

This instruction covers the set-up and use of the bench-top Rapid Thermal Annealing (RTA) systems for processing and annealing samples within the cleanroom.

RTA systems create high temperatures on a timescale of several seconds. Cooling, however, is not hastened in order for the sample and quartzware to not break due to thermal shock. The rapid rate of heating is attained by using high intensity lamps in banks above and below the sample chamber. RTA processes are used to anneal, activate dopants, produce an oxide, or to reflow metals.

There are 2 RTA systems within the Birck Nanotechnology Cleanroom. The RTA 610 system has an older computer, but it does have the capability of extra process gases. The RTA Minipulse has a newer computer, but only has Nitrogen capabilities.



The RTA 610 System



The RTA Minipulse System

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1. SAFETY REQUIREMENTS

- 1.1 Safety glasses must be worn whenever in the cleanroom, except when using a microscope or when wearing protective goggles.
- 1.2 Information regarding the hazardous materials used in the cleanroom can be found through MSDS documentation located in the gowning room.
- 1.3 When handling hazardous liquids and chemicals, Personal Protective Equipment must be worn.
- 1.4 Do not attempt to load or unload samples that are above 150°C.
- 1.5 Please contact the Process & Equipment Engineer for any maintenance, repairs, or problems of the RTA Systems.

2. EQUIPMENT

- 2.1 RTA 610 System
 - 2.1.1 Quartz sample tray
 - 2.1.2 Process gas control box
 - 2.1.3 Computer control system
 - 2.1.4 Thermocouple wafer
- 2.2 RTA Minipulse
 - 2.2.1 Quartz sample tray
 - 2.2.2 Computer control system
 - 2.2.3 Thermocouple wafer

3. FACILITY REQUIREMENTS

- 3.1 RTA 610 System
 - 3.1.1 Electrical: 208VAC / 100amp
 - 3.1.2 Electrical: 110VAC for computer power
 - 3.1.3 Electrical: 110VAC for gas box power
 - 3.1.4 Process chilled cooling water: supply and return
 - 3.1.5 Utility Nitrogen: 20 psi, 1/4" UHP SS Tubing – House supplied
 - 3.1.6 Nitrogen: 20 psi, 1/4" UHP SS Tubing – House supplied
 - 3.1.7 Oxygen: 20 psi, 1/4" UHP SS Tubing – House supplied
 - 3.1.8 Forming Gas: 20 psi, 1/4" UHP SS Tubing – Cylinder supplied
(Forming Gas is 4% Hydrogen in a balance of Nitrogen)
- 3.2 RTA Minipulse System
 - 3.2.1 Electrical: 208VAC / 90amp
 - 3.2.2 Electrical: 110VAC for computer power
 - 3.2.3 Electrical: 110VAC for computer monitor
 - 3.2.4 Process chilled cooling water: supply and return
 - 3.2.5 Utility Nitrogen: 20 psi, 1/4" UHP SS Tubing – House supplied
 - 3.2.6 Nitrogen: 20 psi, 1/4" UHP SS Tubing – House supplied

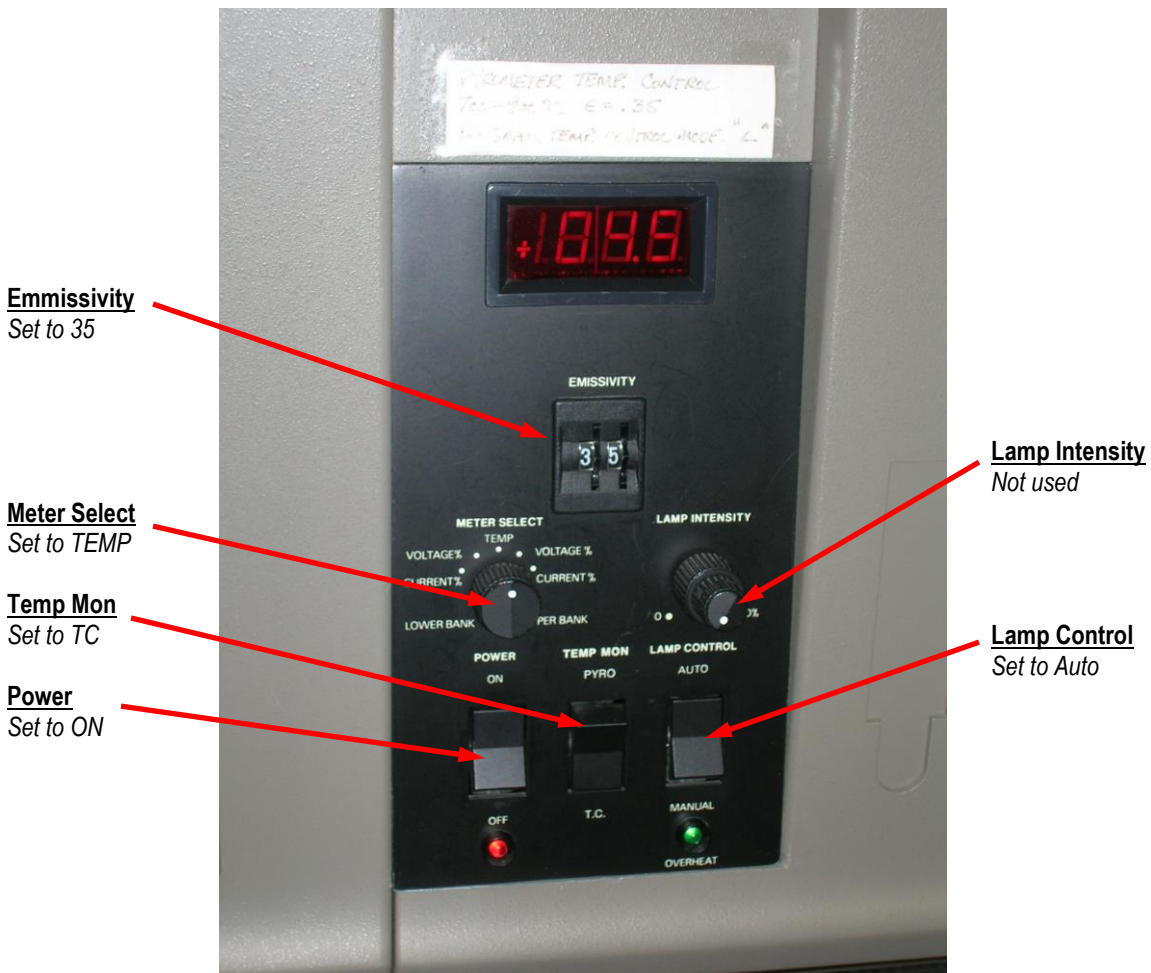
4. CYCLE OF OPERATIONS – RTA 610 using Nitrogen as your process gas

This procedure details how to operate the RTA 610 system using Nitrogen as your process gas. If you desire to use Oxygen, Forming Gas, or a mixture of gases, please refer to Section 5.

- 4.1 Enable the RTA 610 system through the I-Lab portal to ensure proper billing and operation.
- 4.2 Turn on the RTA 610 if not already powered up.
- 4.3 Make sure the temperature is less than 150°C.

Note: *The digital display is offset from the actual temperature by a factor of 10. That means that 15.0 on the digital display is actually 150°C.*

- 4.4 Ensure all control knobs are set according to the picture below:



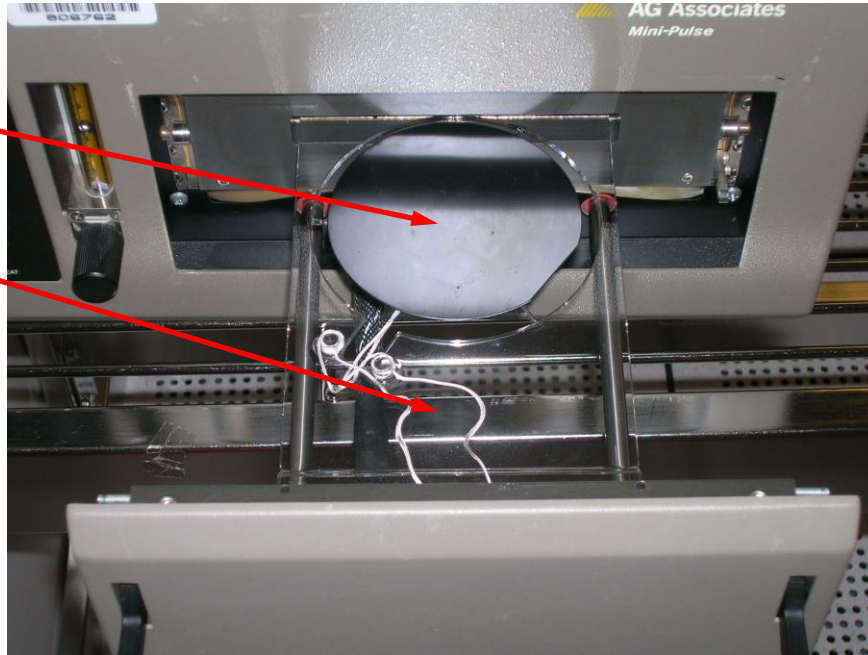
Control Settings

4.5 Open the chamber door very carefully and slowly.

Note: Please be very gentle – the quartz shelf and thermocouple wafer are very fragile!

Thermocouple
Wafer

Quartz
Cantilevered
Shelf



Very Fragile Parts!

4.6 Place your sample on the thermocouple wafer.
Close the door and lock the handle.

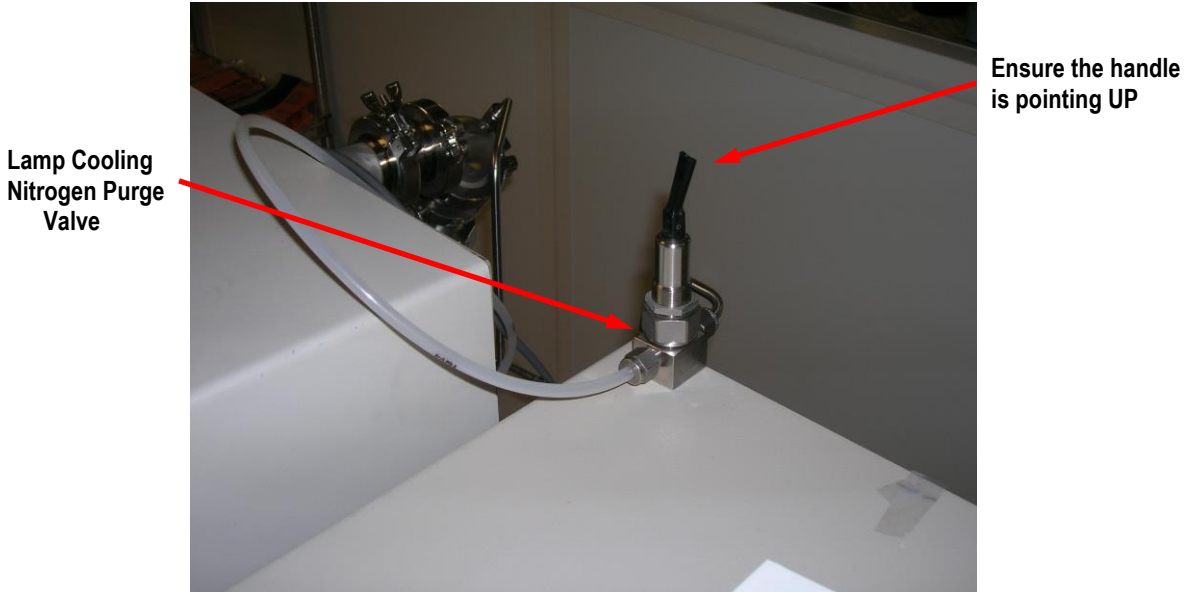
4.7 Adjust your gas flow as necessary with the flowmeter knob.
Allow the chamber to purge for two minutes with your new flow rate.

Nitrogen
Flow
Adjustment



4.8 Ensure the **Lamp Cooling Nitrogen Purge** valve is open. The valve handle should be pointing UP.

Note: *If the lamp cooling nitrogen purge is not opened, the life of the high-output lamps will be greatly diminished. Please make sure it is on through your entire process.*



Lamp Cooling Nitrogen Purge

4.9 At the computer, the main menu should show as **M, A, S, L, T, C, D, U, O.**



The Main Menu

- 4.10 Type **S** to set values.
Type **A** to enter your anneal process time.
Enter your anneal time (in seconds).

Note: *The maximum anneal time is 300 seconds.*

- 4.11 Type **S** again to set another value.
Type **T** to enter your anneal process temperature.
Enter your anneal temperature (in °C).

Note: *The minimum temperature is 300°C
The maximum temperature is 1000°C.*

- 4.12 Type **A** to start Automatic processing.

Note: *The RTA System will now ramp up to your defined temperature in your desired time.
Temperature on both the RTA System as well as the computer should track similar numbers.*

- 4.13 At the end of the run, type **M** to return to the Main Menu.
4.14 Wait for the temperature to reach 150° before unloading your sample.
4.15 Open the chamber door very carefully and slowly.
Carefully remove your sample.
Close the door and lock the handle.
4.16 Disable use of the RTA System within the I-Lab portal.
Leave the Lamp Cooling Nitrogen Purge valve open.
The RTA system is now in an idle state, and you are free to walk away.

5. CYCLE OF OPERATIONS – RTA 610 using Forming Gas or Gas Mixtures

This procedure details how to operate the RTA 610 system using Forming gas or mixtures of Nitrogen, Oxygen, or Forming Gas as your process gas. If you desire to use only Nitrogen as your process gas, a simpler procedure can be found in Section 4.0.

- 5.1 Enable the RTA 610 system through the I-Lab portal to ensure proper billing and operation.
- 5.2 Turn on the RTA 610 if not already powered up.
- 5.3 Make sure the temperature is less than 150°C.

Note: *The digital display is offset from the actual temperature by a factor of 10. That means that 15.0 on the digital display is actually 150°C.*

- 5.4 Ensure all control knobs are set according to the picture below:



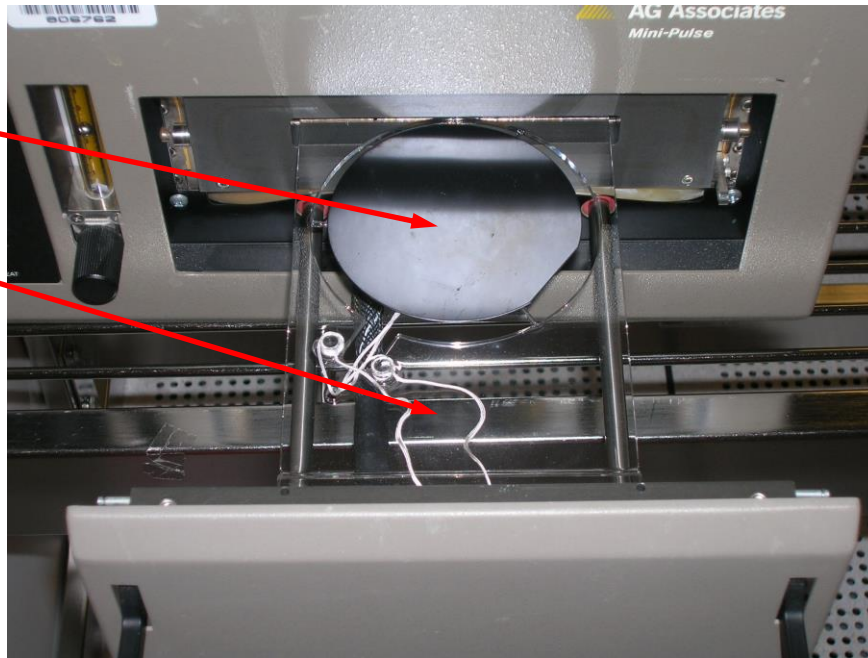
Control Settings

5.4 Open the chamber door very carefully and slowly.

Note: Please be very gentle – the quartz shelf and thermocouple wafer are very fragile!

Thermocouple
Wafer

Quartz
Cantilevered
Shelf



Very Fragile Parts!

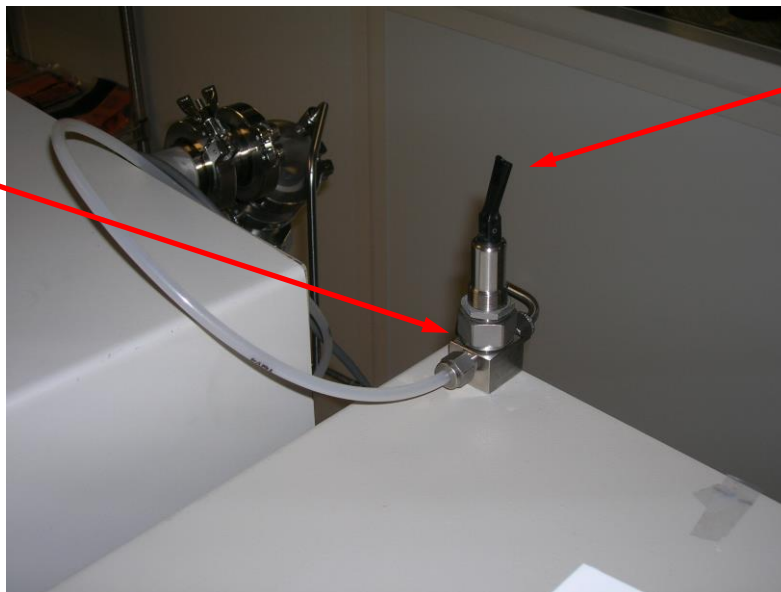
5.5 Place your sample on the thermocouple wafer.
Close the door and lock the handle.

5.6 Ensure the **Lamp Cooling Nitrogen Purge** valve is open. The valve handle should be pointing UP.

Note: If the lamp cooling nitrogen purge is not opened, the life of the high-output lamps will be greatly diminished. Please make sure it is on through your entire process.

Lamp Cooling
Nitrogen Purge
Valve

Ensure the handle
is pointing UP



Lamp Cooling Nitrogen Purge

- 5.7 At the computer, the main menu should show as **M, A, S, L, T, C, D, U, O**. Type **U** to enter "User Vocabulary" settings.

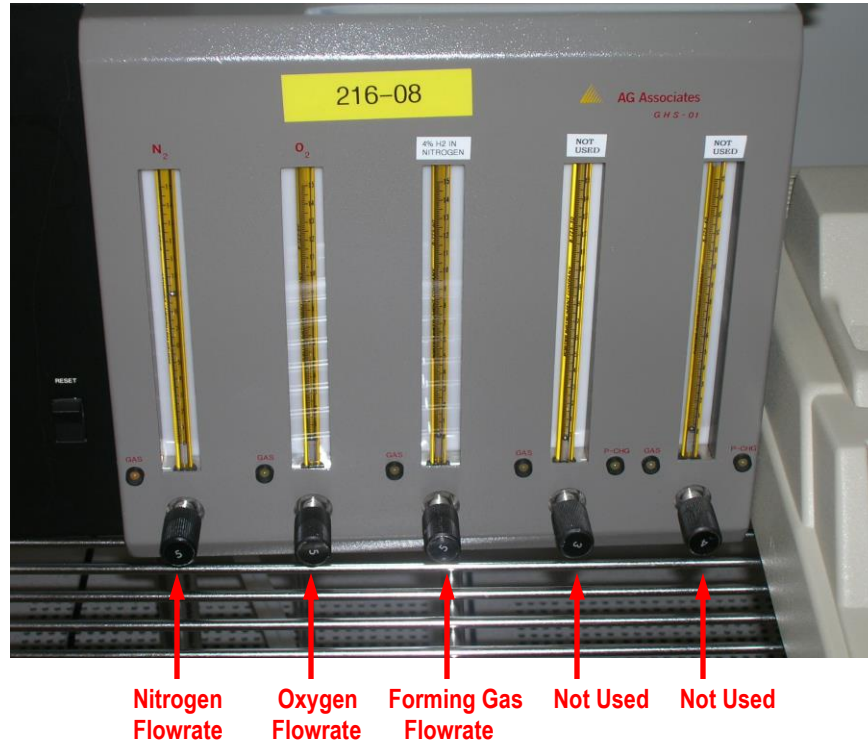


The Main Menu

- 5.8 Type **START** followed by pressing the Enter key.
- 5.9 Decide which gas (or mixture of gases) you wish to use, and type the necessary command:

<u>Type this command:</u>	<u>To flow this gas:</u>
N2	Nitrogen
O2	Oxygen
FORMG	Forming Gas
\$N2 O2\$	Nitrogen and Oxygen Mixture
\$N2 FORMG\$	Nitrogen and Forming Gas Mixture
\$O2 FORMG\$	Oxygen and Forming Gas Mixture

- 5.9 Adjust your gas flows as necessary with the flowmeter knobs.
Allow the chamber to purge for two minutes with your new flow rates.



- 5.10 Enter your Annealing Temperature and your Process Anneal Time in the following format:

XXX YY TANNEAL1

Where XXX = Annealing Temperature (in °C)

Where YY = Process Anneal Time (in seconds)

Example: I want to anneal my sample at 450°C for a time of 60 seconds.

→ Enter the command 450 60 TANNEAL1

- 5.11 Type **RUN** to start the process you defined.
5.12 Type **STOP** if the process overruns its timer.

Note: *The RTA System will now ramp up to your defined temperature in your desired time. Temperature on both the RTA System as well as the computer should track similar numbers.*

- 5.13 Wait for the temperature to reach 150° before unloading your sample.
5.14 Open the chamber door very carefully and slowly.
Carefully remove your sample.
Close the door and lock the handle.
5.15 Type **RESETGAS** to change back to Nitrogen process gas.
5.16 Type **MAIN** to go back to the main menu.
5.17 Disable use of the RTA System within the I-Lab portal.
Leave the Lamp Cooling Nitrogen Purge valve open.
The RTA system is now in an idle state, and you are free to walk away.

6. CYCLE OF OPERATIONS – RTA Minipulse System

This procedure details how to operate the RTA Minipulse system. Please note that Nitrogen is the only process gas used within this system.

- 6.1 Enable the RTA Minipulse system through the I-Lab portal to ensure proper billing and operation.
- 6.2 Turn on the RTA Minipulse if not already powered up.
- 6.3 Make sure the temperature is less than 150°C.

Note: *The digital display is offset from the actual temperature by a factor of 10. That means that 15.0 on the digital display is actually 150°C.*

- 6.4 Ensure all control knobs are set according to the picture below:



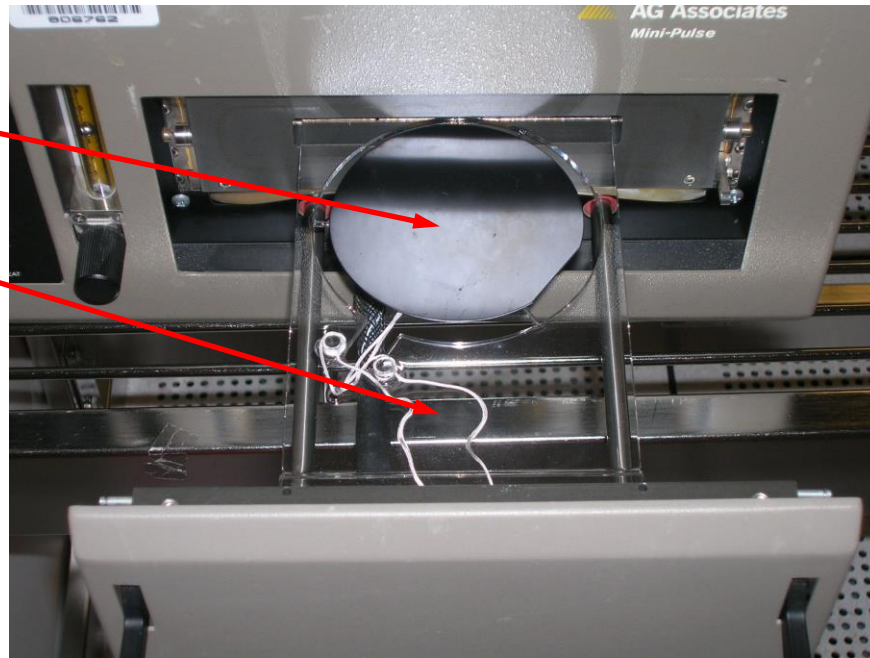
Control Settings

6.5 Open the chamber door very carefully and slowly.

Note: Please be very gentle – the quartz shelf and thermocouple wafer are very fragile!

Thermocouple
Wafer

Quartz
Cantilevered
Shelf



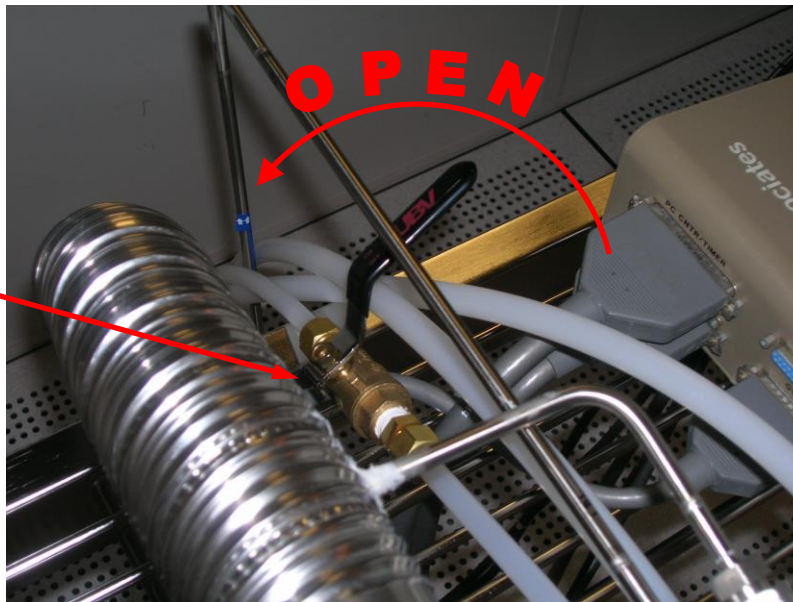
Very Fragile Parts!

6.6 Place your sample on the thermocouple wafer.
Close the door and lock the handle.

6.7 Ensure the **Lamp Cooling Nitrogen Purge** valve is open. Turn the valve handle according to the picture below:

Note: If the lamp cooling nitrogen purge is not opened, the life of the high-output lamps will be greatly diminished. Please make sure it is on through your entire process.

Lamp Cooling
Nitrogen Purge
Valve



Lamp Cooling Nitrogen Purge

- 6.8 Adjust your Nitrogen gas flow as necessary with the flowmeter knob.
This Nitrogen gas flow is your process nitrogen inside the process chamber.
Allow the chamber to purge for two minutes with your new flow rate.



Nitrogen
Flow
Adjustment

- 6.9 Type **P-CAT.EXE** at the DOS prompt if the software is not already running.

Note: Once the p-cat software is running, make sure the version of software is correct. Look in the upper right-hand corner and verify the software version is 2.1.

- 6.10 Type **R** to read a recipe from memory.
Select the appropriate recipe from the extensive list.
- 6.11 Type **E** to execute the recipe.
This step also allows you to view your recipe.
- 6.12 Press F1 to start the process.

Note: If you would like to abort your process at any time, press any key.

- 6.13 Wait for the temperature to reach 150° before unloading your sample.
- 6.14 Open the chamber door very carefully and slowly.
Carefully remove your sample.
Close the door and lock the handle.
- 6.15 Press **F10** to go to the main menu.
- 6.16 Turn off the **Lamp Cooling Nitrogen Purge** valve anytime after the temperature drops below 150°C.
- 6.17 Disable use of the RTA System within the I-Lab portal
- 6.18 The RTA system is now in an idle state, and you are free to walk away.

7. REVISION RECORD

Reason for Revision	Date of Revision	Person Responsible
Initial Release.	August 17, 2009	Dan Hosler
Remove all mention of Coral, and replace with I-Labs	October 20, 2016	Dan Hosler