RAPID THERMAL PROCESSING

RTP - 600S SOP

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NOTE:

- All substrates must undergo an RCA clean before being placed in the RTP. ABSOLUTELY no metals or contaminants are allowed in the processing chamber of the RTP.
- Due to quartz contamination do not handle samples with metal tweezers. Teflon or PEEK tipped tweezers are preferred.
- 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:

- This equipment generates high heat and should be treated as an oven.
- Do not exceed a steady state temperature greater than 1250°C. Melting the substrate will destroy the quartz tray and chamber.
- Do not exceed a combined gas flow over 30 SLPM (standard liters per minute). This may break the quartz due to overpressure.

System Start Up & Processing

1. Log in to FOM.
2. Inside the chase behind the RTP:
   a. Turn ON the disconnect power for RTP.
   b. OPEN both CR Water Valves (return & supply). The handles of the valves will be in line with the water line when it is open.
   c. OPEN the compressed air valve going to the RTP. The handle of the valve will be in line with the air line when it is open.
   d. OPEN the (3) gas lines labeled Argon, Nitrogen and Oxygen (optional) going to the RTP.
   e. CLOSE the blue valve on the back of the RTA to shut off the N_2.
3. On the front panel of the RTP, Figure 1, turn the key switch to the right.

Figure 1. Front panel of the RTP.

4. Press the **EMO RESET** button on the front of the system. Once the computer boots up the system's main menu should appear on the monitor screen.
5. Press the **POWER ON** button and wait for 30 seconds. The system is now ready for operation.
6. Lift the process tray handle upwards and gently pull open the tray to reveal the quartz chamber.

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 (TC) Installation

1. If a TC is to be used, inspect the bare wire TC for damage and replace if necessary. Plug the TC in the center of the inside of the chamber door.
2. Make sure the TC comes into contact with the bottom of the supporting wafer tray, Figure 2.

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.

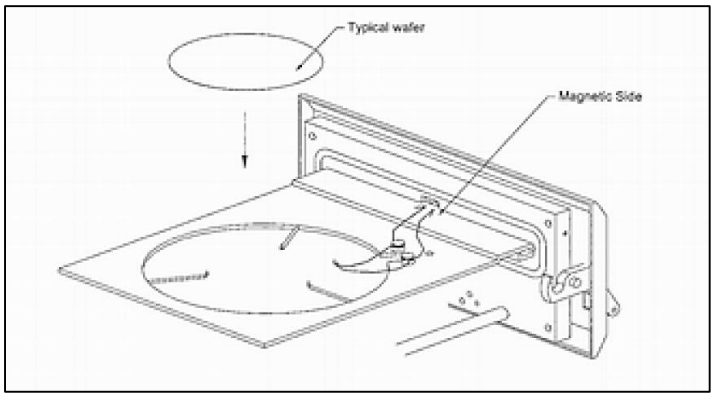

Figure 2. Installation and placement of the thermocouple and supporting tray.

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

4. Ensure that the TC Assembly is installed correctly (See Section 4.2.4 for Drawings Showing Installed TC Assemblies).
5. Enable the lamps, and increase the lamp intensity to 15%.
6. Observe the temperature feedback of the thermocouple display. If the temperature feedback data, the system is functional then the system is ready for processing.
7. After placing your sample gently in the chamber push the sample tray back into the RTP and push down on the handle to lock the door.
8. From the main menu of the RTP computer access the selection of a temperature monitoring device and select TC from the Recipe Editor Screen (F3) or the Systems Diagnostics Screen (F9).

Thermocouple & Susceptor Installation

If a Susceptor Inconel TC tray is to be used, place it within the chamber according to Figure 3.

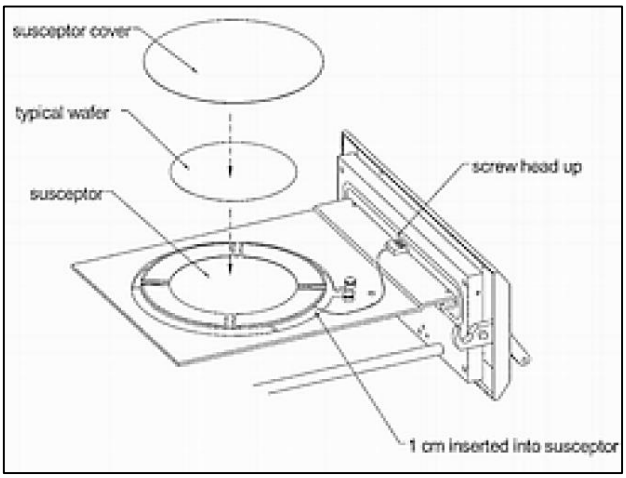

Figure 3. Susceptor installation and sample placement.

After placing your sample gently in the chamber push the sample tray back into the RTP and push down on the handle to lock the door.

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).

Operation Procedure

1. From the Main Menu select the RECIPE EDITOR (F3). Select an existing program or copy a program to edit and save for your specific process.

NOTE: For annealing silicon at 1000°C ramp up and ramp down 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 STOP.

2. In order to Save a program, use an eight letter name that is descriptive of the process beginning with a T for thermocouple control or P for pyrometer control.
3. Temperatures 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.
4. After the recipe has been edited it must be validated (F10) and saved (F2). Validation ensures that the RTP can carry out the proposed process. If errors occur, edit the program and validate the program again until errors do not occur.
5. 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 PROCESS OVER will appear on the screen.

6. Lift the lock handle and gently pull open the sample tray to retrieve your sample. Return the quartz tray back to the chamber and push down the lock handle.

System Shut Down

1. If using the thermocouple or susceptor remove the items and store them in the accessory box below the RTP.
2. Quit the RTP600-S program by typing Q from the Main Menu.
3. Press the POWER OFF button.
4. Press the EMO button.
5. Return the key switch to the vertical position.
6. Close all gases and water lines to the RTP in the chase.

   a. OPEN the blue valve on the back of the RTA.
   b. CLOSE both CR Water Valves (return & supply). The handles of the valves will be perpendicular with the water line.
   c. CLOSE the compressed air valve going to the RTP. The handle of the valve will be perpendicular with the air line.
   d. 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 turns off the heat lamps while maintaining gas flow at the specified flow rate for this step.

STOP ends the entire recipe and is the last step in the recipe.

Factor Definitions

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

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

FACTOR 5 is used in pyrometer control during initial ramp up. It determines the temperature when the open-loop linear intensity increase ends and the closed-loop control starts. The optimal value will ensure that the closed-loop control starts at or above a temperature when the pyrometer begins 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.