University of Minnesota, MN Nano Center
Standard Operating Procedure

Equipment Name:	HDPCVD	**Revision Number:**	2
Badger Name:	HDPCVD	**Revisionist**:	L. von Dissen
Model:	Advanced Vacuum "Apex SLR ICP"	**Date:**	10/25/2016
Location:	PAN, Bay 3		

1 Description

The Apex SLR ICP is a high density plasma enhanced chemical vapor deposition system with an inductively coupled plasma configuration.

2 Safety

a. Be careful when lowering the load-lock chamber lid or when pumping down the load-lock, so you don't get your fingers pinched.

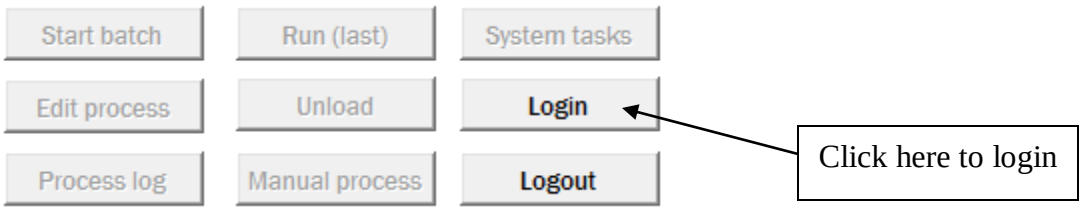
3 Required Facilities

a. Electrical: 208 VAC (120 VAC for G200 Hydrogen Generator)
b. Compressed dry air
c. Process Gas Cylinders: Ar, B2H6, CH4, He, O2, PH3, SF6, SiH4
d. Process Gas Generator: H2
e. Process Gas (House): N2
f. Toxic/Combustible Gas Monitoring (for B2H6, CH4, H2, PH3, and SiH4)
g. House Exhaust (for burnbox, pump, gas box, and gas cabinets)
h. House Process Chilled Water (for RF components, chamber o-ring)
i. Dedicated Water Heater/Chiller (for the Wafer Chuck)

4 Operating Instructions

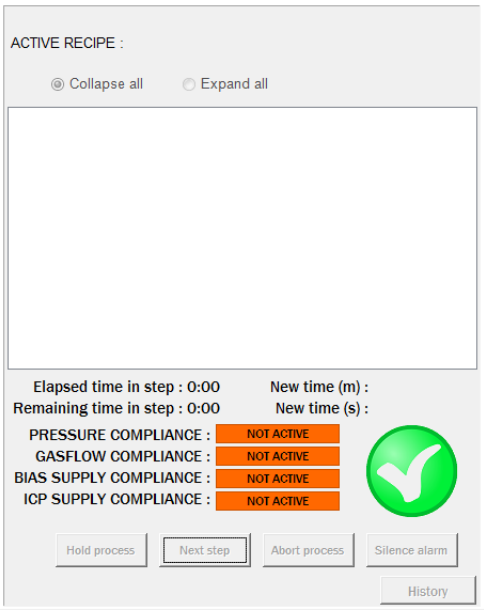
a. Enable the HDPCVD in Badger.

b. In the lower left quadrant of the computer screen, you should see a set of buttons which includes the **"Login"** button (as shown below). Click on it.



c. A window will pop up prompting you to enter the appropriate user name and password. The user name is **"operator"** (no quotes) and the password is **"operator"** (no quotes). Press the **Enter** key to finish logging in to the system.

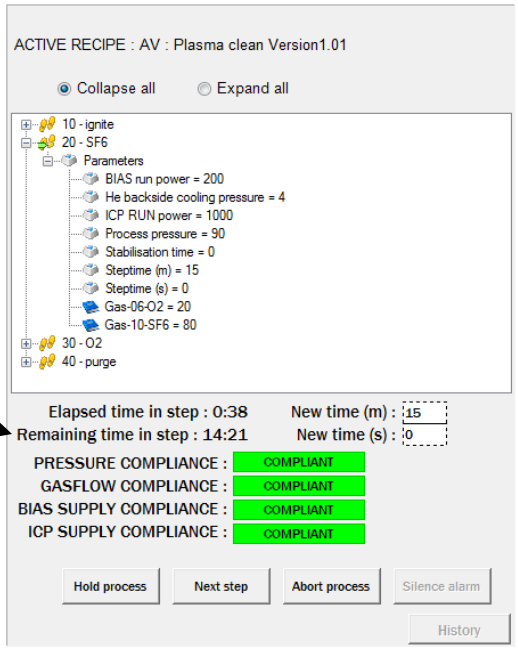
d. Check to see if there is a **"Plasma clean"** process running from the previous user. The simplest way to do this is to look in the right region of the software screen to see if there are any active process recipes running. If there are no recipes running, it should look like the following:



e. On the other hand, if there **is** an active **"Plasma clean"** recipe running in this window, you can check to see how much time is remaining on the recipe. If it's going to be more than a minute or so, feel free to disable the HDPCVD in Badger while you are waiting for the clean recipe to finish running. The window should look like the following:

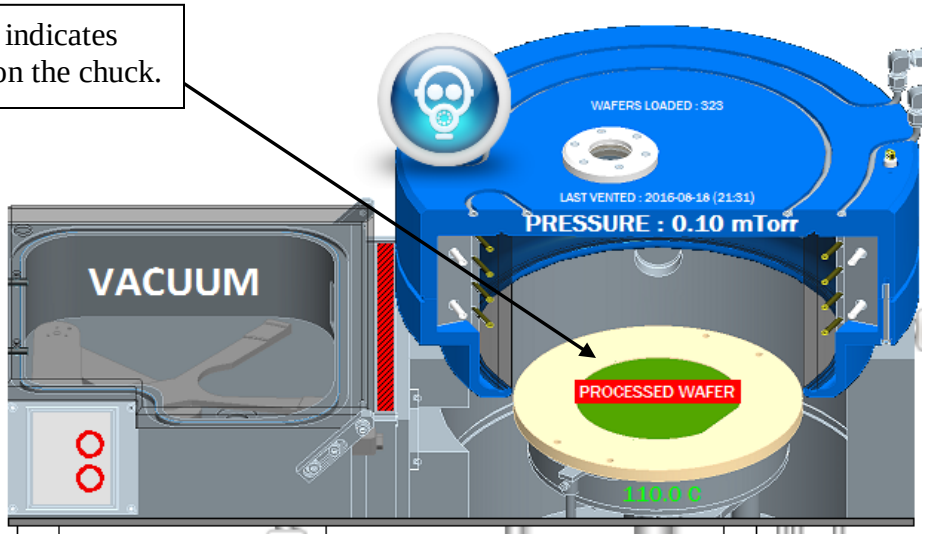
Check to see how much time is needed before the current step is finished. The current step is always in an expanded view where you can see all the parameters in it.

It should be noted that after the "SF6" step has finished, there is a 10 minute "O2" clean step afterward. So when checking how much time remains, verify which step the recipe is on so you know what step the timer pertains to.



f. The chamber should be seasoned with the recipe you plan to use for at least 10 minutes prior to loading your own wafer and running your final process. In order to season the chamber, there needs to be a dummy wafer loaded into the system. There should already be a dummy wafer loaded in the system. You can verify this by looking at the chamber diagram and seeing if there is a "green wafer" on the chuck. It will look like the following:

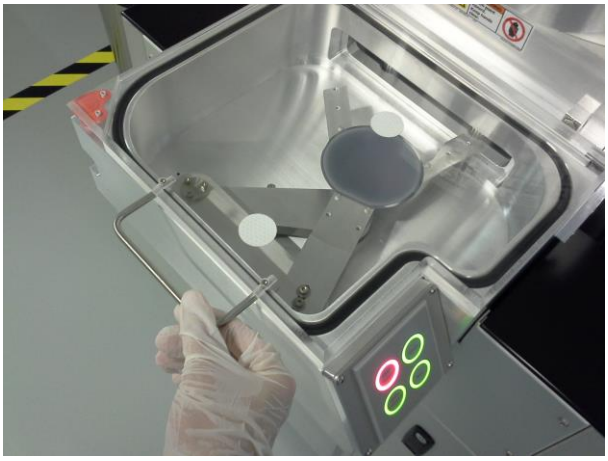
This green color indicates there is a wafer on the chuck.

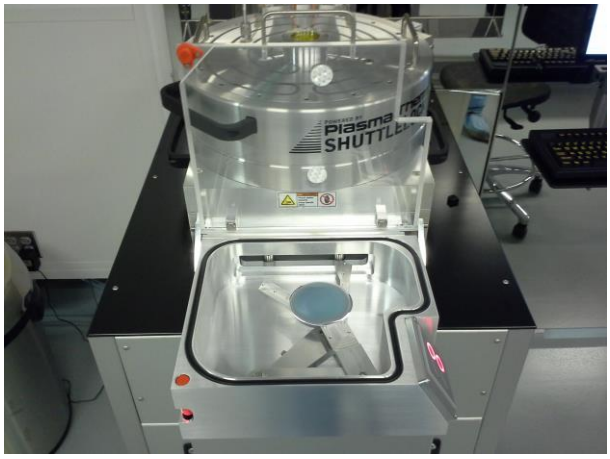


g. If there is a dummy wafer loaded in the chamber already, then you can proceed to step **"L"**. If there is NO dummy wafer loaded in the chamber yet (and if there is NO dummy wafer in the load-lock chamber, then you will need to vent the load-lock chamber and load a dummy wafer onto the robot arm. To do this, locate the **"Vent"** button on the load-lock control panel. If the button is surrounded by a green-colored light (as shown below), that means that the "Vent" option is available and so you can press the **"Vent"** button to vent the load-lock chamber.

Press the "Vent" button

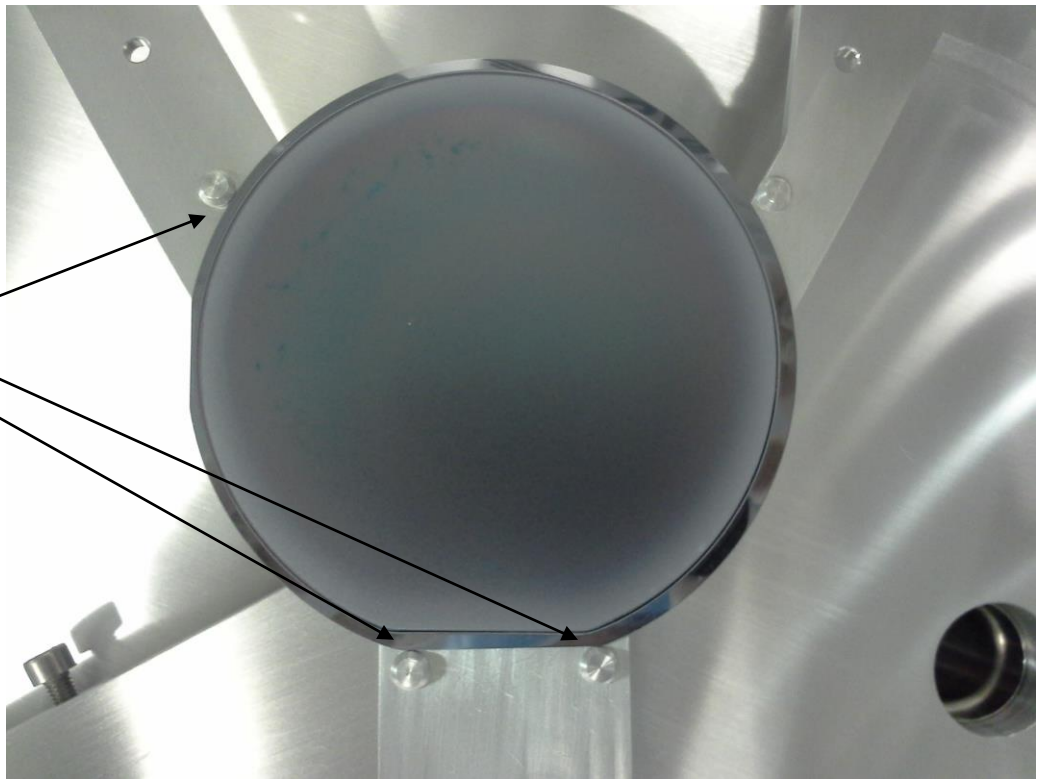
h. This venting happens relatively quickly, so after about 10 seconds, check to see if you can lift the load-lock chamber lid. Once you can lift the lid, open it up all the way so the lid rests up against the side of the main chamber.



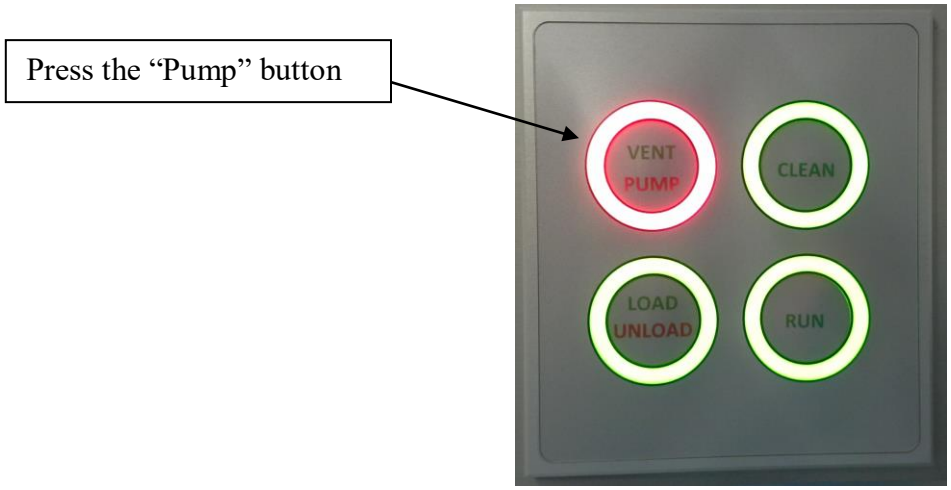


i. Load the dummy wafer onto the robot arm, taking extra care to gently align the wafer's major flat up against the two pins that are farthest from the chamber. Then gently align the left side of the wafer up against the left-most pin. When loaded properly, the dummy wafer should be oriented like the image below:

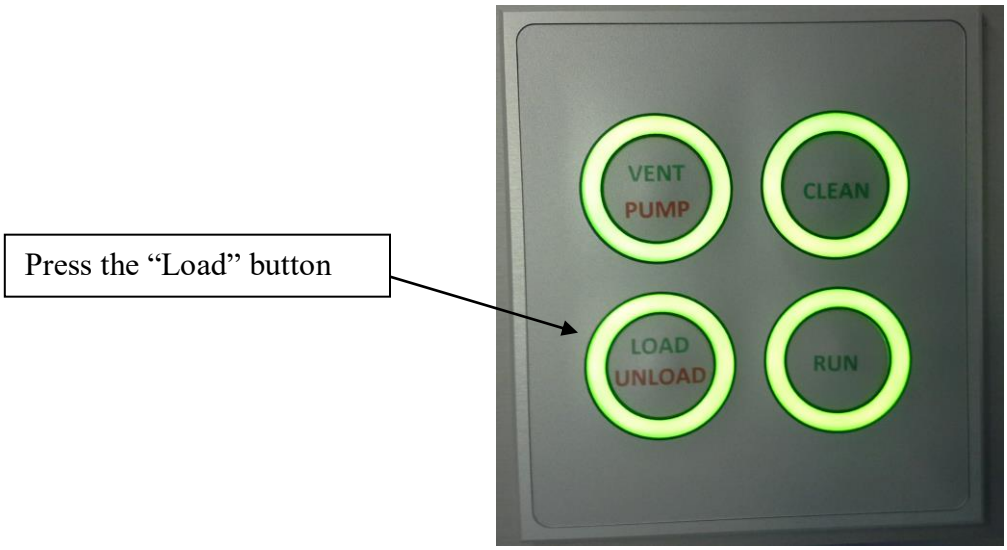
Notice how the wafer is resting up against these three pins. **This is very important!!!** If this is not done properly, **the wafer may be shattered** when the clamp comes down on the wafer after loading!!!



j. After the dummy wafer is loaded onto the robot arm properly, close the load-lock chamber lid. On the load-lock control panel, locate the **"Pump"** button. If the button is surrounded by a red-colored light (as shown below), that means that the "Pump" option is available and so you can press the **"Pump"** button to pump down the load-lock chamber.

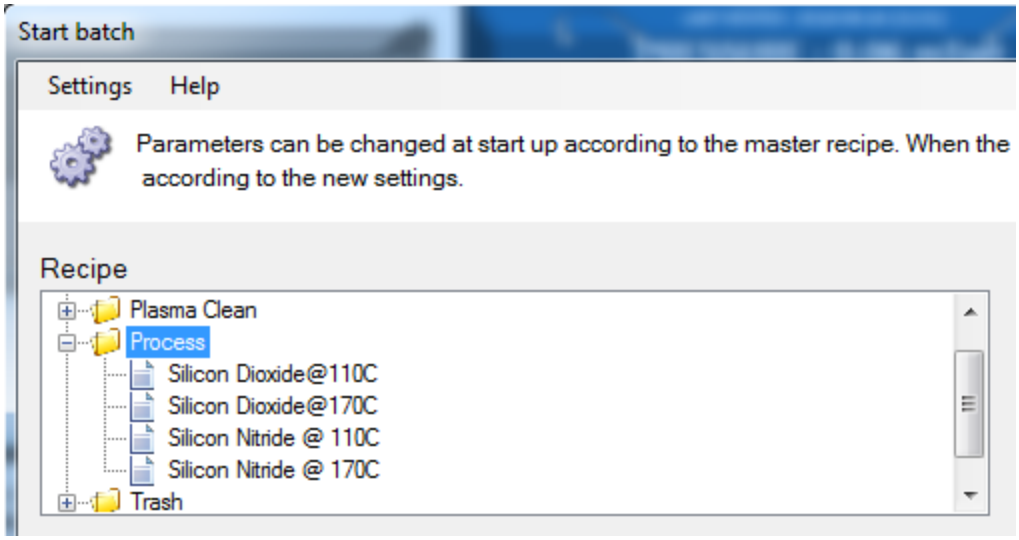


k. Once the Vent/Pump button turns green, that means that the load-lock is now pumped down which means you can load your wafer into the chamber. To do this, locate the **"Load"** button on the load-lock control panel. If the button is surrounded by a green-colored light (as shown below), that means that the "Load" option is available and so you can press the **"Load"** button to load the wafer.

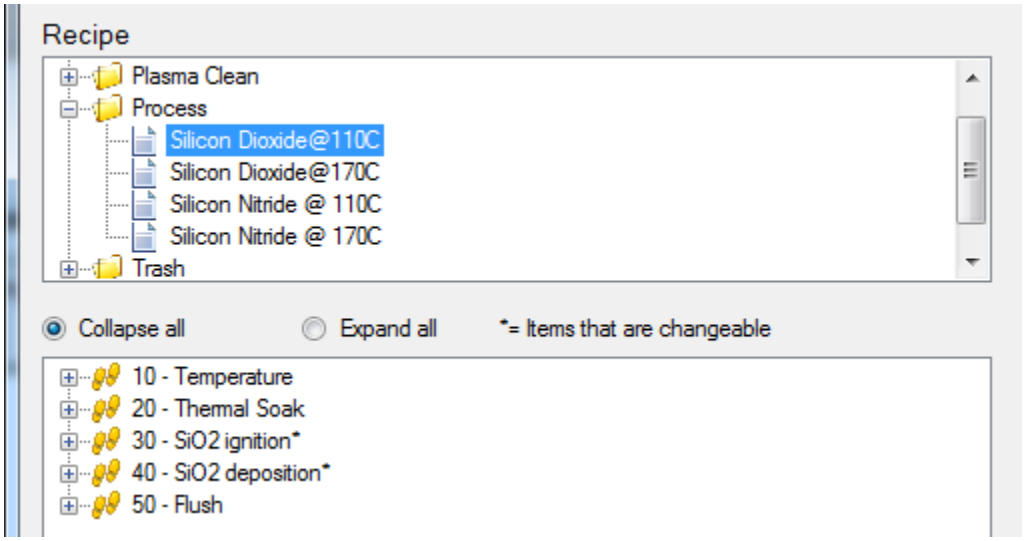


l. In the lower left quadrant of the computer screen (to the far left of the "Login" button), click on the **"Start Batch"** button.

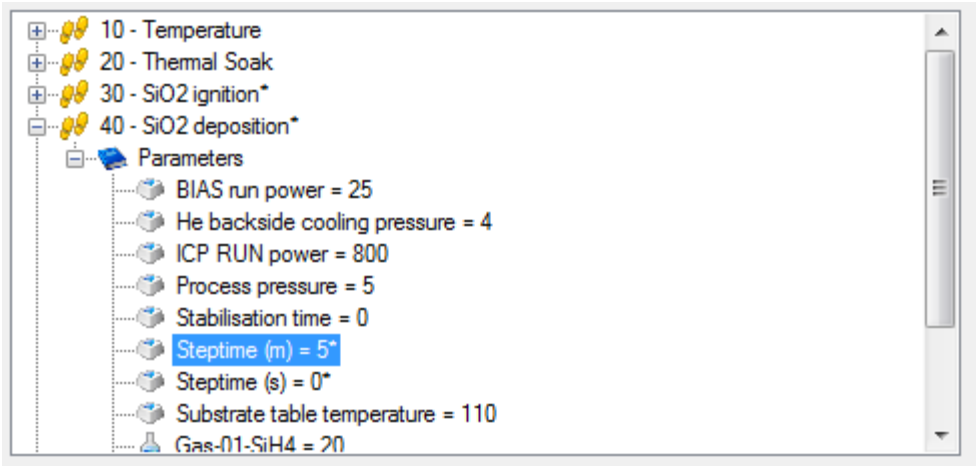
m. A "Start Batch" window will pop up with a list of folders containing various process recipes. In the upper left region of that window, you can access the process recipes by double-clicking on the "Process" folder as shown below.



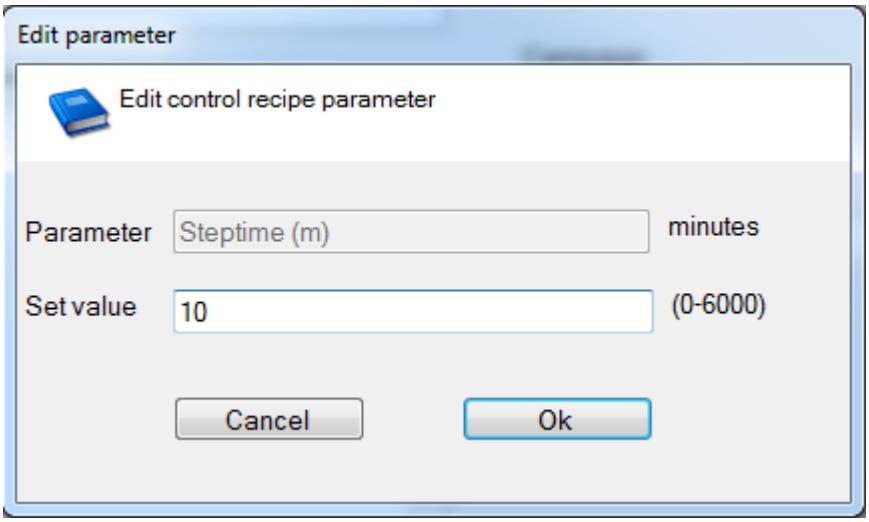
n. Select the recipe you want to season the chamber with. For example, if you want to run a Silicon Dioxide recipe at 110C, then you can select it by clicking on **"Silicon Dioxide@110C".** When you click on it, a set of recipe parameter steps will appear in the lower window as shown in the image below.



o. Double-click on the deposition step (in this recipe it is called "SiO2 deposition"). This will expand your view of that step so you can see the "Parameters" set that is contained within it. Double-click on the "Parameters" set and this will expand your view in order to see all the parameters in that step (as shown below). Notice that in this image, the "Steptime (m)" parameter has been highlighted.

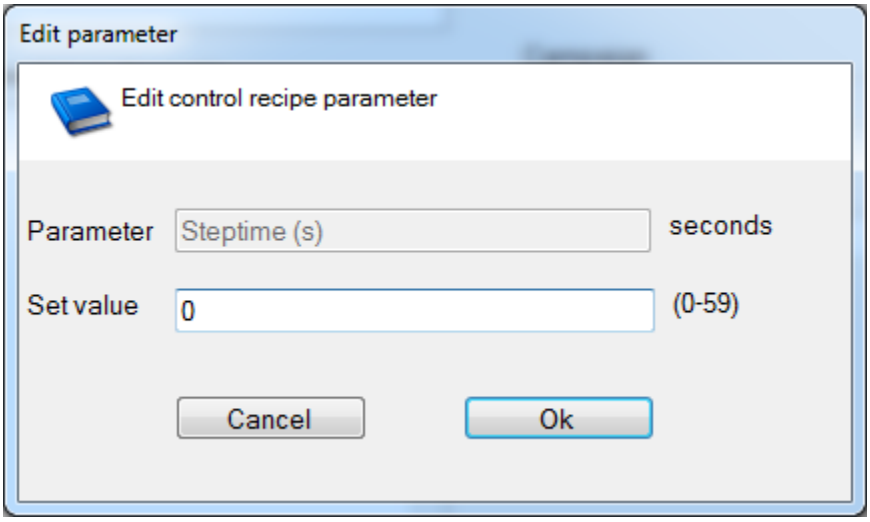


p. Double-click on the **"Steptime (m)"** parameter and this will cause a window to pop up where you can enter the number of **minutes** you'd like to run your deposition recipe for (as shown below).



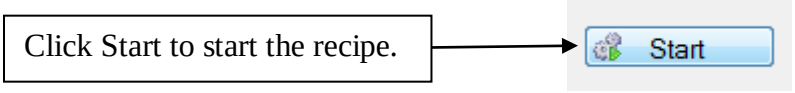
q. In the example above, you can see that 10 minutes was entered. This is the recommended number of minutes for seasoning the chamber with your desired process recipe. If you've already seasoned the chamber and would now like to enter the actual deposition "minutes", then enter the number of minutes you'd like to deposit for. Once the desired time is entered, click **Ok** to save that value.

r. Double-click on the **"Steptime (s)"** parameter and this will cause a window to pop up where you can enter the number of **seconds** you'd like to run your deposition recipe for (as shown below).



s. In the example above, you can see that 0 seconds was entered (because a total time of 10 minutes and **0 seconds** was desired for chamber seasoning). If you've already seasoned the chamber and would now like to enter the actual deposition "seconds", then enter the number of seconds you'd like to deposit for. Once the desired time is entered, click **Ok** to save that value.

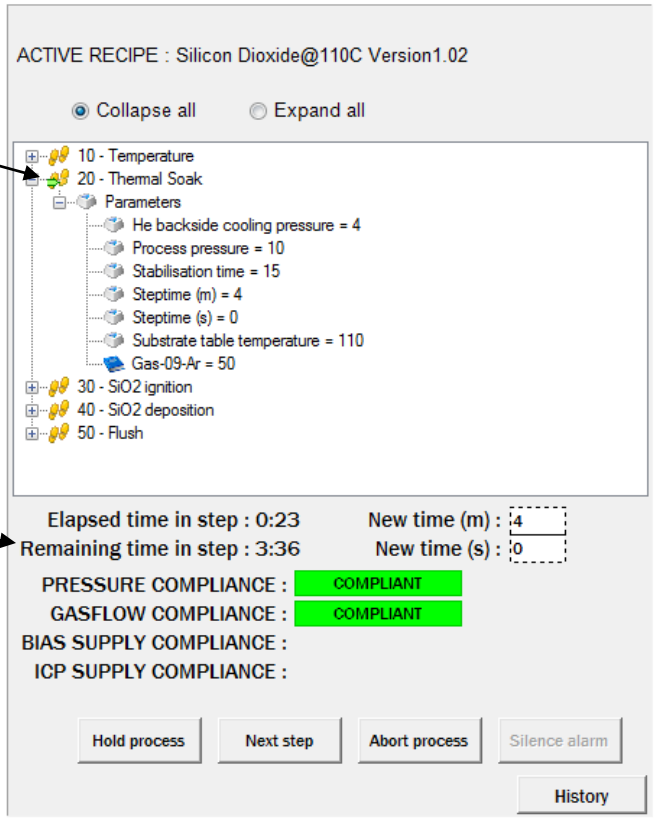
t. When you are finished programming the seasoning time, then you can click on the **Start** button on the lower right portion of the "Start Batch" window as shown below.



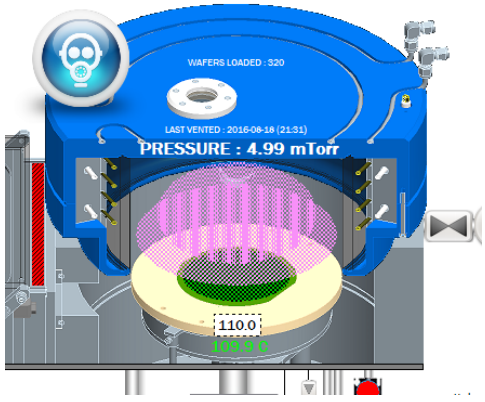
u. When the recipe starts, you may see a yellow-colored "Stabilizing" timer pop up over the chamber diagram. You can keep track of what step is currently running by looking at the window on the right side of the software screen (as shown below).

Green arrow indicates the active step that is running.

You can see how much time is needed for the current step to be completed here.



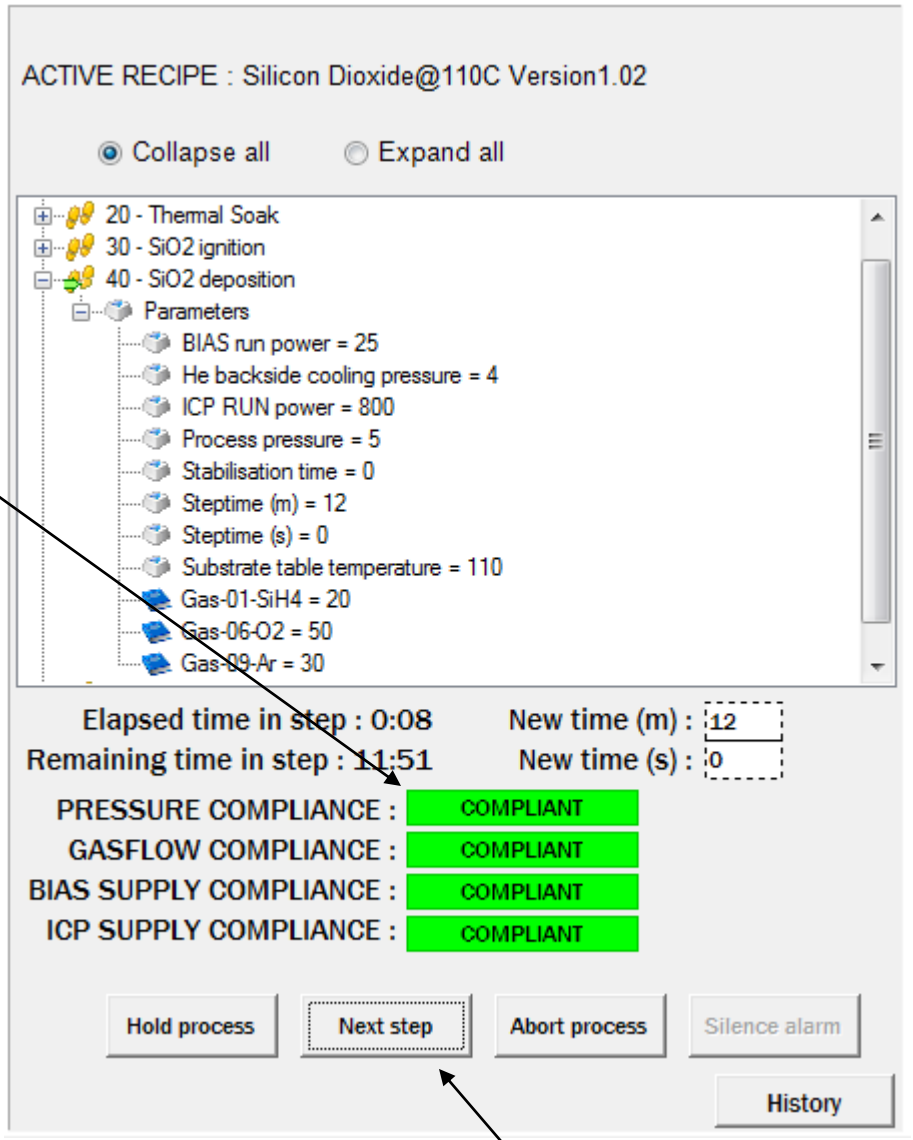
v. When the "ignition" or "deposition" steps are running, you'll notice that the light tower (previously having a green light lit) now has a blue light on as well which indicates that a plasma is running (as shown below in the left image). You'll also notice a plasma indicator in the software, by a purple/pink graphic located in the chamber diagram (as shown below in the right image).



w. If everything is operating normally, you'll also notice that all of the "Compliance" indicators are green as shown below.

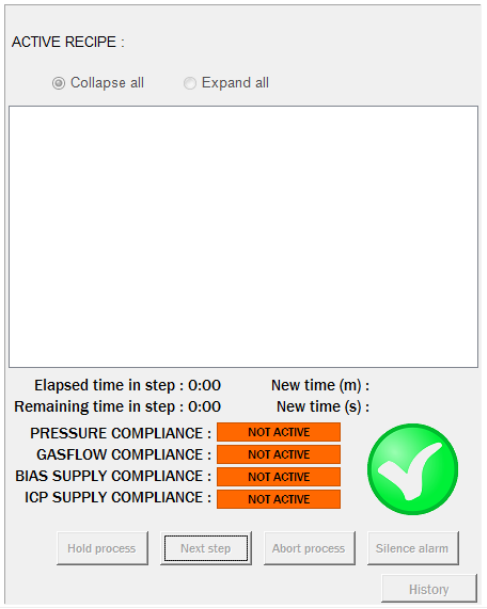
All four of these should be green if everything is running normally. If one or more of them are NOT green for more than a few seconds, it will likely end up alarming and aborting the process recipe.

Report any problems of this sort in Badger if you experience any process aborting due to a non-compliance error.

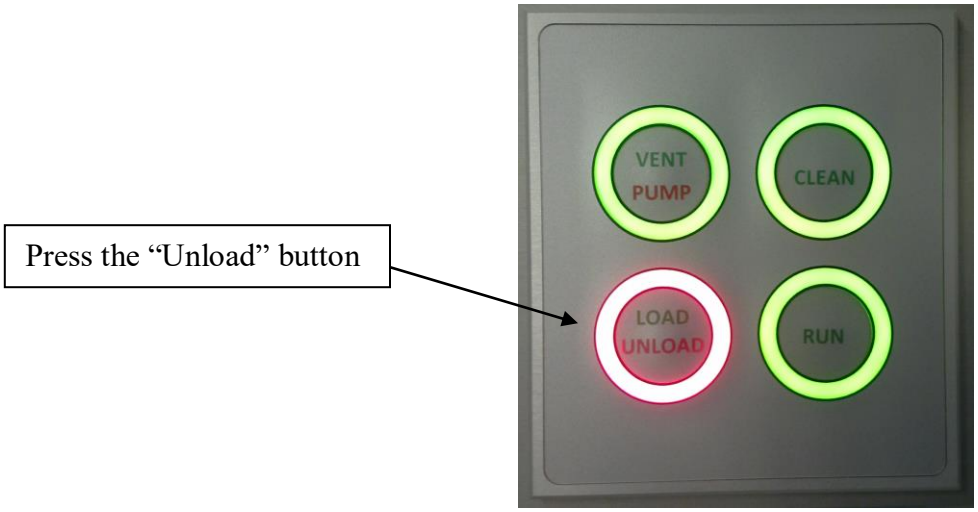


x. **<u>If you need to abort your run for any reason</u>, press the "Next step" button located at the bottom of the "Active recipe window". This will advance the process to the next step in the recipe. If you are running the deposition step, it will STOP depositing and advance the process to the chamber flush/purge step.**

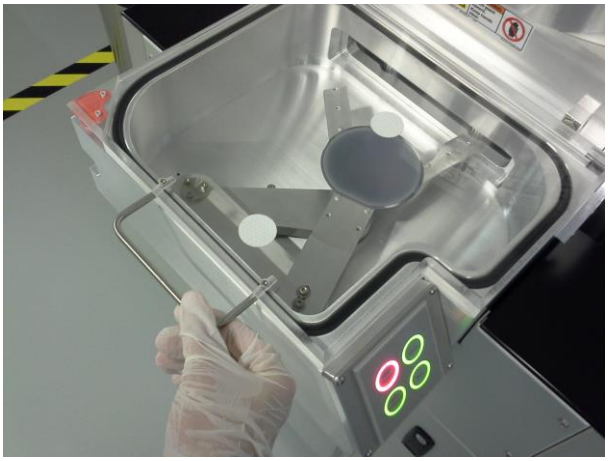
y. After the run has completed and the system has returned to standby, you will no longer see any active process in the window located on the right portion of the software screen. So it will likely look like this:

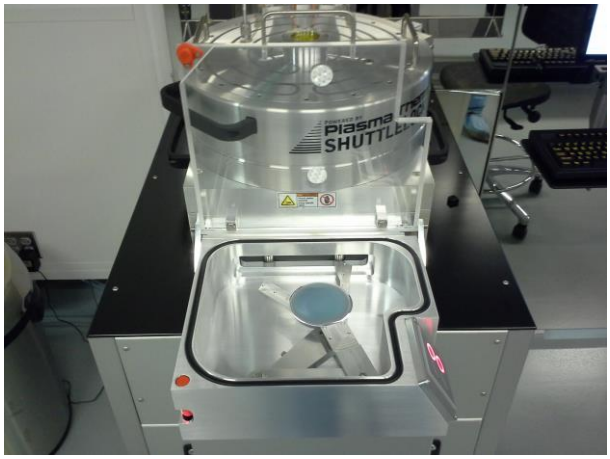


z. You will also notice that when the system is ready, you will have the "Unload" option available on the load-lock control panel (as shown below). Press the **"Unload"** button to unload your wafer into the load-lock chamber.



aa. Once the robot arm transfers the dummy wafer from the main chamber to the load-lock chamber, then the load-lock chamber will begin to vent automatically. This happens relatively quickly, so after about 10 seconds, check to see if you can lift the load-lock chamber lid. Once you can lift the lid, open it up all the way so the lid rests up against the side of the main chamber.

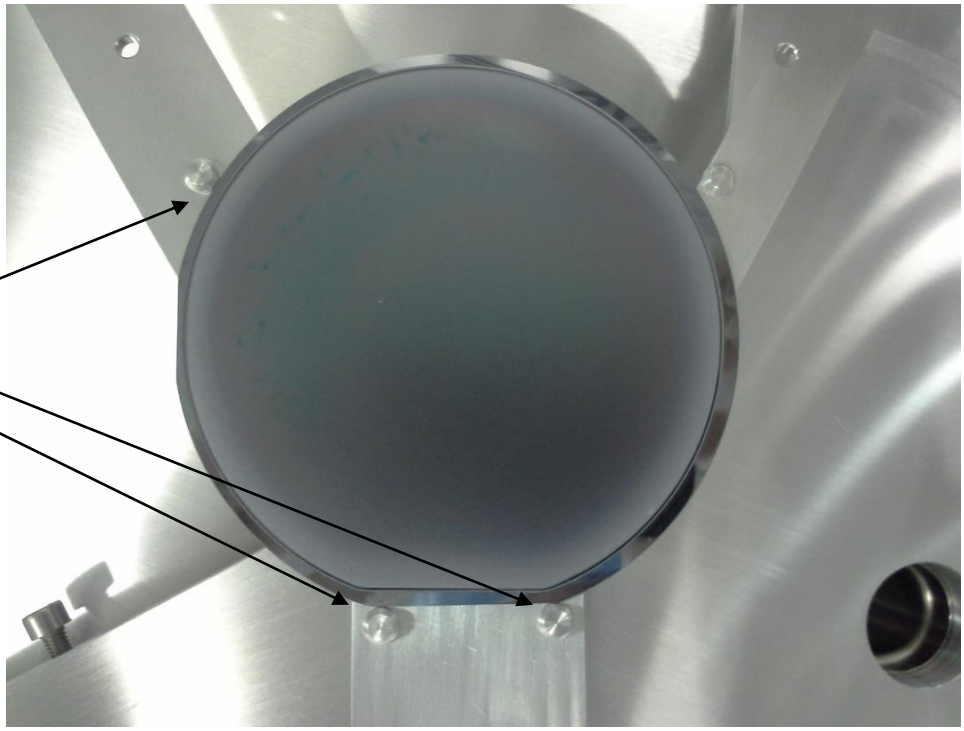




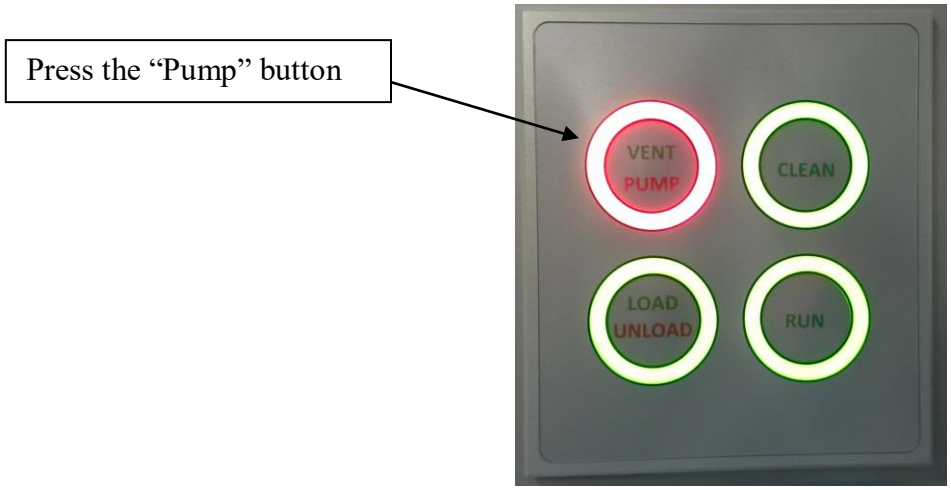
bb. Remove the dummy wafer from the robot arm (using a wafer tweezers) and place it in the dummy wafer cassette / box located next to the chamber.

cc. Load your **process wafer** onto the robot arm, taking extra care to gently align the wafer's major flat up against the two pins that are farthest from the chamber. Then gently align the left side of the wafer up against the left-most pin. When loaded properly, your wafer should look like the following:

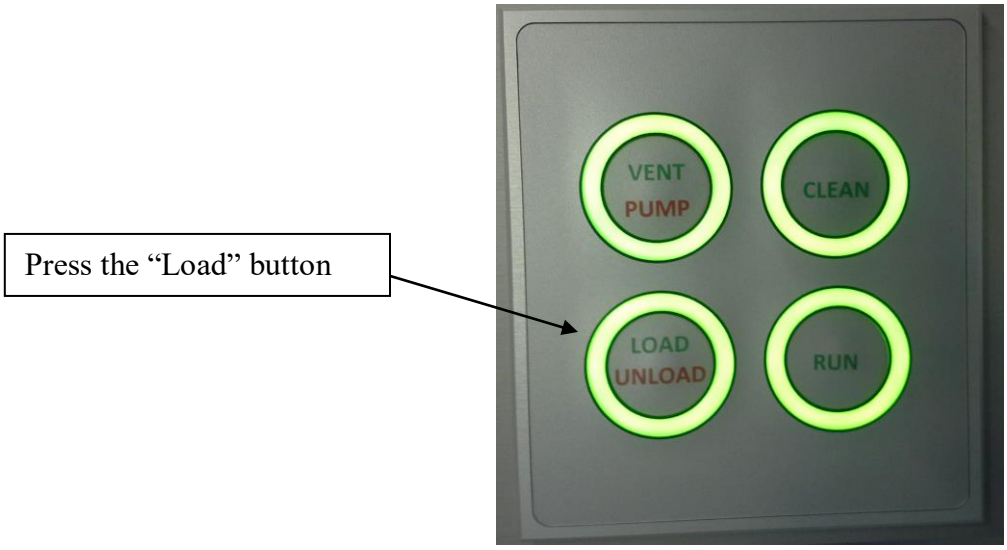
Notice how the wafer is resting up against these three pins. **This is very important!!!** If this is not done properly, **the wafer may be shattered** when the clamp comes down on the wafer after loading!!!



dd. After your **process wafer** is loaded onto the robot arm properly, close the load-lock chamber lid. On the load-lock control panel, locate the **"Pump"** button. If the button is surrounded by a red-colored light (as shown below), that means that the "Pump" option is available and so you can press the **"Pump"** button to pump down the load-lock chamber.

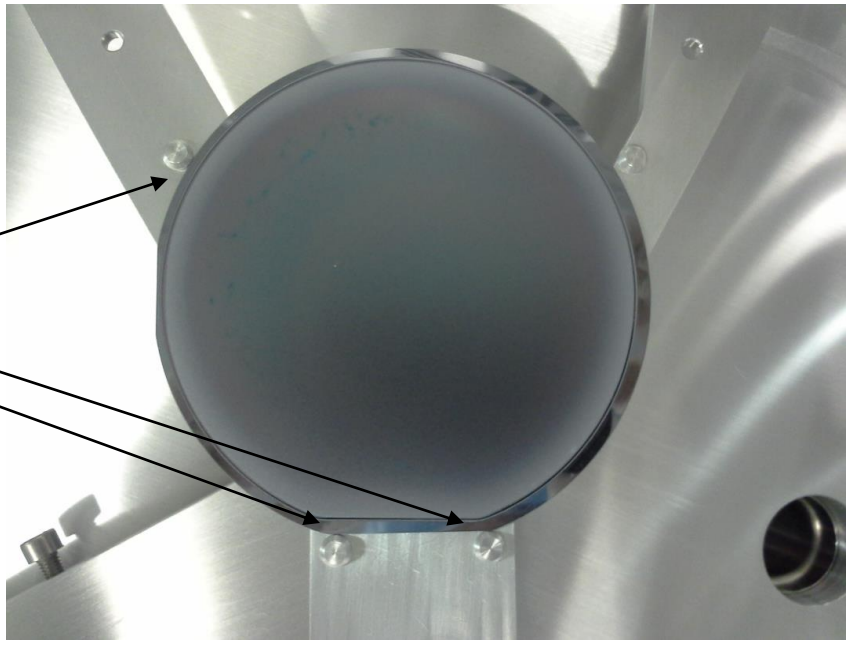


ee. Once the Vent/Pump button turns green, that means that the load-lock is now pumped down which means you can load your wafer into the chamber. To do this, locate the **"Load"** button on the load-lock control panel. If the button is surrounded by a green-colored light (as shown below), that means that the "Load" option is available and so you can press the **"Load"** button to load the wafer.



ff. Repeat steps **"L"** through **"bb"** (pages 6 through 12) to start a batch recipe and program the appropriate time needed for your actual deposition (using the same recipe you just seasoned the chamber with). **After removing your process wafer from the load-lock chamber, you must load a dummy wafer into the load-lock chamber and then run a "Plasma clean" recipe.** Once again, load the dummy wafer onto the robot arm, taking extra care to gently align the wafer's major flat up against the two pins that are farthest from the chamber. Then gently align the left side of the wafer up against the left-most pin. When loaded properly, your wafer should look like the following:

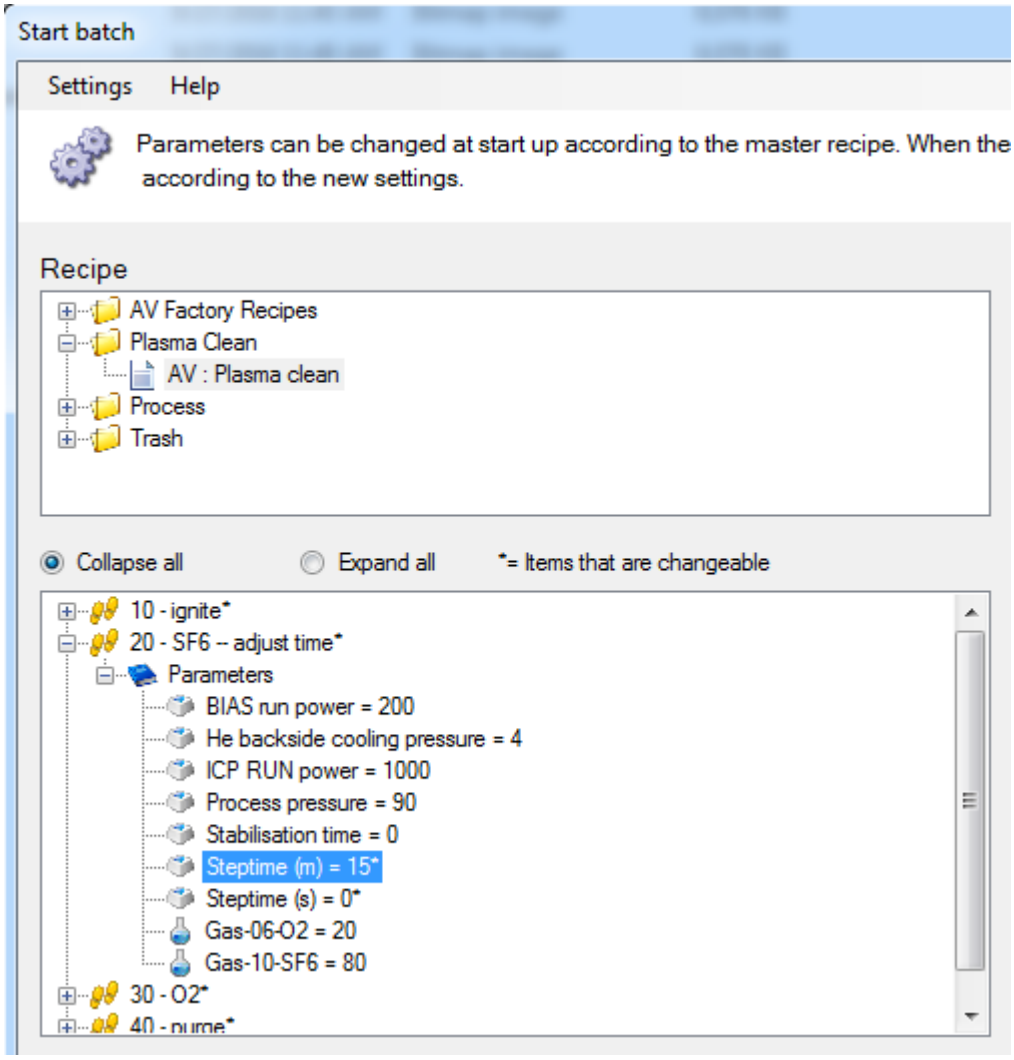
Notice how the wafer is resting up against these three pins. **This is very important!!!** If this is not done properly, **the wafer may be shattered** when the clamp comes down on the wafer after loading!!!



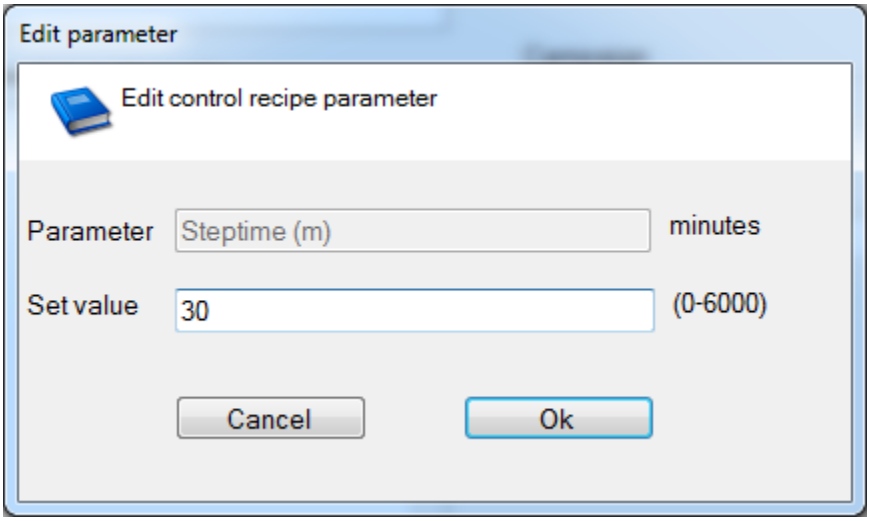
gg. If your process deposition time was **<u>less than 10 minutes</u>** (chamber seasoning time can be ignored here), you can run a 20-minute long plasma clean by simply pressing the **"Clean"** button that is located on the load-lock control panel (as shown below). This is programmed to run for exactly 20 minutes. Then you can skip ahead to step **"ii"**.

Press the "Clean" button

If your process deposition time was **greater than 10 minutes**, then you must manually start a clean recipe. Program the clean time for your **deposition time plus 10 minutes**, and then start the clean recipe. The clean recipe is located in the "Plasma Clean" folder (as shown below).

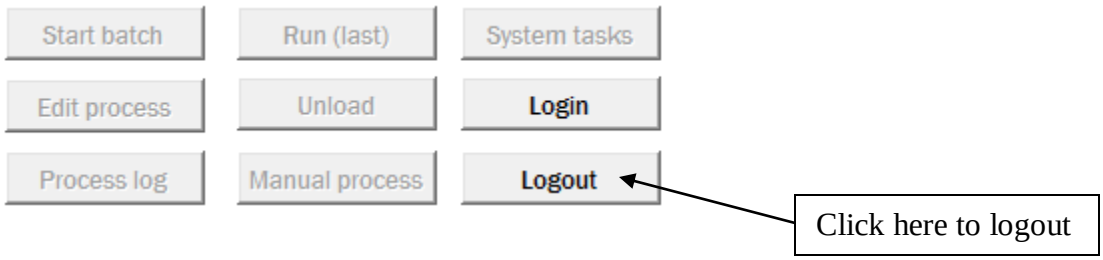


hh. Double-click on the **"Steptime (m)"** parameter and this will cause a window to pop up where you can enter the number of **minutes** you'd like to run your **"Plasma clean"** recipe for (as shown below).



ii. In the example above, you can see that 30 minutes was entered. This would be required if a user ran a deposition recipe for a cumulative total of 30 minutes (for example, a 10 minute chamber seasoning plus a 20 minute process deposition). Once the desired time is entered, click **Ok** to save that value.

jj. Once the **"Plasma clean"** recipe has started, you can click the **"Logout"** button in the lower left quadrant of the computer screen (as shown below).



kk. Disable the HDPCVD in Badger.