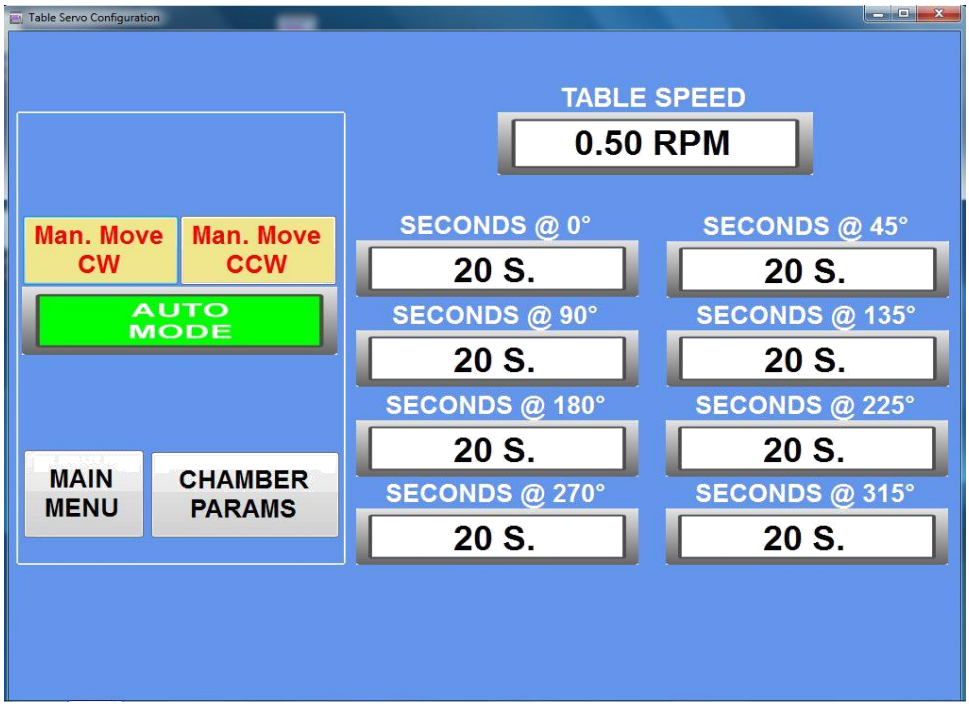

10. After logging into the software, the user would be taken to a screen as shown in figure below.



11. Click on the Recipe Menu, and make changes to the various process parameters as required. The 'Program Enabled' should be activated; else the recipe would not run at all. The 'Auto Vent ON' should also be activated (for safer it should be in deactivated mode). 'Positioned Etch' can be deactivated or activated according to user requirement. The details of the recipe page are shown in figure below. The process parameters that are modified are the gas flow rates, Process time and the RF power. MFC 1 corresponds to $CF_4$, MFC 2 corresponds to $SF_6$, and MFC 3 corresponds to N2. Gas start threshold indicates the system base pressure at which the process is initiated. 'Process Upper Limit' and 'Process Lower Limit' are safety thresholds beyond which the process would shut down. Ramp time is the time which the RF supply takes to reach the set power.




12. When the positioned etch is enabled, we can control the rotation of the wafer clamp at the servo control page. The duration for which the wafer clamp is maintained at a fixed angle can be decided by setting the corresponding time. It is worth noting that the process time should be set in such a way giving enough leeway for the positioned etch. The servo control page is shown in figure below. The table speed and the duration over which the table stays at a fixed angle is shown in figure.




13. Once the necessary recipe parameters have been set, then go to the MAIN MENU page, make it in Auto mode and press START PROCESS icon. The process would run for the set parameters.
14. Once the process is completed, you will get beep alarm as which indicated process is over.
15. Go to manual mode, and click on VENT to vent the chamber with PN2 and evacuate to minimize the smell of SF6. Repeat this step for multiple times.
16. Finally, to unload the sample, click on VENT to vent the chamber to atmospheric pressure Turn off the VENT and open the chamber to unload the sample.

## B) Procedure for Shut Down the Tool:

1. Always keep the chamber in vacuum condition.
2. Turn off all gas lines at the back of the system.
3. Turn off the system by pressing the power button
4. Switch off the PC.
5. Turn off the pump, chiller and supply to computer and system.

# EQUIPMENT MAINTENANCE (FOR SO ONLY) 

## 1) RF calibration/ setting:

When there is a fluctuation in RF source & we will not get plasma.
Follow the procedure as follows:

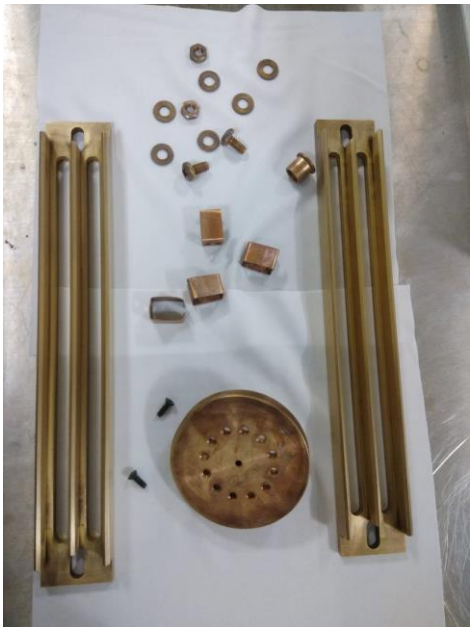
- Go to the manual mode on computer screen.
- Click on R.F. and set low RF value (say 100), the forward power.
- Start pump and VPG.
- Start SF6 (MFC2)/ N2 gas (MFC3).
- Now move to the tuning section of the system as shown in fig.


- Turn the key from Auto mode to manual mode and wait for few seconds the system will try to tune itself and we will get stable plasma having minimum reflected power **or**
- Adjust c1 and c2 up/down (i.e. c1 UP/ c2 Down like wise) to get stable plasma having minimum reflected power.
- Wait for few seconds.
- Turn the key back to Auto mode.
- Now set the required require RF value and run the process.

## 2) Electrode Cleaning:

After a number of runs there is formation of carbon on the electrodes and other parts of the chamber (i.e.: only brass and Cu parts) so we get interrupted plasma during the process. So we need to clean these parts. Remove these parts properly with the help of maintenance person and clean with Scotch brite, water and IPA.

**< Before cleaning >**



**< After Cleaning**