This instruction covers the set-up and use of the bench-top Jipelec RTA System for annealing and processing samples within the cleanroom.

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1. SAFETY REQUIREMENTS

Standard cleanroom safety information:

Safety glasses must be worn whenever in the cleanroom, except when using a microscope or when wearing protective goggles.

Information regarding the hazardous materials used in the cleanroom can be found through MSDS documentation located in the gowning room.

When handling hazardous liquids and chemicals, Personal Protective Equipment must be worn.

RTA Specific safety information:

The RTA is a relatively harmless machine relating to the operator, apart from the obvious hazards such as pinching fingers while closing the chamber door, or picking up a hot specimen too quickly after a process has been completed.

That said, the operator can still damage the instrument in several ways. The most imminent danger is attempting to run the system while using the incorrect temperature control method. For example, if the machine is configured for Pyrometer Control, but you choose and run a recipe that is programmed for Thermocouple Control, you will melt the chamber. That is because the thermocouple is retracted into the water cooled chamber, and will never reach the temperature setpoint asked for by the recipe. The system keeps pumping power and heat into the chamber attempting to warm up that thermocouple. By then, the chamber has overheated.

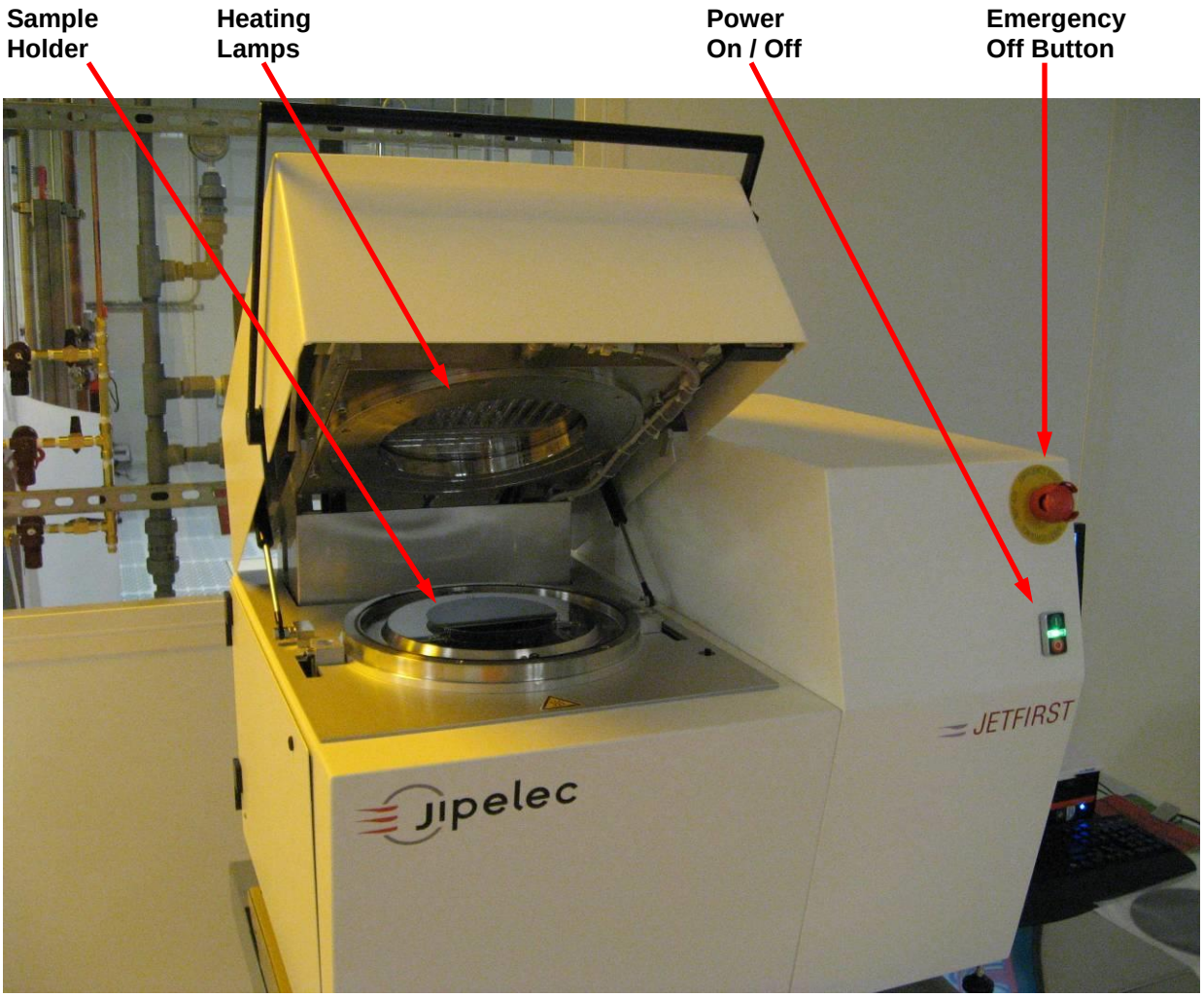
The second failure mode would be to the quartz pins located in the chamber. Please be very careful when placing your wafer on these pins, and placing and removing your samples.

A catastrophic thread is the introduction of a sample that, when heated, contaminates the chamber or the quartz window to the lamp housing. Thus, any material placed inside the chamber must be non-reactive to the temperatures well above the intended process range. Much thought should be given to problems or mishaps where the sample could become hotter than intended. Any contaminant will result in excessive heating of the quartz window.

2. EQUIPMENT

Main Components:
Jipelec RTA System
Computer
6 inch Silicon Wafer
Graphite Susceptor (8 inch graphite susceptor coated with SiC)

Consumable Parts:
PL007 = Tubular Lamp Replacement 6000W / 480V = $117 each
PT018 = Thermocouple used for Silicon substrates = $265 each
PT043 = Sheathed thermocouple for use with the SiC susceptor = $875 each
J5STS122.SP = SiC coated graphite susceptor 200mm used for 6” substrates = $3780 each
J5STS72A.SP = SiC coated graphite cover 200mm = $1990 each
J5STQ24.SP = Quartz window = $1900
J5STP120 = Welded quartz pin for 6” wafer holder
J5STP122 = Straight quartz pin for 8” wafer – outside diameter location
J5STP121 = Tapered quartz pin for 8” wafer – holds the wafer up



Location: Cleanroom / R-Bay

3. FACILITIES & SPECIFICATIONS

Facilities:

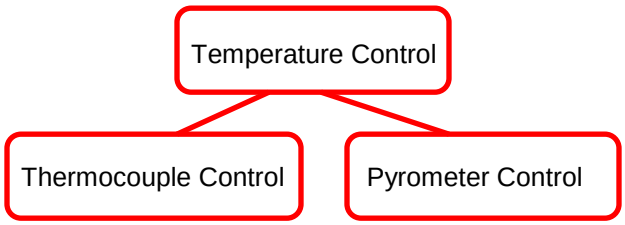
Nitrogen	20 psi – House supplied
Oxygen	20 psi – House supplied
Argon	20 psi – House supplied
Forming Gas	20 psi – Cylinder supplied
Electricity	400V at 100amps
Cooling Water	15 liters per minute at 2 bar inlet/outlet differential pressure
Pneumatics	90 psi of Utility Nitrogen

Specifications:

Temperature Range	0 to 1200C
Ramp Rate	0 to 300°C per second
Weight	341 pounds
Base Vacuum	5 millitorr
Pyrometer	(High temp style) / 400 to 1300°C / 4.8 to 5.2 micrometer wavelength
TC Type	K-Type: 0 to 1000°C
Wafer Size	Up to 8” Wafer

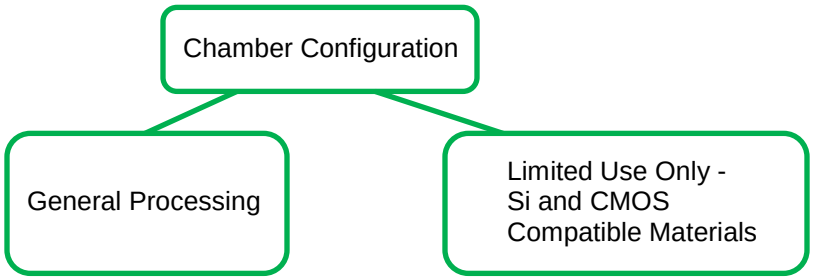
4. MACHINE CONFIGURATION

There are 2 things to note about how the machine is configured as you walk up to it, and they are very important. One factor is the way the machine control's temperature, and the other factor is what contaminants are in the chamber. There are two variations of each factor:



The temperature control mode and must be correct for the type of process you intend to run. If you run a process where the temperature control mode is different than what is currently configured, huge problems will result:

Note: *If the system is not conjured for the type of temperature control you need, please contact the Process Engineer.*



General Processing includes
1. Metal Processing
2. Organic Processing
3. III-V Materials
4. KOH Processing

Si and CMOS compatible Materials Include:
1. Silicon
2. Silicon Oxide
3. Silicon Nitride
4. Polysilicon
5. (No Metals or III-V Materials!)
6. (No Gold, No Platinum, no PZT, No Pyrex)

Cross contamination is a major concern in a shared facility such as the BNC cleanroom. Thus, chambers are classified based upon the cleanliness requirement, and the materials involved in your process. The overall intention is to create and also enforce a laboratory environment for fabricating high quality devices in all realms, (CMOS, MEMS, Etc)

Please observe the placards on the front of the machine to see which variation the machine is currently set up for.

Typically, the default configuration for the machine is for general use and also for Pyrometer control.

5. SILICON CHUCK CLEANING PROCEDURE

- ✓ Samples are placed on a 6 inch silicon wafer.
- ✓ The 6 inch silicon wafer must be cleaned prior to use following this method.
- ✓ Do not use 6 inch silicon wafers intended for other processes, such as a Panasonic sample carrier.
- ✓ The 8 inch graphite susceptor does not need to be cleaned.

5.1 Use glassware large enough to hold your 6" silicon wafer.

5.2 Be sure your glassware is clean.
If not, go through this process without the silicon wafer to ensure your glassware is clean.

5.3 Use Teflon tweezers.
Do not use stainless steel tweezers – it is attacked by the acid.

5.4 Submerge your 6" wafer in the acid Nanostrip 2X (or piranha solution).

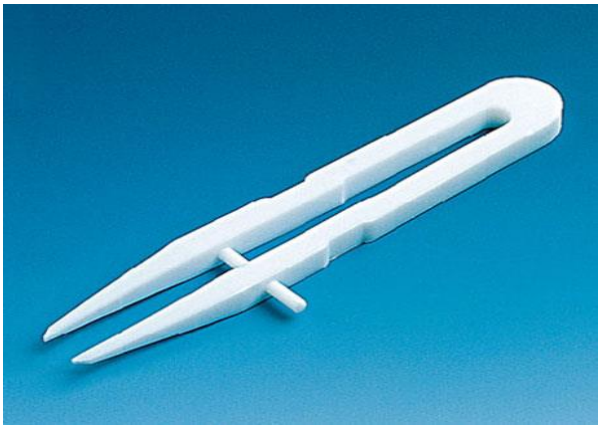
5.5 Let this sit for 10 minutes, stirring occasionally.

5.6 Fully rinse with water.
Rinse multiple times to assure all the acid is removed from both wafer and glassware.

5.7 Dry your silicon wafer with the nitrogen blowgun.

5.8 Replace your 6 inch wafer in its ***clean*** plastic case.
(Clean your 6 inch wafer case by wiping it out with a cleanroom wipe and isopropyl alcohol)

Note: *Proper cleaning of the silicon wafer is a very important step. It keeps the chamber clean, and other research projects free from contaminants.*



6. INSTALLING YOUR SILICON CHUCK

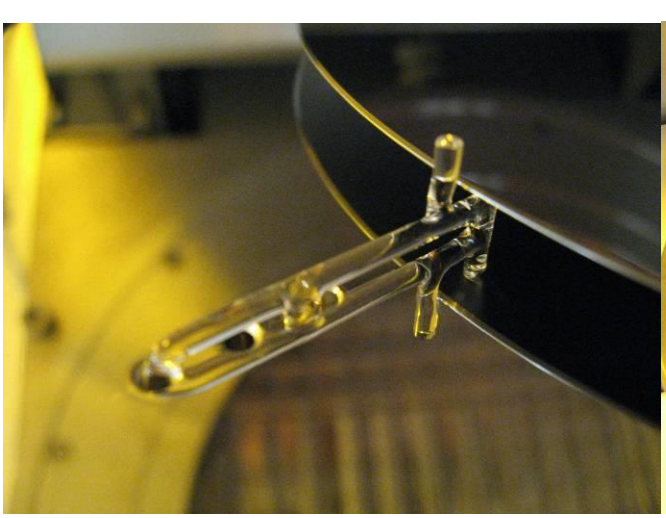
6.1 Prior to beginning, please enable the Jipelec RTA through coral to ensure proper billing.

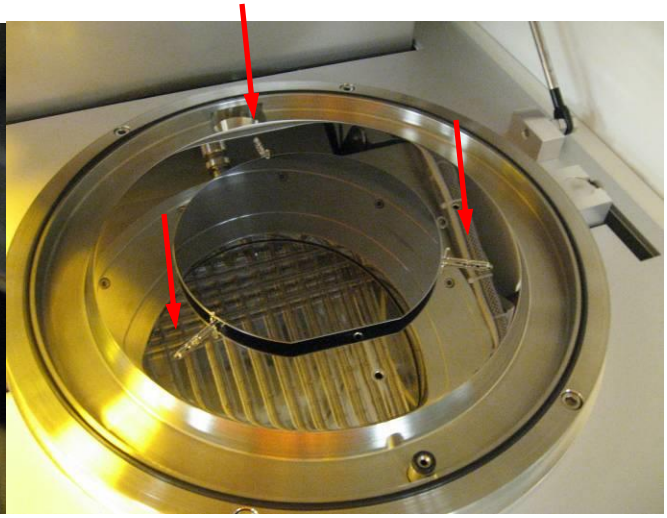
6.2 Turn on the power button on the front of the main machine.

6.3 Carefully open the heating chamber of the machine.

6.4 Observe the quartz pegs sticking out of the bottom plate of the chamber.
Your silicon wafer will rest on these quartz pegs.

Quartz Pin Detail *Three Quartz Pins*





6.5 Put on a new pair of gloves (or put new gloves over your existing gloves).
Be sure not to touch anything with your fresh gloves.

6.6 Take your clean wafer out of its carrier with your new gloves on, and very carefully place it on the quartz pegs of the chamber.

Note: *Do not drop the wafer into place.*
Lay it gently so the quartz pegs do not rattle around.
Avoid touching the interior of the chamber.

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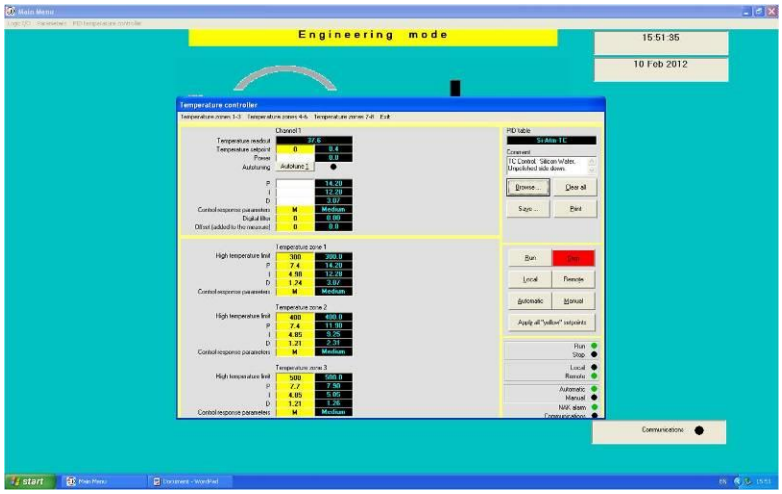
6.7 Using the same brand new gloves, carefully re-seat the o-ring in its seat.
Do not reach over your clean silicon wafer chuck with your arm.
Approach the rear of the o-ring by reaching around your silicon wafer chuck.

6.8 Place your sample to be processed in the center of the 6 inch silicon wafer.
Be very gentle, and do not push the 6” wafer around or you may break the quartz pins.
Close the chamber if you are not loading a sample immediately.

7. CYCLE OF OPERATIONS

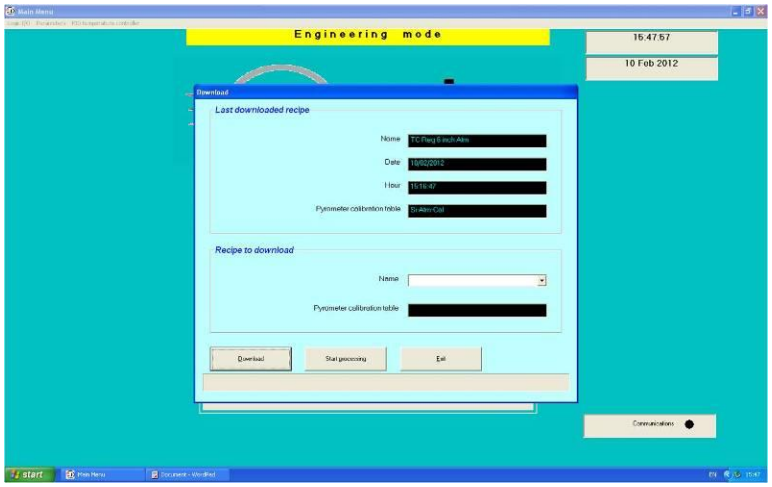
7.1 Predefined recipes can be loaded and processed with these 3 steps:

Step 1:



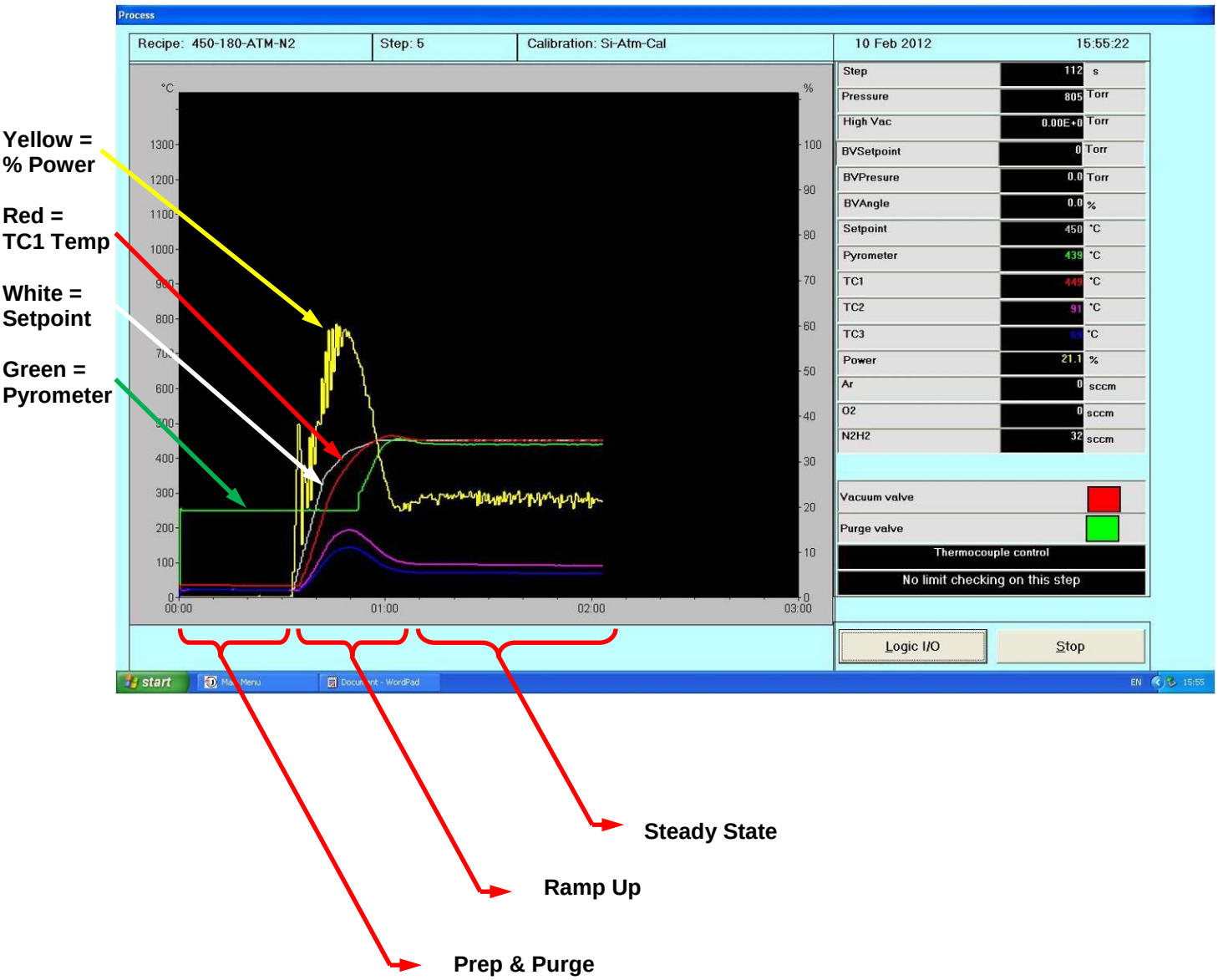
- Click on **PID TEMPERATURE CONTROLLER** in the upper left corner from the main menu.
- Click on the **BROWSE** button.
- Find the appropriate PID table for downloading as mentioned in Step 1 above.
- Click on the button **APPLY ALL YELLOW SETPOINTS**.
- Click “Yes” when asked the verification question.
- Allow a few seconds to have the data transfer, then double check to make sure the columns of data match.
- Exit

Step 2:



- Click on the **PROCESSING** button.
- Use the pulldown menu to browse for the recipe you want.
- Click **DOWNLOAD**.
- Click on **START PROCESSING.**
- Load your sample if not already loaded.
- Click on **START PROCESSING** within the next window.

7.2 Once the machine is running, you are able to observe the real-time graph and monitor progress



7.3 Once your process is finished, you have the option of saving the data and graph for review.

7.4 A 4 minute cool-down period is mandatory, and the stop clock is seen on the monitor.

7.5 Open the chamber and carefully remove your sample.
If you are finished processing for the day, also remove your Silicon wafer and return it to its clean wafer carrier.

7.6 Before you walk away, check to make sure the Jipelec RTA is in the following state:

- ✓ Chamber cooled down
- ✓ Placards are properly placed (for both temperature control mode and chamber configuration)
- ✓ The machine is powered down.
- ✓ You have exited the software.

8. TROUBLESHOOTING

8.1 Temperature overshoot

Problem: The actual temperature far exceeds the temperature setpoint upon ramp up.

Discussion: The most likely cause is oxidation on your silicon chuck. A small amount of silicon dioxide on the backside of the silicon wafer chuck can change how the TC interacts, and also the emissivity of the surface. Another possibility is the size and mass of your sample. Since recipes are created looking at the mass of only the chuck without your sample, your sample adds a certain amount of thermal mass to the process.

Action: Clean the oxide off your wafer with a dilute HF strip (or BOE).
Try smaller samples in more batches.

8.2 Temperature Control Failure

Problem: An error/alarm pops up during ramp up or steady state indicating there is a problem with the closed-loop temperature control system.

Discussion: The most likely cause of this error is contaminants on the backside of the wafer (where the pyrometer and TC observe the wafer).

Action: Clean the wafer with piranha followed by BOE.

8.3 Temperature does not ramp up at all

Problem: When running a recipe, the temperature setpoint goes up, but the actual temperature does not.

Discussion: A couple of issues may exist:

1. The wrong temperature control mode has been selected. That is, the recipe may be expecting to control with the thermocouple, but it is retracted into the water cooled chuck due to running in pyrometer control mode.
2. The PID Parameters may be in the wrong “mode”.

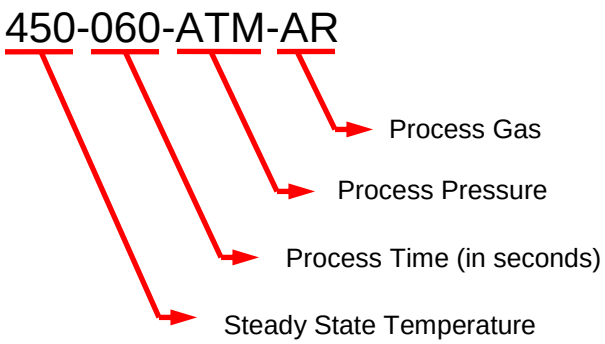
Action:

1. Make sure the recipe you’re running is set up for the current configuration of the machine. (Run TC controlled recipes with the TC touching your sample)
2. Open the PID Parameter window, and make sure the green lights are on the following buttons:
   - ✓ Run
   - ✓ Auto
   - ✓ Remote
   - ✓ NAK (flashing green / black)

9. RECIPES

Recipes have been created for you. The syntax of the recipe name is as follows:

Example:



Temperature: Recipes have been defined from 250 to 1000°C in 50°C increments.

Process Time: Recipes have been defined at standard times of 30, 60, 120, 180, and 300 seconds.

Process Pressure: Recipes are either at atmospheric pressure (760 Torr) or at vacuum pressures (approximately 50 millitorr)

Process Gas: Recipe options are N2, Ar, O2, or Forming Gas.

Generally speaking:

Thermocouple Control is used for recipes with temperatures in the 0 to 500°C range.
Pyrometer Control is used for recipes with temperatures in the 500 to 1200°C range.

10. REVISION RECORD

Reason for Revision	Date of Revision	Person Responsible
Initial Release	Mar 05, 2012	Dan Hosler
Modify Section 5 to remove BOE etch	Sep 11, 2012	Dan Hosler
General review	Jan 25, 2017	Dan Hosler
Removed Section 7.1 (Not Needed for Students)	December 13, 2017	William Arnett