

RAPID THERMAL PROCESSING (RTP)



STANDARD OPERATING PROCEDURES (SOPs) 2018 (v.1)

Category: Semi-clean PV



NCPRE FABRICATION LAB

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1. INTRODUCTION

1.1 Rapid Thermal Processing (RTP)

The AccuThermo AW610 is a rapid thermal processing (RTP) system, which uses high intensity visible radiation to heat single wafers for short process periods of time at precisely controlled temperatures. The process periods are typically 1 - 600 seconds in duration, although periods of up to 9999 seconds can be selected. These capabilities, combined with the heating chamber's cold-wall design and superior heating uniformity, provide significant advantages over conventional furnace processing.

1.2 Equipment Configuration

- AccuThermo AW610 Main Frame with wires.
- Aluminium chamber with water cooling and gold plating.
- Isolated Quartz Tube without window.
- Oven control board and main control board
- Bottom and top heating with Radiation heating lamps (21 nos. Each 1.2 kW) module with 4 bank zones (Top Front & Rear, Bottom Front & Rear).
- Quartz Tray for 4 to 6 inch round (or square) wafer
- One gas line with one MFC without shut-off valve.
- Computer with AW Software, 17" LCD Monitor, Mouse, Standard Keyboard
- T Shape Quartz with TC and one Quartz holder for 100-800°C
- One package of 5 pieces of thermocouple wires
- One USB with original Software backup

1.3 Software

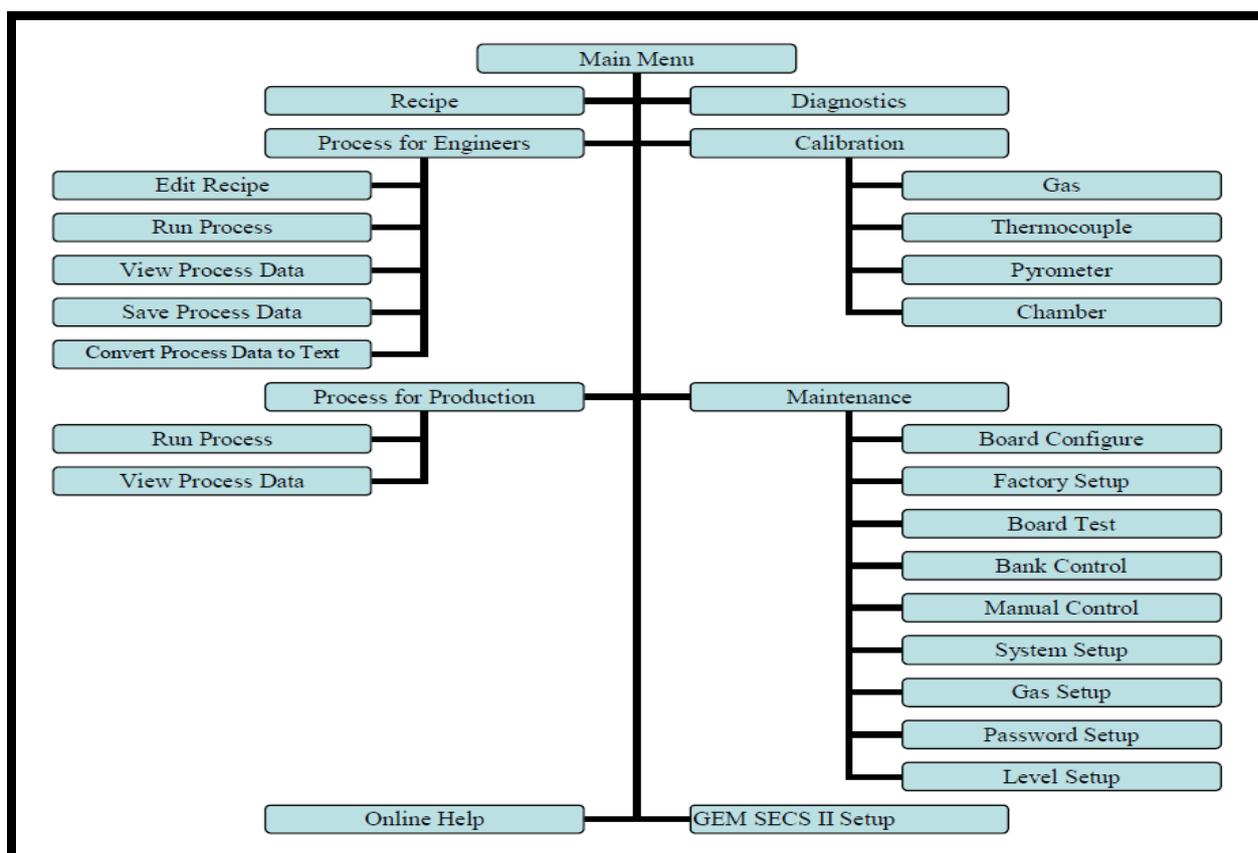
The AccuThermo RTP AW 610 rapid thermal processing system consists of an oven unit and a controller computer running the Allwin21 RTAPRO controller software. The wafer to be processed is placed on a quartz tray that slides into a quartz isolation tube in the oven unit. Four banks of lamps, two above the quartz tube and two below it, provide the source of energy for heating the wafer. The lamps can be controlled manually and automatically from the controller computer.

The RTAPRO control software allows full control and diagnostics of the AccuThermo RTP system. In addition, it allows the creation of recipes for automated control of the temperature, optionally and process gas flow.

The control software uses a set of operating instructions known as recipes to automatically control the AccuThermo RTP system. These recipes are created by the Process Engineer to monitor and control the parameters of the processing cycle. The Operator then uses the software to select and run the process parameters (steady state temperature, process time, ramp rates, etc.).

The RTAPRO software is also used to create, delete, copy, modify and store the recipes and to execute system diagnostics.

RTP control software main menu tree:



1.4 System Installation

This manual describes how to install the AllWin21 AccuThermo RTP system and perform an operational check of the system. These activities are outlined in the following sequence of steps.

- Prepare the site utility connections (refer to Section 3 of the Manual).
- Unpack the AccuThermo RTP oven, computer, pyrometer chiller and any additional parts (refer to Section 2 the Manual).
- Inspect the system for damage or missing parts (refer to Section 2 the Manual).

- Connect the utilities to the AccuThermo RTP system and chiller (refer to Section 4 the Manual).
- Inspect and install the quartz ware (refer to the Maintenance Manual for installing the quartz ware for the AccuThermo RTP system).
- Install and connect the computer to the AccuThermo RTP system (refer to Section 6 the Manual).
- Power-up the system (refer to Section 6 the Manual).
- Configure the computer and set system constants (refer to Section 6 the Manual).
- Confirm proper operation (refer to Section 6 the Manual).
- Check for temperature accuracy (refer to Section 6 the Manual).
- System troubleshooting (refer to the Maintenance Manual for troubleshooting the AccuThermo RTP system).

Installed System



Fig 1.1: Major units of equipment viz. Main Unit, DOS PC

Connections associated with the DOS PC



Connections associated with the Main unit



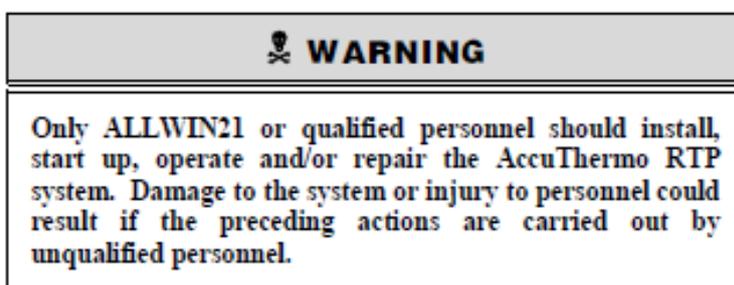
Power Supply Connections



2. SAFETY PRECAUTIONS

2.1 OVERVIEW

This section provides information intended to prevent damage to the AccuThermo RTP system and injury to operation and maintenance personnel. All hazards are not covered, only those most prevalent and serious. Your full understanding of the capabilities and limitations of this equipment is necessary for safe and efficient operation.



Prior to applying power or starting up the AccuThermo RTP system, follow these safety precautions:

- Check all utilities for proper connections. Connect only those gases specified for use in the system.
- Make sure the cabinet cover is on.
- Check the scrubber exhaust to make sure it is properly connected to the facility scrubber. Ensure the facility scrubber is operating properly. Check the purge gas outlet for any restrictions

2.2 NOTES, CAUTIONS AND WARNING

When operating and maintaining the AccuThermo RTP system, the following safety procedures and precautions must be followed to avoid certain hazards. Observe all warnings and cautions. Their purpose is to protect personnel from injury and long term health hazards and to protect the machine from damage.

Kindly pay special attention to notes, cautions and warnings located in appropriate areas in this manual.

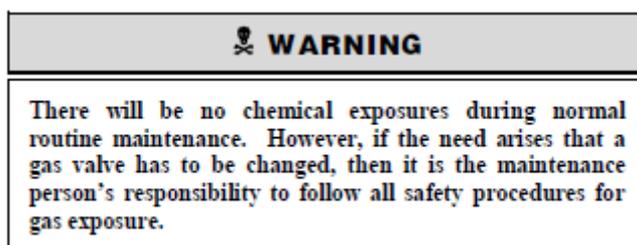
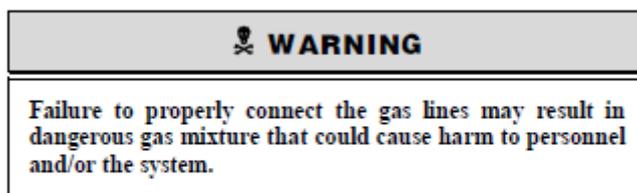
2.3 SAFETY FEATURES

- There is a watchdog timer on the AccuThermo RTP system control board that will shut off the lamps if the software or computer freezes.
- Chamber Door Interlock Switch: This interlock detects if the chamber door is closed. If the chamber door is not closed, then the heating source will not come on. This cannot be bypassed.
- Cabinet Cover Interlock Switch: This interlock detects if the cabinet cover has been removed. If the cabinet cover has been removed, then the heating source is turned off by disengaging the power contactor. This can be bypassed by a maintenance person by pulling up on the switch into the maintenance position. As soon as the cabinet cover is replaced, the cabinet cover interlock switch is automatically reset to detect the removal of the cabinet cover.
- **EMO (Emergency Off):** When the EMO is depressed; the power to the lamp contactor is turned off. This turns off the heating source.
- Overheat Thermal Switch: If the oven overheats (>155°F), there is a thermal switch that opens and the heating source is turned off by disengaging the power contactor. Once the chamber has cooled below 135°F, the thermal switch can be reset by pressing on the thermal switch reset button.
- **Water Flow Switch:** The water needs to flow at least 2 gallons per minute (GPM). If the flow rate drops below this, the heating source is turned off by disabling the lamp control circuit. However, if the oven plates are below 74°F, the water may not need to flow. This is to prevent condensation on the oven in an un-air-conditioned facility. If the oven plates are less than 45°F, the water valve is closed, preventing the oven from being cooled more. If this happens, the chiller control temperature has been set too low.
- **Electrical:** The main circuit breaker on the rear panel of the chassis (on 3-phase units only) removes all electrical power from the machine. There are no storage devices (e.g. capacitors) within the machine.
- **Pneumatic:** The pneumatics is used to operate the Positive Shut-off valves. If there is no air pressure, these valves will close. If the power is removed from the AccuThermo RTP system, then the pneumatic gas valves close automatically.

2.4 GAS HANDLING

- Only use gases that have been specified for use in the AccuThermo RTP system. Typically these include **Nitrogen (N₂)**, **Argon (Ar)**, **Forming Gas**, **Oxygen (O₂)** and **Helium (He)**.

- Make sure the specified gases are connected to the proper inlets on the rear panel.



2.5 HAZARDS

The AccuThermo RTP system presents certain hazards if operated or maintained improperly. These fall into the following categories:

- Electrical shock hazards
- Process gas hazards
- Process by-product hazards
- Oxygen hazards
- Thermal hazards.

2.5.1 ELECTRICAL SHOCK HAZARDS

The AccuThermo RTP system requires electrical power which is distributed through the machine. Safety interlocks are installed to shut off electrical power to the system when the cover is removed. Only qualified troubleshooting maintenance technicians should be permitted to work on an uncovered AccuThermo RTP system. Allwin21 assumes no liability for injuries or deaths caused by operation with interlocking devices defeated.

Caution and safety measures characteristically taken with AC and DC circuitry are imperative.

2.5.2 PROCESS GAS HAZARDS

An AccuThermo RTP system process may use these two complex process gases: O₂ or forming gas (5% to 15% H₂ in N₂ or Ar), depending on user application. O₂ is an oxidant and it supports combustion. It must be handled with care. Forming gas is non-toxic and odourless. It is flammable and never should be stored at 125°F or greater. Inhalation of forming gas should be avoided.

Note: Make sure the forming gas mixture is correct.

2.5.3 PROCESS BY-PRODUCT HAZARDS

The process by-products found in the chamber surfaces of the AccuThermo RTP system should be treated as potentially hazardous.

Due to the variations in chemistry employed to meet application requirements, the exact constituents of effluents from the process family cannot be defined. However, the following general precautions should be observed:

- Solvent-proof neoprene or Viton gloves should be worn while maintaining the chamber surfaces and its accessories.

Allwin21 Corp. claims no responsibility for the safety of the by-products of the AccuThermo Rapid Thermal Processor system.

2.5.4 OXYGEN HAZARDS

In RTP systems, oxygen (O₂) may be utilized as a process gas, either alone or in conjunction with other gases. A possible EXPLOSIVE condition exists. Oxygen is an oxidizing agent which accelerates combustion. Contact with flammable materials may cause fire or explosion. Any time there is heat, and if the concentration of oxygen is greater than 21% of the volume, the condition for an explosion exists. It should be noted this potential condition exists anytime oxygen is connected to the system.

Note: Use appropriate procedures when processing with oxygen.

2.5.5 THERMAL HAZARDS

The quartz tray and isolation tube must be allowed to cool down before they are serviced. Allow 20 to 30 minutes for the quartz ware to cool before touching. Burns may result if the quartz ware is touched before the cooling time elapses. In addition, use of solvents, such as IPA (isopropyl alcohol) or acetone to clean the chamber, may pose a hazard if used while the quartz ware is still hot.

NOTE

The control system contains three safety shutoffs. The first is a watchdog timer that turns OFF the heating lamps if the control software has been interrupted for more than approximately 2 seconds.

The second shutoff shuts down the heating lamps and the MFC's if the measured temperature is above 1250°C. These high readings indicate that the thermocouple is broken or, disconnected from the Controller board, in which case the interface reads something greater than 1250°C.

The third safety shutoff shuts down the heating lamps if the outer chamber walls exceed 65°C. This would only happen if there was no water flow.

3. Cleaning Method

Weekly tool cleaning Procedure for RTP tool

1. Use Lint free cloth and IPA only for cleaning purpose.
2. Wipe thoroughly the top side of the instrument and attached Monitor and Keyboard by lint free cloth wet with IPA.
3. Always use hand gloves for cleaning/using the instrument.
4. You can use Nitrogen gun with slow flow rate for cleaning the restricted region by blowing the dust particles out with nitrogen gas (GN2) flow.
5. After cleaning, keep all the accessories and tools at proper place and keep the system region neat and clean.

4. Operation Theory (RTP)

The basic operational principal of RTP systems is radiation heat transfer. This is effectively achieved by lamp based heating system in which the process chamber is securely isolated to achieve optimum heating. One feature that distinguishes RTP systems from traditional diffusion furnaces is the existence of thermal in equilibrium between chamber walls, and wafers itself. It is this feature that allows “rapid” heating of wafers. Second distinction comes from temperature control devices used in both systems. These basic features of RTP systems are shown in the Figure schematically.

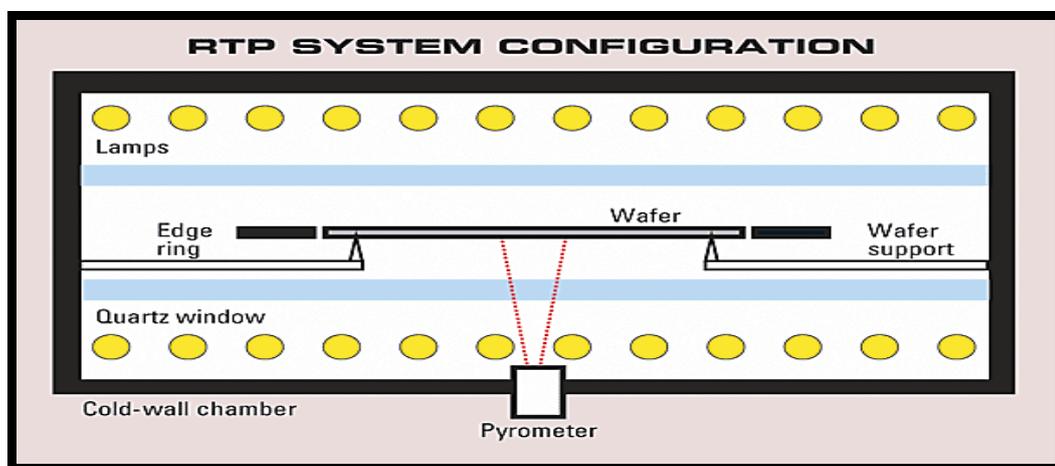


Fig. 4.1: Basic Features of RTP

This includes thermally isolated process chamber inside which cooling water lines are installed. Process chamber also contains gas inlet for the process and ambient gases used in a given process. Lamps are installed on top, bottom and sides of the chamber and also cooled by air or nitrogen based cooling. Inside the process chamber and close to the lamps, several quartz plates or tubes are installed to effectively isolate wafer from process chamber. Inside the quartz ware, quartz tray is installed which contains Silicon (Si) edge guard ring and quartz pins on which wafer resides. Silicon wafer stays on three to four quartz pins surrounded by Si edge guard ring to eliminate edge to centre temperature variation. Quartzware is cooled by CDA (Clean Dry Air cooling) or PN₂ (Pure Nitrogen based cooling). Pyrometer assembly is mounted at the bottom of the chamber and looks for the emitted radiation from backside of the wafer. Standard pyrometer consists of a Photo detector that translates optical radiation to electrical signal and in turn temperature measurement is obtained. The basic understanding of physics of heat transfer in RTP is to recognize that it consists of number of radiating bodies at different temperatures, each with its characteristic energy spectrum.

5. STANDARD OPERATING PROCEDURE (SOP)

5.1 Pre check before entering in the lab for RTP Process

Step: 1. Check if any other tools in Fab Lab are ON or not. If any other tool (PECVD, Edge isolation tool) is/are ON, then enquire from facility people if you can use RTP as some gases are on sharing basis.

Step: 2. Check if cooling water is ON [Set pressure should be 25 -30 PSI (~ 2 bar)].

Step: 3. Check if water supply to Pyrometer is ON [Set temperature should be 20 °C and stable].

Step: 4. Check if exhaust is ON (Ask facility people if not sure).

Step: 5. Check if CDA is available and ON (Ask facility people if not sure).

Step: 6. Check the process gases N₂ or Ar which you want to use is ON [Set pressure should be 20 psi]. [Gases, which are available for RTP, are Nitrogen, Oxygen and Argon].

Step: 7. Wait for 10 minutes to stabilize all the flow and setups.

Step: 8. Ensure that you have followed step 1 - 7 as mentioned in “Pre check before entering in the lab for RTP Process”.

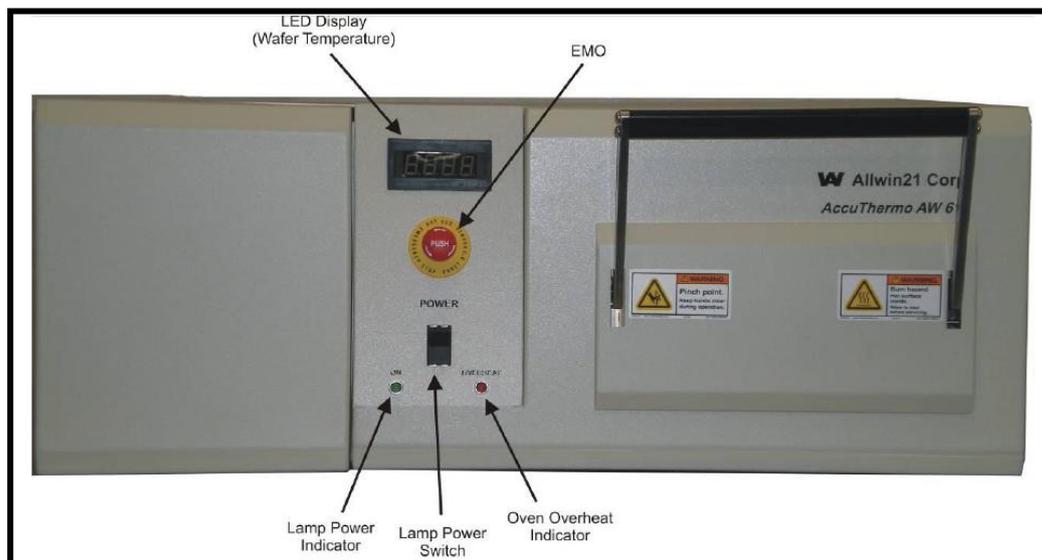


Fig 5.1: Front utilities and connection names.

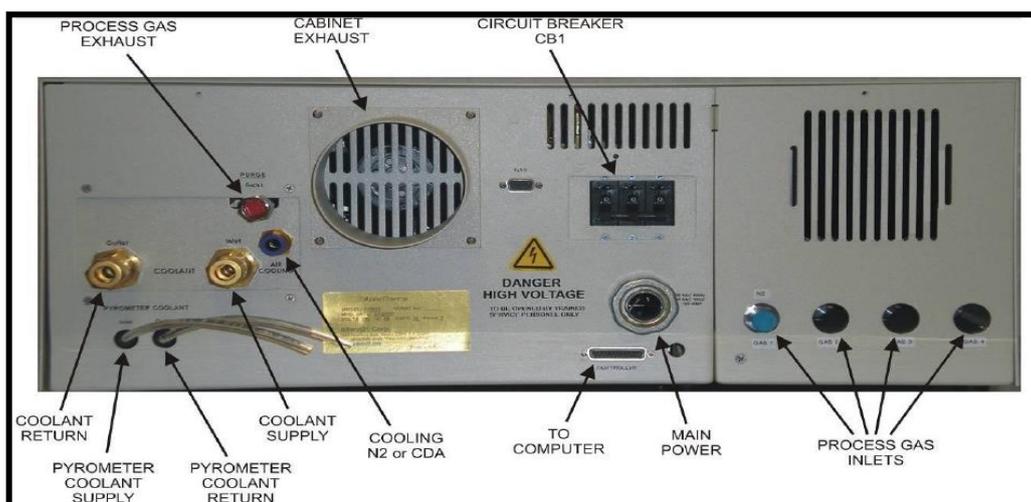


Fig 5.2: Back utilities and connection names.

5.2 System Power UP

Step: 9. Ensure that you have followed step 1 - 7 as mentioned in “Pre check before entering in the lab for RTP Process”.

Step: 10. Open the valve for CDA which is connected to regulators of MFC and Air cooling.

Step: 11. Crosscheck if CDA regulator for Pneumatics valve is set at 70 psi. [Consult Facility people] and the regulator is ON.

Step: 12. Crosscheck if CDA regulator for Air-cooling for system is set at 20 psi. [Consult Facility people] and the regulator is ON.

Step: 13. Ensure if the RTP system exhaust is Open [see fig 5.3].



Fig 5.3: Exhaust line



Fig 5.4: RTP mains

Step: 14. Switch ON the main supply for RTP system [see fig 5.4].

Step: 15. Switch ON the circuit breaker (CB1) available at backside of the system (see fig above).

- Step: 16.** Switch ON the lamp power switch available at the front panel of the system.
- Step: 17.** Check if LED display at front panel is showing Room Temperature (24-26 °C).
- Step: 18.** Switch ON the computer and LCD monitor for the system. [Sequence is important. Always start RTP system first and then computer].
- Step: 19.** You will see software control interface as below:

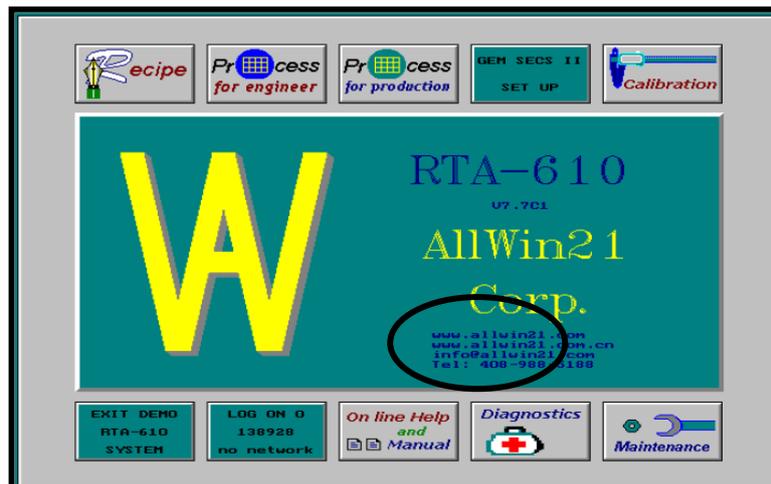
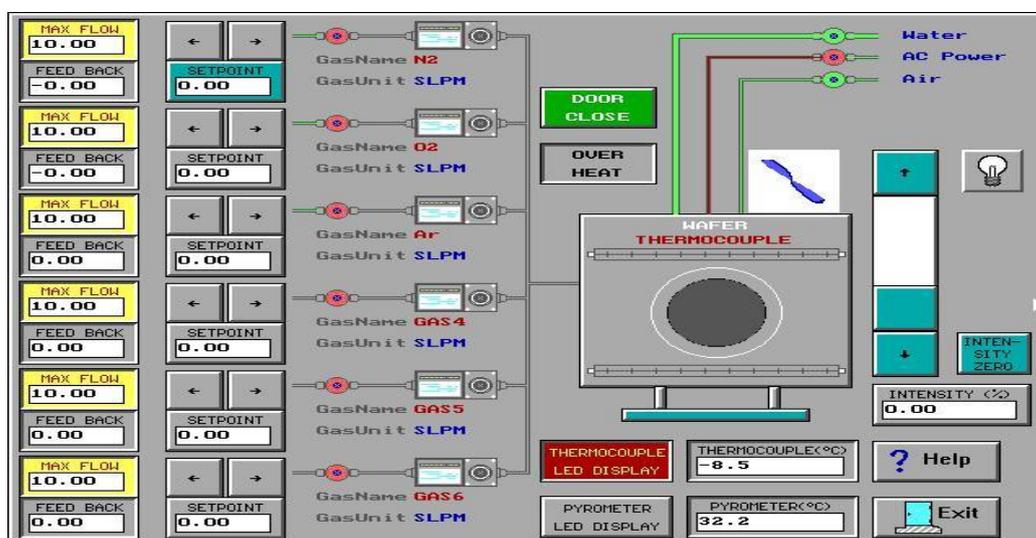


Fig 5.5: Software control interface.

- Step: 20.** In case if you see command window then type rtapro and then press enter. This will lead you to interface as above.
- Step: 21.** Ensure that there is no wafer/sample left inside by someone in the process chamber of RTP except the test wafer, which is for balancing the thermocouple bead for free movement of thermocouple without interfering the walls of the chamber.
- Step: 22.** Click on the **Diagnostics** at the main software control interface. You will see software interface as below. Make sure that the thermocouple (TC) sensor is selected and temperature display at software interface for TC is same as LED display temperature at front panel of RTP system.



Step: 23. Once you are at **Diagnostics** software interface, check for the following to ensure the working of all sensors:

- a. Click on the water valve icon. The water flow should stop.
- b. Click on it again to make the water flow.
- c. Click on the air valve icon. The air flow should stop.
- d. Click on it again to make the air flow.
- e. Open and close the door of the chamber. The indicator “Door Close” should change from green to grey when door is opened.
- f. Open the process gas valve [N₂ or Ar whichever is open or to be used] and set 3 to 5 SLPM of selected process gas flow in software interface to ensure tube purging. Observe that there is gas flow being displayed on the **Diagnostics** screen in flow feedback section. [The chamber door can be opened slightly (1 cm) during this test and again close it].
- g. Check if thermocouple is connected properly inside the chamber (the two wires of thermocouple should not touch anywhere except at end point). If yes then place a dummy wafer inside on the quartz tray such that the tip of the cantilever thermocouple touching the backside of the wafer. Close the chamber door after this check.
- h. Set the lamp **intensity** to 5% in the **Diagnostic** screen and ensure that “Thermocouple Led display” is selected in the software interface and then click on the lamp icon. Observe the rise in the thermocouple (TC) section in the software interface. It should increase if so then TC is working fine. Also observe that the displaying temperature is same as Led display temperature at the front panel of the RTP system. [**Note that this test should be done quickly in short duration so that temperature should not rise above 200 °C. Also there should be a dummy wafer inside to ensure the heat sink**] Once test is done, then click again on the lamp icon to stop the lamp. Also set the lamp **intensity** to back to 0 % in the **Diagnostic** screen.

Note: For high temp process (> 700 °C) on Si wafer, you need to remove the thermocouple arrangement from the chamber and in that case you should select “Pyrometer LED display” in the software interface to test the temperature rise with intensity. Also note that Pyrometer is not sensitive below 500 °C temperature.

Step: 24. Click on Exit icon to go to main menu.

If all the steps from **Step 1- 15** are OK, then the system is ready for Process. If you find any abnormality, contact the System Owner/technical person.

5.3 Process Recipe Making/Editing or Running

Step: 1. If you are sure that the system is ready for process after following the “System Power UP” steps 1 -15, then follow as below.

Step: 2. Go to main menu which looks as below:



Fig 5.6: Software control interface.

Step: 3. Click on “Process for Engineer” icon.

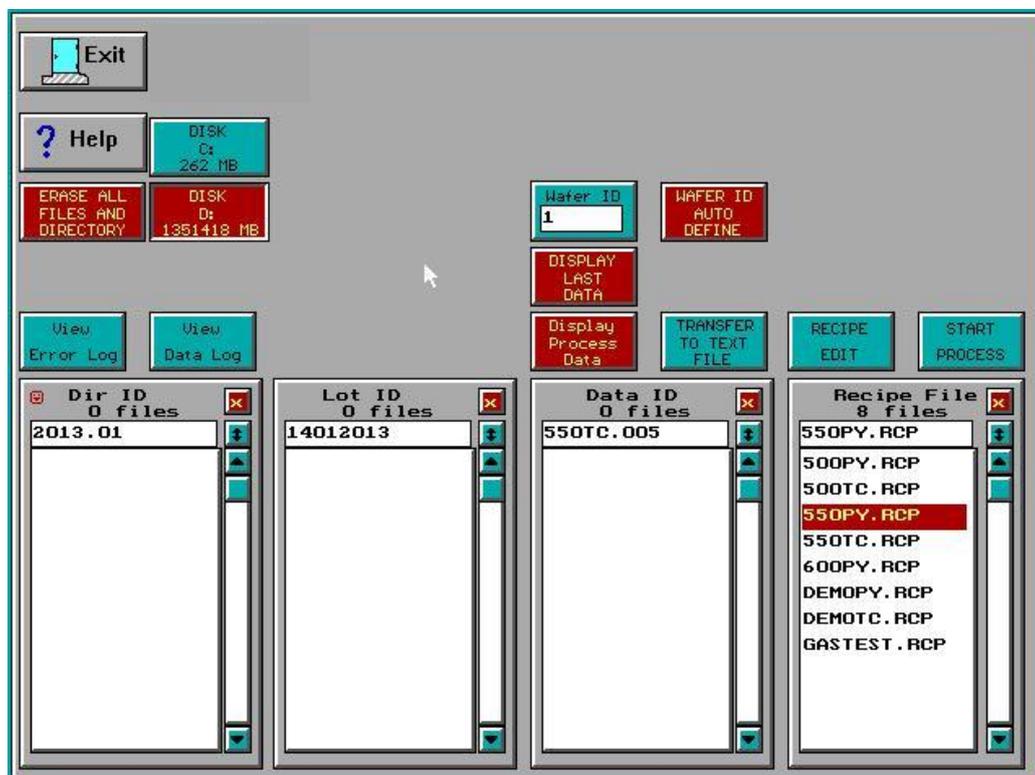


Fig 5.7: Process for engineer.

Step: 4. Now to create or modify recipe follow steps 5 -32. Creating a new recipe and editing an existing recipe are very similar. The differences between creating a new recipe and editing an existing recipe occur when the changes are saved. **Creating a new recipe also involves changing the Recipe Name field.**

Step: 5. Use the slider to the right of the list to display. Click on the Recipe to select it. Click on the Recipe Edit button to display the Recipe Editor for any pre-existing recipe to make new recipe. Check all the parameters are correct and as per wish for the process. For this, follow the following.

Step: 6. After selecting a pre-existing Recipe by click on the “Recipe edit” icon. You will be at an interface as below:

The figure displays two screenshots of the Recipe Editor interface, showing the process of editing a recipe. The interface includes various control fields and a table of process steps.

Top Screenshot (Recipe: 500TC):

- RECIPE NAME: 500TC
- EXT: RCP
- WAFER TYPE: WAFER
- Use sensor Offset LOCAL: -32.00
- PYRO Offset: 1.00
- TC Offset: 1.00
- SENSOR TYPE: THERMOCOUPLE
- Use Emissivity LOCAL: 77.04
- SENSITIVITY: 1.00
- Psum1 Average: 1.00
- Psum2 Average: 1.00
- DELAY: 1.50
- Gain: 1.00

No.	Step Temp Func	Time (sec)	Temp/Intrn (°C/%)	Steady Intrn Factor	Gas 1 N2 SLPM	Gas 2 O2 SLPM	Gas 3 Ar SLPM	Gas 4 GAS4 SLPM	Gas 5 GAS5 SLPM	Gas 6 GAS6 SLPM	Steady Intrn
1	Delay	45.0	0.0	1.00	10.0	0.0	0.0	0.0	10.0	0.0	0.0
2	Ramp	20.0	500.0	1.00	5.0	0.0	0.0	0.0	5.0	0.0	0.0
3	Steady	30.0	500.0	1.00	5.0	0.0	0.0	0.0	5.0	0.0	0.0
4	Delay	240.0	0.0	0.00	10.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Bottom Screenshot (Recipe: 550PY):

- RECIPE NAME: 550PY
- EXT: RCP
- WAFER TYPE: WAFER
- Use sensor Offset LOCAL: -20.00
- PYRO Offset: 1.00
- TC Offset: 1.00
- SENSOR TYPE: PYROMETER
- Use Emissivity LOCAL: 77.04
- SENSITIVITY: 1.00
- Psum1 Average: 1.00
- Psum2 Average: 1.00
- DELAY: 1.50
- Gain: 1.00

No.	Step Temp Func	Time (sec)	Temp/Intrn (°C/%)	Steady Intrn Factor	Gas 1 N2 SLPM	Gas 2 O2 SLPM	Gas 3 Ar SLPM	Gas 4 GAS4 SLPM	Gas 5 GAS5 SLPM	Gas 6 GAS6 SLPM	Steady Intrn
1	Delay	45.0	0.0	1.00	10.0	0.0	0.0	0.0	10.0	0.0	0.0
2	Intrn	15.0	15.0	0.00	5.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Ramp	20.0	550.0	1.00	5.0	0.0	0.0	0.0	5.0	0.0	0.0
4	Steady	30.0	550.0	1.00	5.0	0.0	0.0	0.0	5.0	0.0	0.0
5	Delay	240.0	0.0	0.00	10.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Finish	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Fig 5.8: Recipe edit.

(Note in the above figure when Thermocouple sensor is selected, there is no INTN step at no. 2 in edit section. So whenever use thermocouple, don't use INTN step. It may be used when you wish fast ramp up but not advisable here. But INTN step is must if pyrometer is to be used as main sensor.)

Step: 7. Edit it. (If a new Recipe is to be created, also change the Recipe Name field before saving.)

Step: 8. For editing the recipe parameters follow the following.

Step: 9. The editor is divided into two main sections. The top section (header) is where the user inputs information pertinent to the overall recipe. The lower section (data entry area) is for the process recipe data entry.

Step: 10. The Recipe Name can be edited. This should be done if a new recipe is to be created. Follow the structure for recipe ID as (Temp) (Sensor-TC/PY) e.g. **500TC** or **550PY** (note that the name should not exceed 5 digits). Also leave the EXT field as RCP. This is the filename extension and the AW-900 software expects it to be RCP for a recipe.

Step: 11. Wafer type wafer button on header of edit pages as figure above toggles between "wafer" and "susceptor". Default value is "wafer". For small samples, it may be required to use a susceptor to hold the wafer inside. Also note that it is necessary to use a different type of chamber calibration data specific for the susceptor. **When use susceptor, follow Appendix - I before you move to next Step: 12.**

Step: 12. Sensor type thermocouple button on header of edit pages as figure above is for the temperature measurement sensor and can be toggled between the TC, pyrometer. Choose appropriate sensor, which you are going to use. **(For Pyrometer use, the temperature should be > 600 °C and for TC the temperature should be < 700 °C unless specified.** Also when use TC, make sure that thermocouple is connected in the chamber and working fine).

Caution: Make sure the proper sensor is selected. A selected sensor that is not installed could give low temperature readings. This would make the temperature control increase the lamp intensity too much and may overheat and melt the wafer. The melted wafer could drip onto the quartz ware and break it.

Step: 13. Use pyro offset button on header of edit pages as figure below, to use of the "system" "local" recipe value (Pyro Offset) for the pyrometer temperature measurement-correcting offset. To determine required offset value, use data from processing which is done earlier on process temperature on TC sensor based process for above 500 °C. Then use offset value x if TC display temperature > Pyro display temperature and TC temp -PY

temp = x and if TC display temperature is < Pyro display temperature and PY temp -TC temp = x and use off set vale as (-) x.



Note: Never change the TC offset value. Its default value is 1.

Step: 14. Use emissivity button on header of edit pages as figure of screen as below, the pyrometer emissivity will use the “system” “local” recipe value (Emissivity). The value for the emissivity to be used with the pyrometer. A standard silicon wafer has an emissivity of 77.04.



Note: The software treats emissivity as a factor that offsets the pyrometer temperature reading. If the pyrometer temperature is not the same as the real processed temperature, then adjusting the emissivity offsets the pyrometer temperature reading (Don't change value without permission from technical person).

Step: 15. The five variables (Gain, Sensitivity, Delay, Psum1 Average and Psum2 Average) are for fine tuning the temperature control performance.

Step: 16. : The value for the coefficient of the gain in the STEADY period of the recipe. This makes the gain for a STEADY step different from a RAMP step. The gain value for STEADY is GAIN x SENSITIVITY. If the SENSITIVITY value is 1.0, there is no difference between the gain for a RAMP and a STEADY.

Step: 17. : This is the value for the transient period from RAMP to STEADY. Normally and default value is 1.0.

Step: 18. : The value for the gain of the temperature PID control for the process steps RAMP and STEADY. Normally and default value is 1.5.

Step: 19. : This checks the average intensity. If Psum1 is set larger than 10.0 and if the first steady-state step is out of range, then there will be an alarm. If Psum1 is set smaller than 10.0, then the range checking is disabled. To get some statistical data for the normal average intensity of Psum1, Psum1 should be set to 1.0 to disable the alarm.

Step: 20. : This checks the average intensity. If Psum2 is set larger than 10.0 and if the second steady-state step is out of range, then there will be an alarm. If Psum2 is

set smaller than 10.0, then the range checking is disabled. To get some statistical data for the normal average intensity of Psum2, Psum2 should be set to 1.0 to disable the alarm.

Step: 21.  : This button toggles between Yes and No. Yes means that all of the gases will be turned off when the process ends. No means the last gas settings will remain on after the process ends. Select Yes if at end, step of recipe is a delay step.

Step: 22.  : This button resets all bank factors to the default value of 1.0. [Don't edit this section]

Step: 23.  : SYSTEM (cyan) uses the default system zone factors that are defined in the Zone Control screen. LOCAL (red) use the zone factors that are defined in the Recipe Head screen. Recommended is Local.

Step: 24. In data entry Area:

Note: A typical recipe steps using TC as main sensor consist of **Delay→Ramp→Steady→Delay**
A typical recipe steps using PY as main sensor consist of **Delay→Intn→Ramp→Steady→Delay**
See image at step 6 above for some idea.

Here in data entry section:

- a. Up to 40 steps can be defined.

b.  : This is the Process Function, which describes the type of process function for that step. It can be RAMP, INTN, STEADY, DELAY, or FINISH.

c.  : During the Steady step, the controller increases and decreases the lamp intensity so the specified temperature can be maintained. It then maintains that value until the specified time spent in the step has elapsed.

d.  : The Ramp step instructs the controller to increase the temperature at a constant rate until the specified temperature has been reached. The rate is calculated by dividing the difference between the temperature specified in the step and the temperature specified in the previous step by the time specified in the step.

Note: The process controller **cannot** do two consecutive RAMP steps.

e.  : The controller keeps the lamp power at a constant intensity during an Intensity step. **It is normally used to warm up the wafer sufficiently for the pyrometer sensor, since the pyrometer is not reliable below a temperature of 450°C.** If an INTN step is followed by a RAMP or STEADY step and the set

point temperature has been achieved during the INTN step, then the temperature will be maintained at that set point.

f. : The Delay step instructs the controller to turn the lamps off while setting and maintaining the set point of the other controlled parameters (i.e. Gases), until the specified time spent in the step has elapsed.

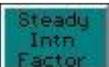
g. : Finish ends the recipe. This is the last step in the recipe. Once the process controller sees a "FINISH", it stops all processing.

h. : This is the amount of time, in seconds, to act on the current step.

Note: Extremely long, high temperature processes may damage the AccuThermo RTP system.

Step: 25. : This is the target temperature or intensity the AccuThermo RTP system strives for.

- If the step function is STEADY, then this is the set-point temperature that is to be maintained.
- If the step function is RAMP, then this is the ending temperature of the ramp.
- If the step function is INTN, then this is the percentage of the lamp power intensity. **[It should not be set more than 15 %]**
- If the step function is DELAY, then this field has no effect if this is a DELAY step. The lamps are turned off during this step.

Step: 26. : The Steady Intensity Factor is a coefficient used only during RAMP and STEADY steps. It is used at the beginning of the steps to correct the initial lamp power intensity. (See the section for fine-tuning the system in main manual to understand how to use this parameter effectively).

Step: 27.   : This is the value for the flow rate of N₂, O₂ and Ar for the system for process. Note that the value of total sum of set flow rate for process gas (either N₂/O₂/Ar or combination) in the edit section must be ≤ 5 SLPM, either use single or multiple gas. Be cautious when you use oxygen as it may explode at high temperature and high flow rate.



Step: 28. : This is a legacy parameter as is no longer used. It is now a global parameter and is in the System Setup screen as the Intrn Tolerance field. It is normally less than 20%. **[Don't change anything in this section].**

Step: 29. Validate the Recipe by clicking on the "Recipe validate" icon. If the recipe is invalid, an error message will appear. Once the error has been corrected, validate the recipe again. The five variables (Gain, Sensitivity, Delay, Psum1 Average and Psum2 Average) are for fine-tuning the temperature control performance.

Step: 30. Save the Recipe by clicking on "save" icon.

Step: 31. Exit the Recipe Editor by clicking on the Exit button or pressing ESC on the keyboard. If exiting the Recipe Editor before saving the recipe, a dialog box will appear asking if the recipe should be saved.

- a. Click Yes (or press Y on the keyboard) to save the recipe.
- b. Click No (or press N on the keyboard) to discard all changes since the last save.
- c. Click Cancel (or press ESC on the keyboard) to go back to the Recipe Editor and continue editing the recipe. It does not save any changes

➤ Some shortcut keys are listed here:

Keyboard Editing Keys and Meanings		
F2		Save recipe.
ESC		Exit the <i>Recipe Editor</i> .
Home		Go to the first column of the step.
End		Go to the last column of the step.
↑		Move up one line.
↓		Move down one line.
←		Move left one column.
→		Move right one column.
PgUp		Move up one page.
PgDn		Move down one page.
Ctrl + Home		Move to the top of the page yet stay in the same column.
Ctrl + End		Move to the bottom of the page yet stay in the same column.
Ctrl + PgUp		Go to the beginning of the recipe.
Ctrl + PgDn		Go to the end of the recipe.
Ctrl + Ins	Line Insert	Insert a step above the current step.
Ctrl + Del	Line Delete	Delete the current step. (click on the step number to select it).
Ctrl + F7	Line Copy	Copy the current line into a memory buffer. (click on the step number to select it).
Ctrl + F8	Line Paste	Insert a step above the current step and then Paste the step that was copied into the memory buffer into the inserted step.
F8		Show the recipe on a graph.
F10		Validate recipe.

While in the process function column (**Step Temp Func**), pressing the first letter of the function name is another way to select the function (i.e. S = STEADY, R = RAMP, I = IDLE, D = DELAY and F = FINISH).

Note: Never test or edit these sections without permission. like “Bank Factor Reset” button, “Use System bank factor” button, “Recipe Head” button, “Bank Control” button.

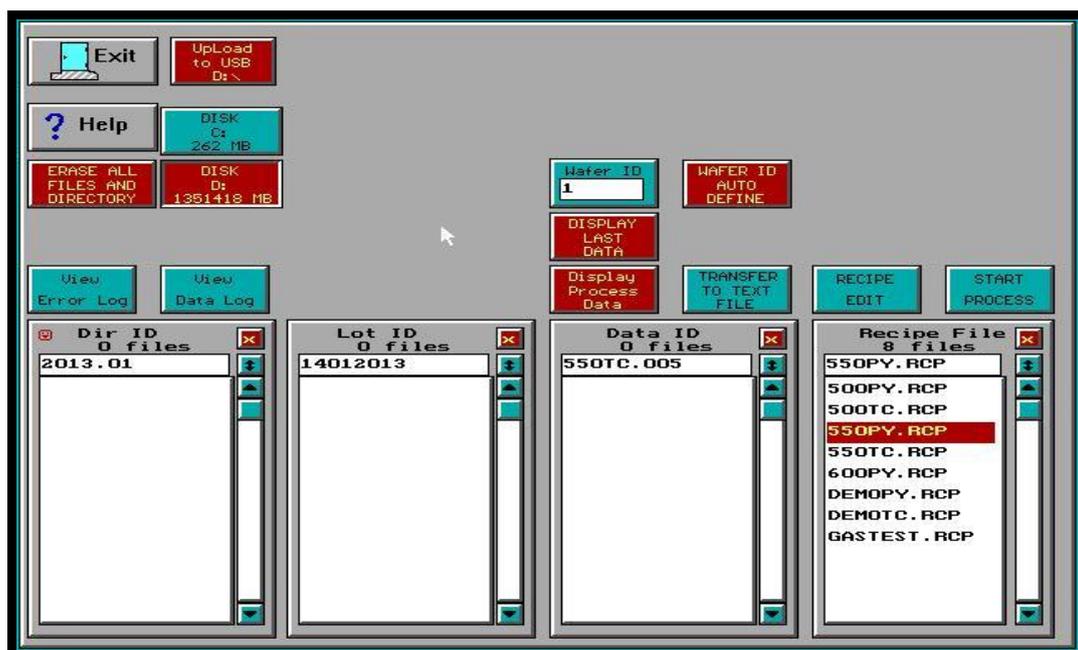


Fig 5.9: Recipe edit.

Step: 32. After exiting the “Recipe editor”, will be back at the “Process for Engineer”

Step: 33. After editing recipe, select where the Process Data will be stored: The process data is stored on the hard drive after the process ends. The place on the hard drive it will be stored needs to be specified. Check, it should be **Disk D** (display in red colour).

Step: 34. Select a “Dir ID” e.g. YYYY.MM and a “Lot ID” eg. DDMMYYYY from the list of Directory IDs and Lot IDs. The Data ID will be generated automatically as per Recipe ID after process.

Step: 35. Run the Recipe: To run the selected Recipe, click on the Start Process button. This will display the Process Monitor screen (see figure below). When this screen is displayed, the process will begin processing the wafer inside the heating chamber according to the selected Recipe. (Note: If you experience any problem/feel something wrong in temperature sensor, immediately press **ESC** button / use Emergency switch (EMO) at RTP front panel).

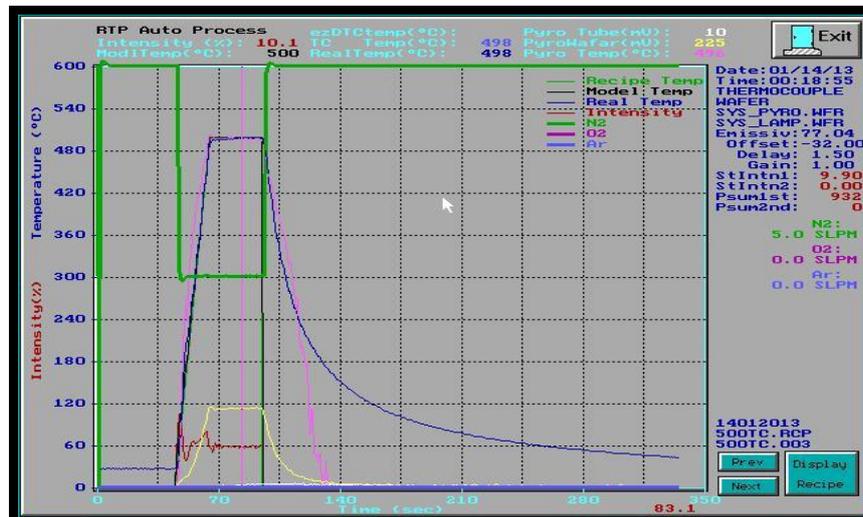


Fig 5.10: Process graph.

Step: 36. At the end of the process, “Process Over” will be printed over the Process Monitor screen and be blinking in different colours. Press any key to save the process data. This will also exit back to the Process for screen.

Step: 37. After the process is over, wait for some time until the LED display at RTP front panel shows < 50 °C.

Step: 38. Stop process: A process may be interrupted and stopped by pressing the **ESC** key on the keyboard. This will turn off the lamps. Use this if any sudden change in temperature in LED display/screen display you observe during process or interrupt is required.

Step: 39. To review the process data: To view the last run process data graphically, click on the Display Last Data button. This will display the process data on a screen very similar to the Process Monitor screen.

Step: 40. To view process data from previous runs, select the process data to be viewed from the “Data ID” column, and then click on the Display Process Data button.

➤ Brief about different buttons in “Process for Engineer screen”:

Wafer No.	The number of wafers that have been processed for the selected recipe. This will be used for the wafer ID for the next wafer that will be processed with the selected recipe.
Wafer Number	Automatically increment the “Wafer No.” (process wafer number) for the selected recipe, or the user has to manually change the wafer number. Auto Automatically increment the process wafer number Manual User manually changes the wafer number
Display Last Data	View the process data graphically of the last wafer that was processed on the <i>Process Plotting screen</i> .
RTP_PROC Data Display	Display the selected process data graphically on the <i>Process Plotting screen</i> .
Recipe Edit	Loads the selected recipe file into the <i>Recipe Editor</i> to allow the engineer to modify the recipe.
Start Process	Start processing the wafer that is in the process chamber, using the recipe that is selected.
Dir ID	This groups certain types of lots together.
Lot ID	The user defined lot ID. All process data pertaining to this lot should be kept under here.
Data ID	The process data from each wafer is stored here. The operator can review the process of each of the process data.
Recipe File	The list of recipes which are available to be used to process wafers in the process chamber.

5.4 System Power Down

Note: Be alert at all times during power-up. If at any time during these procedures the lamps turn on at high intensity unexpectedly, immediately turn the power switch OFF. The system can heat up a wafer very rapidly until it melts. This can cause extensive damage to the AccuThermo RTP system.

Do Not Power-Down the AccuThermo RTP system unless it has been more than 10 minutes since the last use of the unit. Let the system cool down with cooling water and cooling air.

Step: 1. Turn off the gas valves for process gases in use.

Step: 2. Turn off the oven unit LAMP POWER switch (on the oven unit control panel.)

Step: 3. Turn off the facilities breaker/safety switch (CB1) at the back of RTP system.

Step: 4. Turn off the facilities breaker switch main.

Step: 5. Turn off the CDA valve to regulators of MFC and Air cooling.

Step: 6. Turn off the quartz isolation tube cooling CDA/nitrogen [Ask facility person].

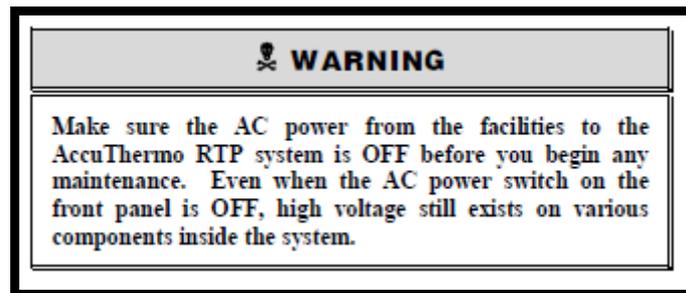
Step: 7. Turn off the pyrometer chiller water dedicated for RTP system. [Ask facility person].

Step: 8. Turn off the oven cooling chiller water dedicated for RTP system [Ask facility person].

Step: 9. Turn off the CPU and Computer monitor.

6. EQUIPMENT MAINTENANCE (FOR SO ONLY)

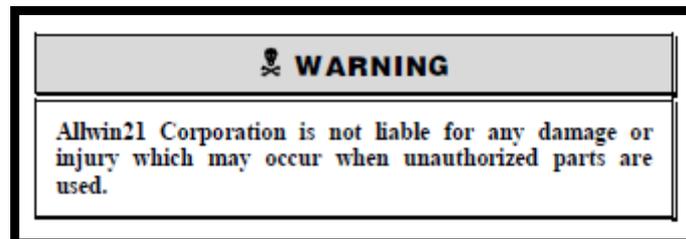
The AccuThermo RTP system needs to be powered down before performing any maintenance. Turn off the main power at the circuit breaker. Use proper lock-out/tag-out procedures.



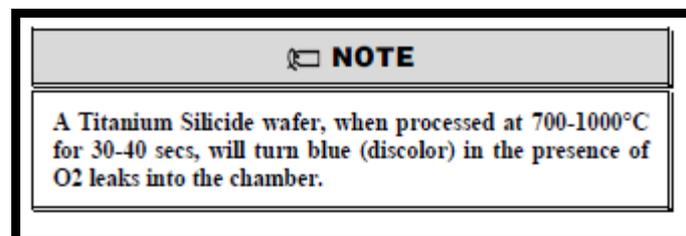
6.1 MAINTENANCE

During the maintenance operation, observe the following precautions:

- Do not use replacement parts not provided or recommended by Allwin21 Corporation.



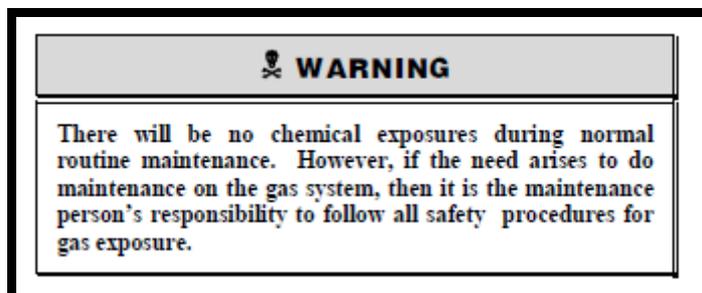
- Disconnect power to the system at the main disconnect box before performing any maintenance activity that requires the removal of access covers. Use proper lock-out/tag-out procedures.
- Whenever the quartz isolation tube is changed, perform a gas leak test, using a Titanium Silicide (TiSi) wafer, on the process chamber. Replace the O-rings on the isolation tube nipple each time the tube is removed.



6.2 PREVENTATIVE MAINTENANCE SCHEDULE

Preventive maintenance checks should be performed on a weekly and quarterly basis to ensure consistent operation of the AccuThermo RTP system. Power down and switch off the

power to the AccuThermo RTP system at the wall breaker and use proper lock-out/tag-out procedures whenever you remove the cover.



6.3 QUARTERLY MAINTENANCE

Oven Inspect for frayed or damaged wiring to lamps. Check O-Rings for burning or damage.

Interlocks Check water interlock by turning off water supply to the system and trying to increase the intensity to the lamps from the *Diagnostics* screen. (If the chamber wall is below 23°C, the lamps will still come on because of the over cooling sensor on the bottom of the chamber. Refer to the chassis wiring diagram). Check door interlock by opening door and trying to increase the lamp intensity from the *Diagnostics* screen. The Interlocks should prevent the lamps from turning on.

Quartz Inspect wafer tray and quartz isolation tube for signs of cracking, chipping, or other unusual wear. If GaAs wafers are processed frequently, clean the quartz ware often according to the instructions in the Quartzware section of this manual.

Leakage Perform a gas leak test to ensure the quartz tube is hermetically sealed. See Section Gas Leak Check Failure.

Lamps Visually inspect lamp sockets for cracks or discoloration.

Water Inspect for water leaks and bad hoses. Check water flow against last quarterly flow reading. If the flow is lower, change the filter. If this does not change the flow, check lines for clogging by checking differential pressure across the oven, as recommended in the installation section of this manual.

EQUIPMENT MAINTENANCE WORKSHEET (FOR SO's ONLY)

Sr. NO	Date	People involved	Action	Remarks

EQUIPMENT MAINTENANCE WORKSHEET (FOR SO's ONLY)

Sr. NO	Date	People involved	Action	Remarks

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