CORAL: DRIE-STS-MMPLEX

Location: U6
Tool Category: Etch
Contact: Donal Jamieson or Dennis Ward

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Introduction

The ST Systems Multiplex ICP tool is a Deep Reactive Ion Etch (DRIE) tool. Utilizing the Bosch Process, it can etch high aspect ratio, anisotropic trenches deep into Silicon and even through the wafer. The tool uses two independent 13.56MHz Radio Frequency (RF) power supplies; inductive power coupling of the coil to the plasma creates high density plasma which results in high etch rates. The Bosch Process alternates between an etch cycle flowing only SF_6 gas and a passivation cycle using C_4F_8 gas to deposit a polymer layer. The directional etch cycle preferentially removes the passivation polymer from the bottom of the trenches leaving the sidewall film intact to prevent features from widening; as the cycle is repeated over and over a high aspect ratio trench is formed.



Because of the necessity to mechanically clamp the substrate in the process chamber for effective cooling, only 6” wafers can be processed in the chamber. Smaller substrates can be mounted to a 6” carrier wafer. Users wishing to etch completely through a 6” wafer must also mount their substrates to prevent wafer breakages and/or process failure.

Safety

The EMO for this system is located in the center front of the tool. Do not try to defeat any interlock on the system. This system utilizes RF radiation, high voltage electricity, and compressed gases. The plasma generated during deposition radiates UV, it is blocked by the chamber viewport material, but users should not spend much time viewing the plasma. Keep your hands away from all moving parts and be aware of the loadlock lid as a pinch point. Be sure that all covers are in place when you are processing. If you encounter any equipment problems while operating the system, contact the technical staff in charge of the system - do not try repairs on your own.

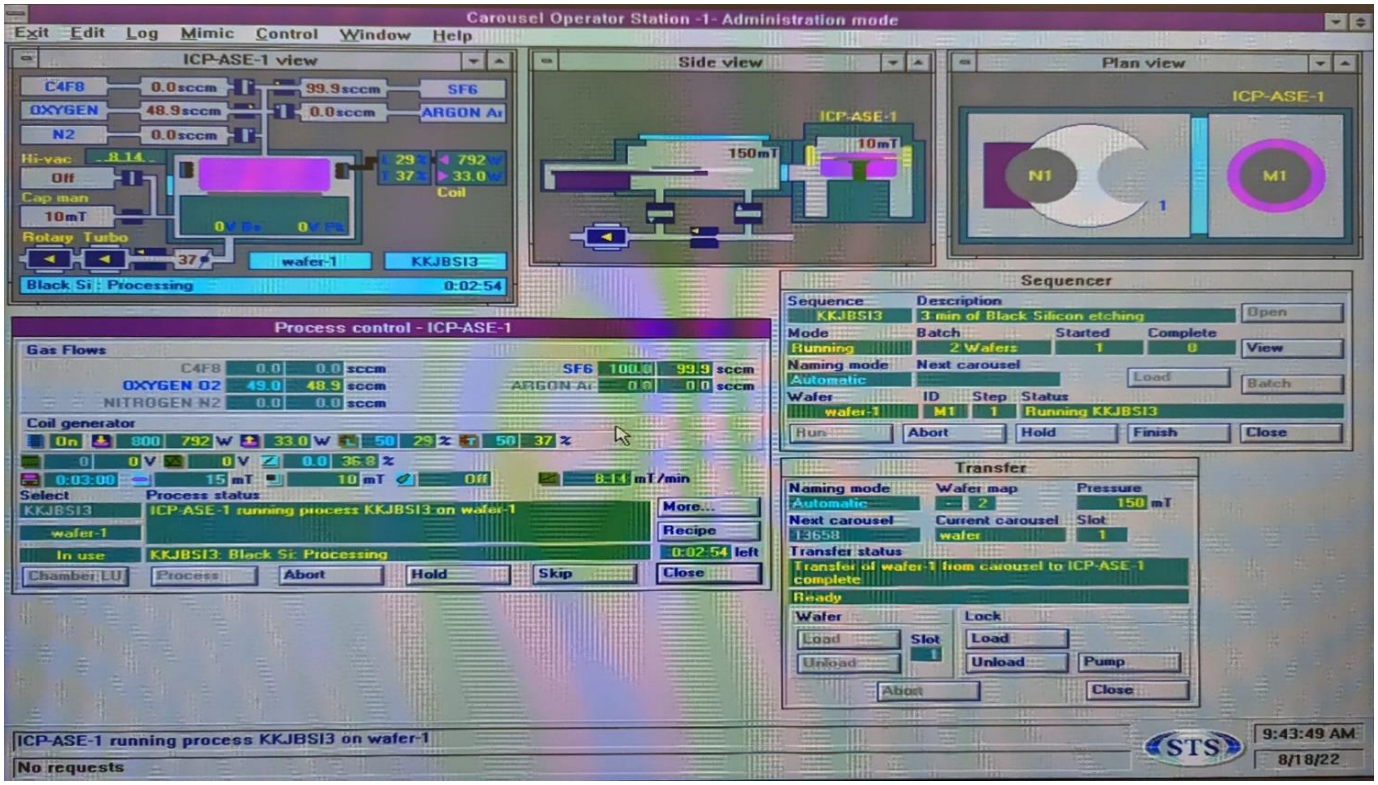
User Qualifications and Responsibilities

It is the Users responsibility to report any issues with the system in CORAL.
When the process run is complete, the user should pump down the loadlock.

Operating Procedures

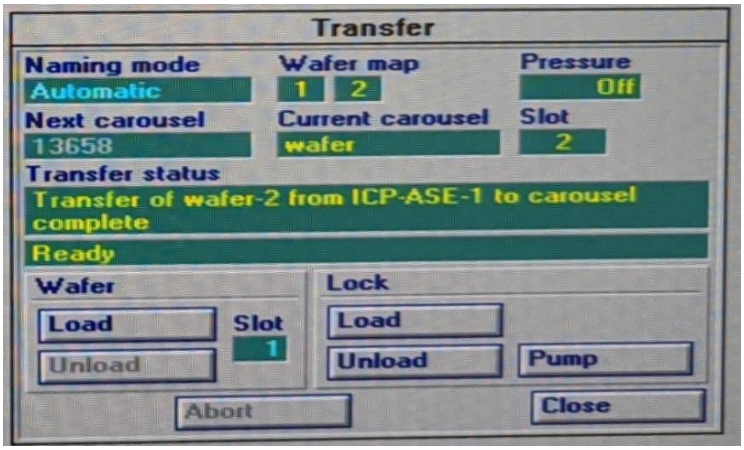
The main software screen contains a number of dedicated windows for controlling and monitoring the system operation.

- On the upper left is the **ICP-ASE-1 View** that displays the current status of the chamber and all the subsystems associated with it - gas flows, RF power, temperatures and pressures.
- The **Plan View** in the upper right will allow the user to monitor wafer movement within the system and displays the process status of each wafer. An unprocessed wafer is gray; in process is maroon; and a finished wafer is green.
- The **Side View** window displays the pressures in the loadlock and the process chamber.
- The **Process Control** window displays the recipe parameters and feedback readings during the deposition process.
- The **Sequencer** window allows the users to run single or multiple wafers processes.
- The **Transfer** window is used to manually load or unload wafers from the process chamber and controls venting and pumping down the loadlock.



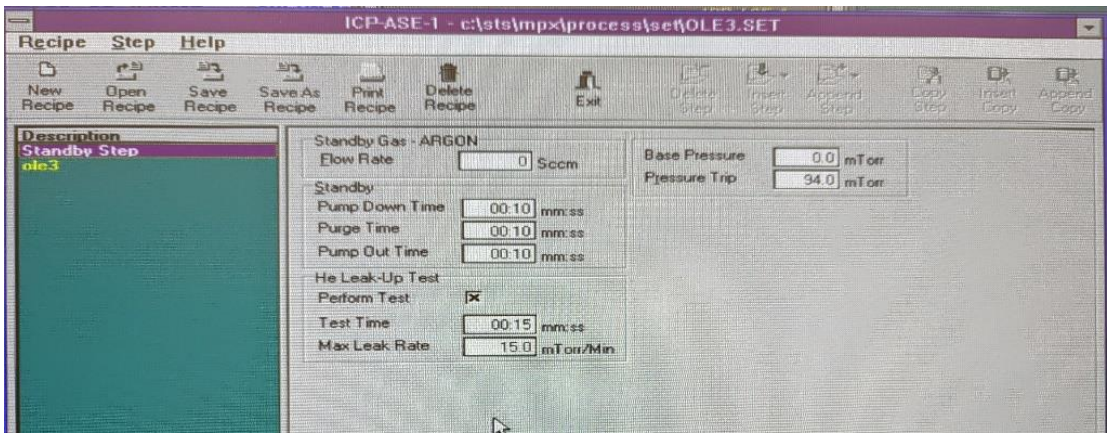
Loading a Sample:

1. Make a reservation in Coral with sufficient time to complete your etch.
2. Engage the system in Coral.
3. Click on the Unload button on the Transfer window – this will cycle purge the loadlock and pressurize it with Nitrogen until the chamber reaches atmosphere. The loadlock lid will then pop open.
4. Place your wafer or mounted sample in one of the 2 available slots on the load arm.
5. Shut and latch the loadlock lid. The latch holds the lid in place until the chamber is under vacuum and will then release.

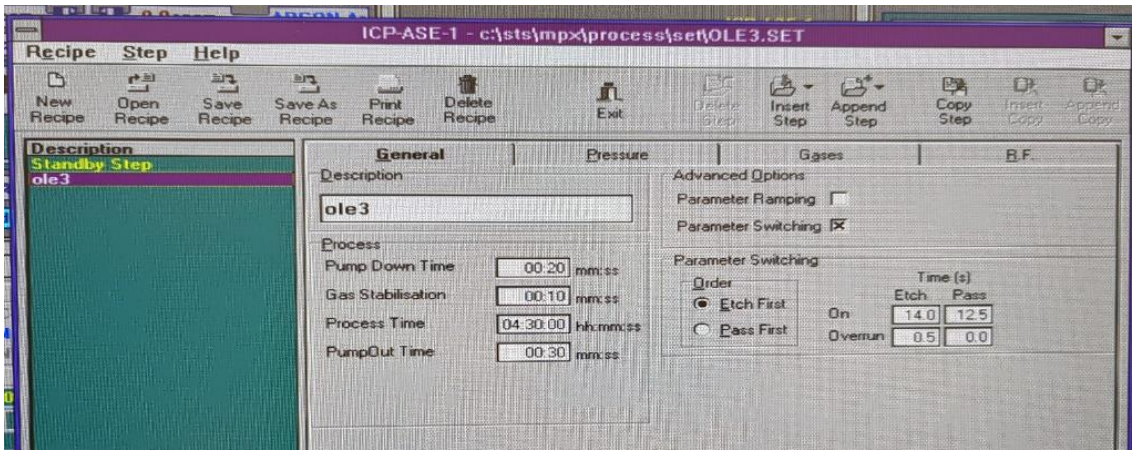


Editing a Recipe:

1. Click on the **Recipe** button in the Process Control window, this will open the Recipe Editor.
2. Click on the **Open** Recipe button to peruse the recipe list and select the recipe you would like to run.



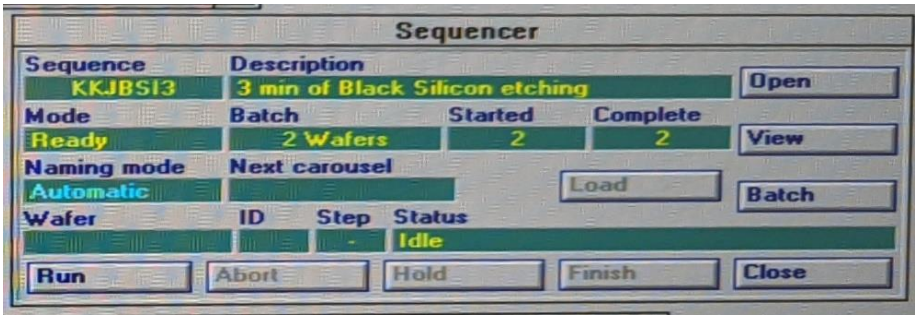
3. The left side of the editor lists the steps contained in the recipe, and the rest of the screen details each steps parameters. In general, each recipe contains just two steps: the first step is the Standby Step and this sets up general pump/purge times and the Helium Leak rate test parameters. The second step is typically the main process step.



Here we adjust the **Process Time** in order to etch the sample to the desired depth. This should be the only change made to standard etch processes.
Custom recipes can be created with help from staff.

4. **Save** the recipe change and exit the Recipe Editor.

Processing the Sample:

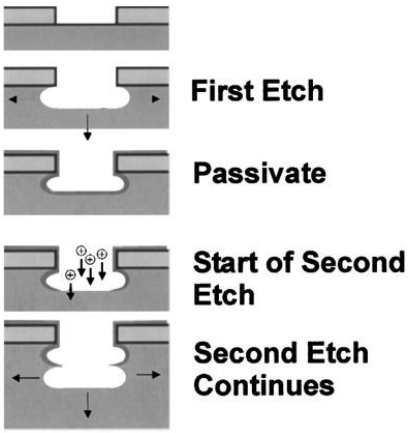


1. Samples are processed using the Sequencer – this automatically pumps down the loadlocks and uses a laser to locate the wafer, loads the sample into the chamber, runs the selected recipe, unloads the sample, optionally runs a second sample if loaded and configured, and finally vents the loadlock so the samples may be removed.
2. Click on the **Open** button on the Sequencer window and select the desired sequence from the list, the sequence typically has the same name as the etch recipe.
3. Click on the **Batch** button and set to number of wafers being run.
4. Click on the **Run** button to begin processing.
5. Ensure that the wafer passes the Helium leak up rate test and the plasma ignites before leaving the system to complete the run.
6. When complete the wafers will be returned to the loadlock, to retrieve the wafers, vent the loadlock by clicking the **Unload** button on the right side of the **Transfer** window.
7. **Pump** the loadlock back down when you are finished with the system and disengage the machine in Coral.

Appendices

Bosch process descriptions:

https://en.wikipedia.org/wiki/Deep_reactive-ion_etching
https://www.azom.com/article.aspx?ArticleID=18694
https://www.youtube.com/watch?v=6Wva2a_4IA4

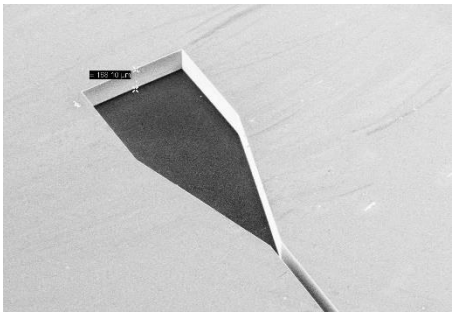


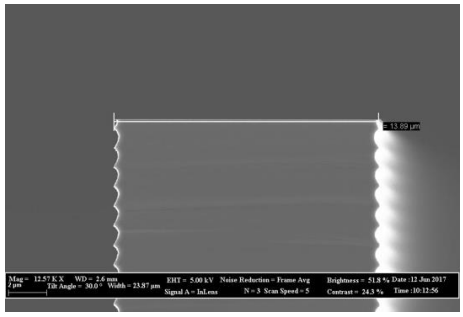
1. Ref: Craigie, C. & Sheehan, T & Johnson, V. & Burkett, Susan & Moll, Amy & Knowlton, Bill. (2002). Polymer thickness effects on Bosch etch profiles. Journal of Vacuum Science & Technology B: Microelectronics and Nanometer Structures. 20. 10.1116/1.1515910.

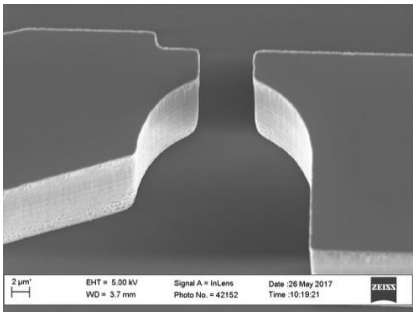
Mounting a Sample:

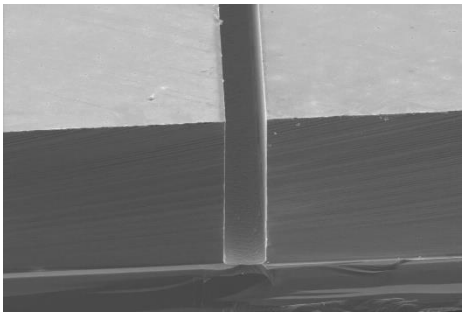
In order to process a sample in this system, the substrate contacting the platen must be a 6" wafer – Silicon or Quartz may be used. The sample must be adhered to the surface of the carrier wafer in order to be cooled effectively and also avoid being displaced during pumpdown. Samples may either be mounted using Photoresist or a vacuum oil – see staff for training.

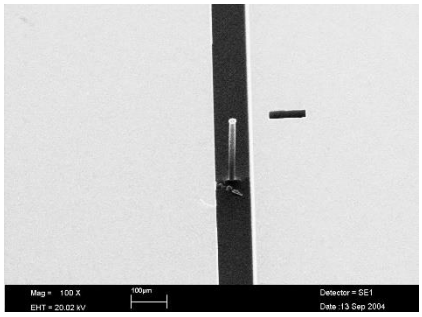
Sample Images:











2. *Craigie, C. & Sheehan, T & Johnson, V. & Burkett, Susan & Moll, Amy & Knowlton, Bill. (2002). Polymer thickness effects on Bosch etch profiles. Journal of Vacuum Science & Technology B: Microelectronics and Nanometer Structures. 20. 10.1116/1.1515910.*