RAPID THERMAL PROCESSING

RTP - 600S SOP

June 2013

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WARNING: This equipment generates high heat and should be treated as an oven.

NOTE 1: Due to quartz contamination do not handle samples with metal tweezers. Teflon of PEEK tipped tweezers are preferred.

NOTE 2: Wear clean white nitrile gloves when handling and placing materials inside the oven. This includes your sample, the quartz tray, thermocouple components or susceptor trays.

WARNING: Do not exceed a steady state temperature greater than 1250°C. Melting the substrate will destroy the quartz tray and chamber.

WARNING: Do not exceed a combined Gas Flow of 30 SLPM (standard liters per minute) or 30,000 sccm. The quartz may break due to overpressure.

System Start Up & Processing

Step 1: Inside the chase behind the RTP open the following:

- **a.** Open both C.R. Water Valves (return & supply). The handles of the valves will be in line with the water line.
- **b.** Open the compressed air valve going to the RTP. The handle of the valve will be in line with the air line.
- **c.** Open the (3) gas lines labeled Argon, Oxygen and Nitrogen going to the RTP.

Step 2: On the front panel of the RTP, Figure 1, turn the key switch to the right.

Figure 1. Front panel of the RTP

Step 3: Press the **"EMO RESET"** button. Once the computer boots up, the system Main Menu should appear on the monitor screen. If it does not, check to make sure the monitor is switched **ON**.

Step 4: Press the **"POWER ON"** button. The RTP600-S system is now ready for operation.

Step 5: Lift the lock handle and gently pull open the Sample Tray to reveal the quartz chamber.

Step 6: Temperature Sensing Device Selection & Installation.

Based upon the type of processing temperature, use either the thermocouple (TC), susceptor (SUS) or pyrometer (PY) from table 1.

	Below 800°C	Below 950°C	Above 950°C
Thermocouple	X		
Susceptor	X	X	
Pyrometer			X

Table 1. RTP temperature sensing device based upon temperature processing level

If processing above 950°C, gently place your sample on the (3) quartz prongs and use the pyrometer for temperature sensing.

Thermocouple Installation

If a TC is to be used, inspect the bare wire TC for damage and replace if necessary, plug the TC in center of the inside section of the chamber door.

NOTE: There is a special procedure for replacing the TC plug so that a dissimilar metal contact does not affect TC performance. See the manual (Section 4.2.4, p. 64-65) or seek qualified personnel for help.

If a bare wire TC is to be used, make sure the bare wire TC comes into contact with the bottom of the supporting wafer tray, Figure 2.

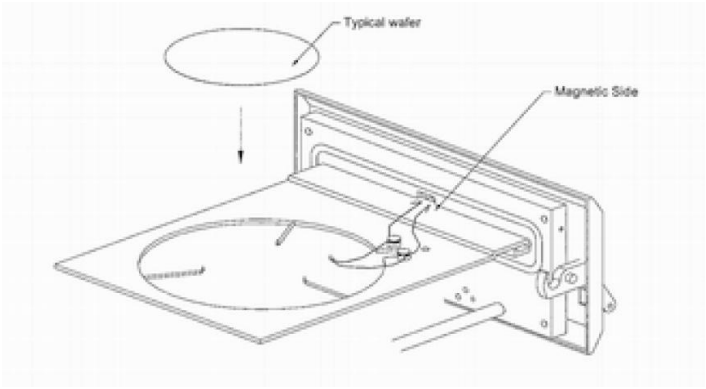

Figure 2. Installation and placement of the thermocouple and supporting tray

Thermocouple & Susceptor Installation

If a Susceptor Inconel TC tray is to be used, place the Susceptor Inconel TC within the chamber according to Figure 3 after removing any other installed TC.

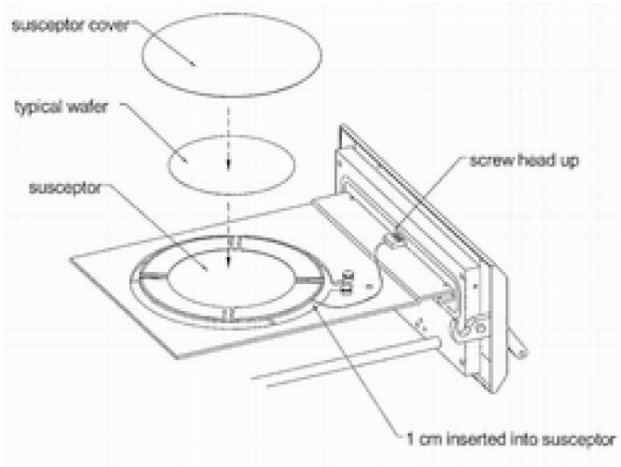

Figure 3. Suseptor installation and sample placement.

STEP 7: After gently placing your sample in the chamber push the Sample Tray back into the RTP and push down on the handle to lock the door.

STEP 8: From the main menu of the RTP computer, access the selection of a temperature monitoring device, either TC or pyrometer, from the Recipe Editor Screen (**F3**) or the Systems Diagnostics Screen (**F9**).

If using a TC (from the above temperature restrictions) use the following sub-procedure to ensure the TC is properly installed and functioning.

1. From the Main Menu go to the System Diagnostics screen (F9).

2. Ensure that the TC Assembly is installed correctly (See Section 4.2.4 for Drawings Showing Installed TC Assemblies).

3. Enable the lamps, and increase the lamp intensity to 15%.

4. Observe the temperature feedback of the thermocouple display.

5. Upon successful monitoring of temperature feedback the system is ready for TC controlled processing.

STEP 9: From the Main Menu select the **RECIPE EDITOR** (**F3**). Use an existing program or copy a program to edit and save for this specific process. For annealing silicon at 1000°C, Ramp up and Ramp sections should have durations of at least 20 seconds per ramp. Hold

times should be approximately 30 seconds with an idle time of 10 seconds, followed by a **STOP**.

STEP 10: In order to Save a program, use an (**8**) letter name that is descriptive of the process beginning with a **"T"** for thermocouple control or a **"P"** for pyrometer control.

STEP 11: Temperature for each step of the process (Idle, Ramp, Hold, and Stop) are controlled by Factors 1 through 7 (Factor 8 is not used). Factors 1 through 6 may have values in a range from 0.01 to 1 and Factor 7 may have values from 1 to 20. Each factor determines how closely the temperature follows the intended recipe. Definitions of each factor are located in the appendix.

STEP 12: After the recipe has been edited it must be validated (**F10**) and saved. Validation ensures that the RTP can carry out the proposed process. If errors occur, edit the program and validate again until errors do not occur.

STEP 13: Return to the main menu by hitting **<ESC>**. Select the appropriate Run Process Directory (**F4:** Thermocouple Control) or (**F5:** Pyrometer Control). Select the intended program using the arrow keys. Press **<ENTER>** to begin processing. If you wish to abort the process at any time, press **<ESC>** to return to the Run Process Directory.

The Door Unlock LED will illuminate and the door will remain locked during processing. When the process has finished, the words **"PROCESS OVER"** will appear on the screen.

STEP 14: Lift the lock handle and gently pull open the Sample Tray to retrieve your sample. Return the quart tray back to the chamber and push down the lock handle.

System Shut Down

STEP 1: If using the thermocouple or susceptor remove the items and store them in the accessory box below the RTP.

STEP 2: Quit the RTP600-S program by typing "**Q**" (Quit) from the Main Menu.

STEP 3: Press the **"POWER OFF"** button.

STEP 4: Press the **"EMO"** button.

STEP 5: Return the key switch to the vertical position.

STEP 6: Close all gases and water lines to the RTP.

a. Close both C.R. Water Valves (return & supply). The handles of the valves will be perpendicular with the water line.
b. Close the compressed air valve going to the RTP. The handle of the valve will be perpendicular with the air line.
c. Close the (3) gas lines labeled Argon, Oxygen and Nitrogen going to the RTP.

APPENDIX

The maximum time allowable is controlled by software, where time is decreased as the temperature increases, Table 2.

Temperature (°C)	Maximum Time (sec)
1250	120
1200	150
1150	200
1100	300
1050	327
1000	360
950	400
900	450
850	514
800	600
750	720
700	900
650	1200
600	1800
550	2592
500	3200
450	3600
400	4050
350	5280
300	7200
250	9999 (max)

Table 2. Maximum Time at Temperature

Definition of Process Steps

RAMP increases the temperature at a constant rate until the desired temperature has been reached. For best results the gas flow during Ramp is set to the same specified value as the Hold step. The process controller cannot do two consecutive Ramp steps. For multiple ramp recipes, a critical ramp must be chosen for optimization.

HOLD increases or decreases the controlled parameter as fast as possible until the desired value has been reached, and then maintains that value until the step time has elapsed.

IDLE sets the lamps at **"OFF"** while maintaining the gas flow at the specified flow rate for this step.

STOP ends the entire recipe. This is the last step in the recipe once the process controller sees a Stop. This stops all further processing.

Factor Definitions

FACTOR 1: Factor 1 affects steady state, or Hold step, temperature control. Higher values result in faster response. However, oscillation can occur with high values.

FACTOR 2: Factor 2 strongly influences the transition from Ramp to Hold. It determines the duration of the transition. Higher values can cause undershoot at the beginning of Hold step, while lower values can result in overshoot.

FACTOR 3: Factor 3 also strongly influences the transition from Ramp to Hold. It is a multiplier of lamp intensity going from **RAMP** to **HOLD**. Low values can cause undershoot at the beginning of Hold step, while high values can result in overshoot.

FACTOR 4: Factor 4 affects response in Ramp steps. Low values can cause undershoot, while high values can result in instability, oscillation and high noise.

FACTOR 5: Factor 5 is used in pyrometer control during initial ramp up. It determines the temperature at which the open-loop linear intensity increase ends and the closed-loop control starts. The optimal value will ensure that closed-loop control starts at or above a temperature where pyrometer begin to respond to temperature change.

FACTOR 6: Factor 6 controls the rate of increase in lamp intensity during the initial stage of the temperature ramp up. Higher values result in faster rate. An optimal value will lead to a smooth start of closed-loop control in the ramp up.

FACTOR 7: Factor 7 is the lamp intensity during pre-warm-up prior to ramp step for susceptor recipes **ONLY**. **WARMUPINTN:** lamp intensity percentage during pre-warm step prior to ramp up. This Lamp intensity will run for 10 seconds. You will note that this intensity/time step is **NOT** represented in the recipe or on the real-time process event screen.