

MODEL MILA-3000
MINI-LAMP ANNEALING SYSTEM
INSTRUCTION MANUAL

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INTRODUCTION

Read this manual carefully before use and operate the system correctly.

WARRANTY

The MILA-3000 is warranted free from defects for a period of twelve (12) months from the date of delivery.

If any trouble imputable to defects in material or workmanship should occur during normal operation within this warranty period, SINKU-RIKO will correct it free of charge either by repair or replacement of defective parts.

Troubles imputable to the following are not covered by this warranty.

1. Operation not in conformity with the instructions in this manual
2. Operation under special conditions not mentioned in this manual
3. Repair or modification of the equipment not authorized by SINKU-RIKO

This warranty is limited to repair or replacement of defective parts of the MILA-3000 and does not cover secondary or sequential damage or loss caused by the trouble of the MILA-3000.

COMPLIANCE WITH EXPORT REGULATIONS

If this system is to be exported to outside Japan, the exporter shall take necessary procedures for export permit by the Japanese Government according to the Foreign Exchange and Foreign Trade Control Laws.

GENERAL PRECAUTIONS

Carefully read this manual and fully understand and comply with the instructions on installation, operation, inspection and maintenance and safety cautions, and operate the system correctly.

After reading the manual, keep it at your hand for immediate reference.

Always operate the system within the specifications given in this manual.

Also conduct inspection and maintenance correctly to prevent troubles.

SINKU-RIKO does not assume any responsibility for troubles caused by operation not given in this manual, handling, use of replacement parts other than genuine parts or unauthorized modification of the system.

If you come up with any question about the contents of this manual, please contact SINKU-RIKO or its representative.

The contents of this manual are subject to change without notice for future improvement.

In case of trouble or failure of the system, contact SINKU-RIKO or its local representative with the following information.

i Model name, type and serial No. of your equipment, trouble symptom (detailed information including the condition before and after trouble)

No part of this manual may be reproduced without consent by SINKU-RIKO in writing.

SAFETY CAUTIONS

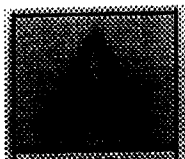
Incorrect operation of the system may cause troubles such as ignition, electric shock, etc. Read this manual carefully before starting installation, operation, inspection or maintenance and operate it correctly. Do not try to operate it before you are familiar with the equipment and safety cautions.

Warning and caution denotations are used throughout this manual to call operator's attention to safety.

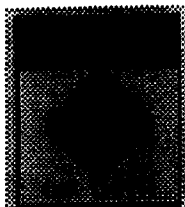
WARNINGS AND CAUTIONS

- WARNING:** Failure to comply with this involves the possibility of death or serious personal injury.
- CAUTION:** Failure to comply with this involves the possibility of personal injury or damage to equipment.
- Serious personal injury:** Injury such as loss of eyesight, injury, burn, electric shock, fracture, intoxication, etc., which causes sequella and injury that requires hospitalization or going to hospital for treatment for a long period.
- Injury:** Injury, burn, electric shock, etc., which do not require hospitalization or going to hospital for treatment.
- Physical damage:** Damage to property and/or equipment.

WARNING AND CAUTION DENOTATIONS

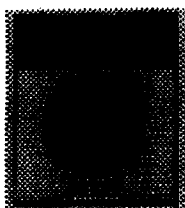


Be sure to read this manual before operation.



WARNING Beware of electric shock.

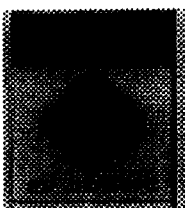
High voltage is present in the cover. Turn OFF the main power before access.



WARNING Ground

You may receive an electric shock.

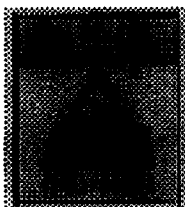
Be sure to ground (Class 3: ground resistance less than 100 ohms)



WARNING Beware of burn.

You may get burned. Do not touch it.

Keep your hand and face away from the exhaust port and gas outlet.



CAUTION Beware of burn.

The surface is very hot. Contact with it for an extended time can cause burn. Do not touch it during heating and immediately after heating.



The currently set thermocouple is
K thermocouple.

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* Paragraphs marked with * are for the P (program) type only.

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1. GENERAL DESCRIPTION

The MILA-3000 mini-lamp annealing system uses an infrared lamp with high density and high output as a heating element and permits rapid clean heating and cooling of a 20mm × 20mm sample by reflection convergence, which is an outstanding feature of the infrared gold image furnace, by simple operation and at controlled temperatures in a variety of atmospheres.

Also a glass substrate, which cannot be heated efficiently by the conventional infrared heating method, can now be heated with high efficiency by use of the far-infrared lamp.

1.1 Ordering information

MILA-3000-1-2

1 P = program operation type (temperature controller)

M = manual operation type (temperature indicator + potentiometer)

2 N = near-infrared lamp (high temperature type)

F = far-infrared lamp (uniform heating type)

1.2 Specifications

| | | |
|---|--|--|
| Type | Near-infrared lamp (N) high temperature type | Far-infrared lamp (F) uniform heating type |
| Temperature range | Room temperature to 1200°C (max.) | Room temperature to 800°C (max.) |
| Max. heating rate | 50°C/sec (50°C to 1200°C) in vacuum | 4°C/sec (50°C to 800°C) in vacuum |
| Temperature uniformity | ± 2°C ($\Delta T = 4^\circ C$) at 1200°C in vacuum | ± 1.8°C ($\Delta T = 3.6^\circ C$) at 500°C in vacuum |
| Heating atmosphere | In air, vacuum and inert gas | In air, vacuum and inert gas |
| Sample size | Maximum 20W × 20L × 20T (mm) | Maximum 20W × 20L × 20T (mm) |
| Temperature control sensor | Compatible with JIS thermocouple K fixed | Compatible with JIS thermocouple K fixed |
| Lamp rating | 1 kW-4-100V/pc | 250 W-4-100V/pc |
| <p>* The heating rate and temperature uniformity above are the measured values of a 0.5mm thick × 20mm deep × 20mm wide nickel plate. * Subject to change depending on material and size.</p> | | |
| Temperature program specifications | (for the program operation type only) | |
| Program mode | Temperature vs. time setting 99 steps/pattern No. of patterns: Maximum 99 Cyclic, hold, advance and other functions PID + fuzzy control, auto tuning RS-232C communication function (front panel), auto/manual available. | |

| Utility | Model | Model |
|---|--|---|
| Utility requirements | | |
| Power | 200 VAC, single phase, 4 kW | 200 VAC, single phase, 1 kW |
| Cooling water | City water, pressure 3 kg/cm ² 4 l/min | City water, pressure 3 kg/cm ² 2 l/min |
| Gas inlet port | 1/4" Swagelok joint | 1/4" Swagelok joint |
| Gas discharge port | 1/4" Swagelok joint | 1/4" Swagelok joint |
| Pumping port | NW-16 | NW-16 |
| Outside dimensions | 360W × 179H × 307D (excluding protrusion) | 360W × 179H × 307D (excluding protrusion) |
| Weight | Approx. 15 kg | Approx. 15 kg |
| Standard safety features | Thermocouple burnout, overtemperature setting, furnace body temperature sensor | |
| * Thermocouple burnout and overtemperature setting are only for the program operation type. | | |

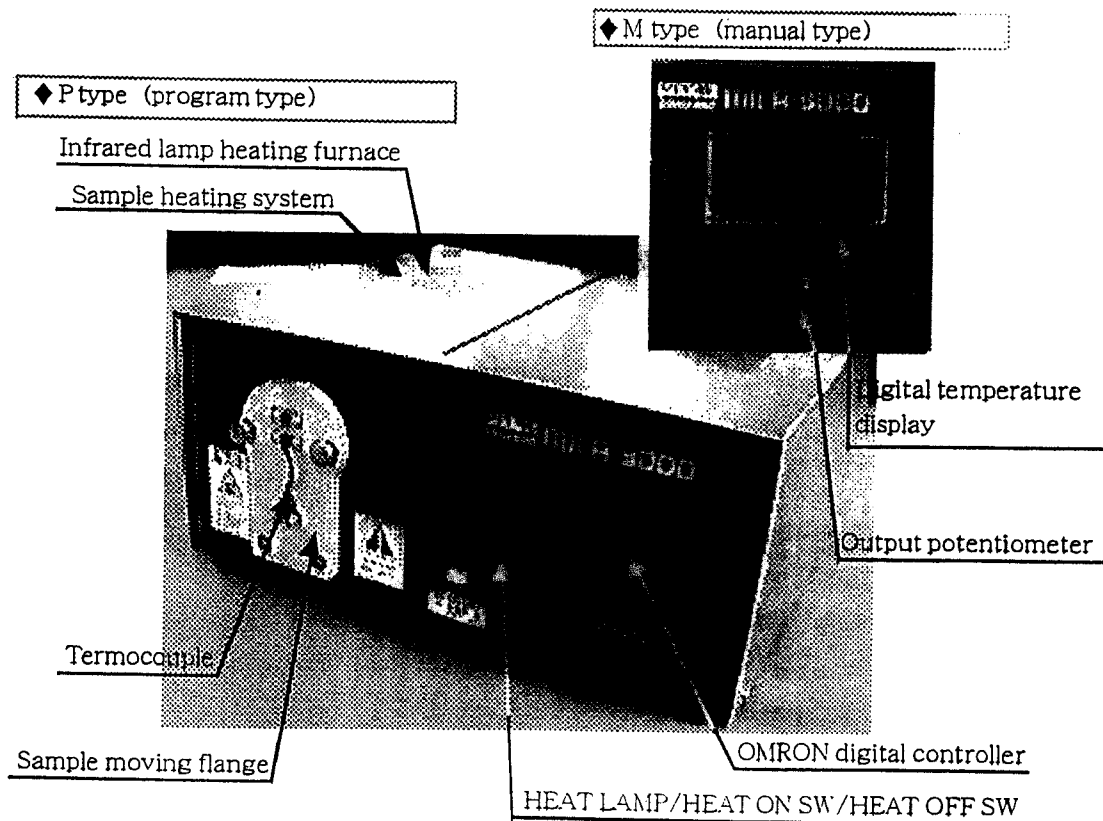
1.3 Application

- ï Rapid thermal process (RTP) for silicon wafer
- ï Thin ferroelectric film crystallization annealing
- ï Glass substrate annealing
- ï Ceramic material heating

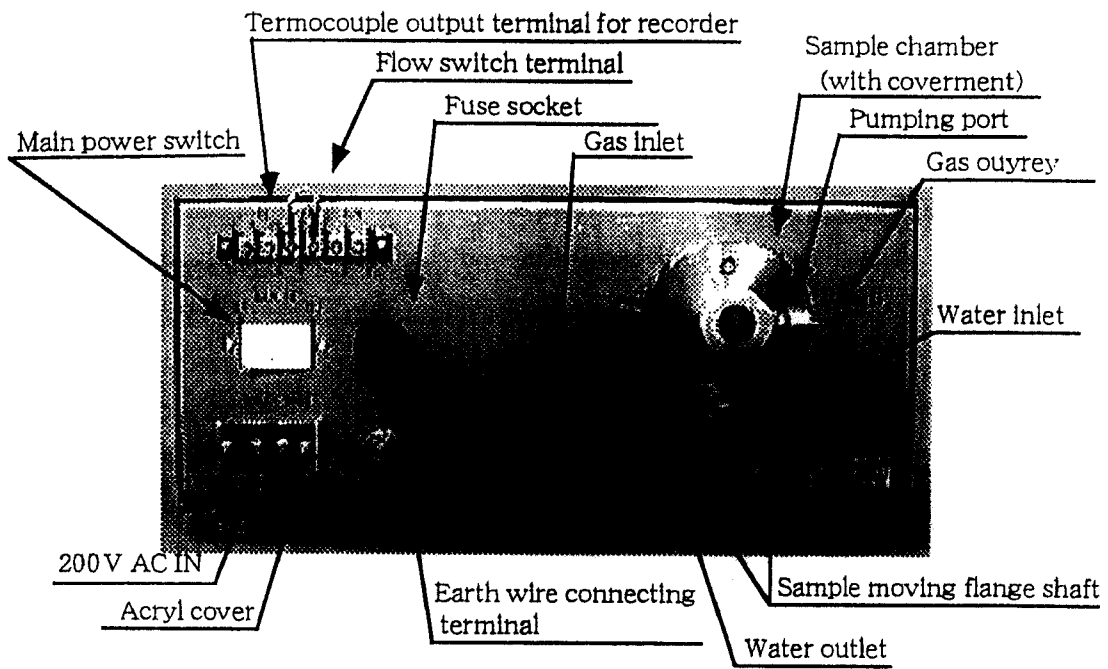
2. COMPONENTS

- 2.1 Mini-Lamp Annealer
 - 2.1.1 Infrared lamp heating furnace (near-infrared lamp, far-infrared lamp)
 - 2.1.2 Sample assembly
 - 2.1.3 Temperature control system
- 2.2 Vacuum Pumping System (Optional)
- 2.3 Heated Sample Observation System
CCD camera, micro lens, filter, light source, XYZ goniometer, measurement framework, 14-inch color monitor, video deck (optional)
- 2.4 Gas Flow Unit (Optional)
- 2.5 Cooling Water Circulation Unit (Optional)
- 2.6 Cooling Water Flow Switch (Optional)

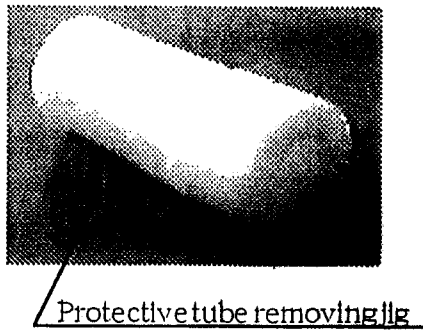
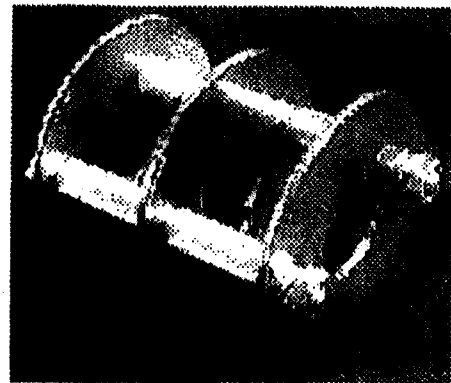
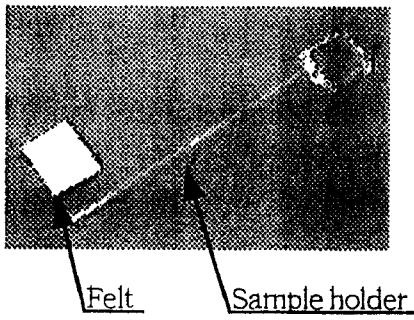
[Front view]



[Rear view]



[Parts for MILA]



3. NAMES AND FUNCTIONS OF COMPONENTS

3.1.1 MILA infrared lamp heating furnace

The heating furnace of this system has an infrared (far-infrared) lamp fixed at the focus of a parabolic reflection surface reflector and heats sample by reflecting infrared rays in parallel. The furnace is available with a near-infrared lamp (100 V, 1 kW) with high energy density that can heat sample to a high temperature with high efficiency within a short time and a far-infrared lamp (100 V, 250 W) for heating atmosphere, which is suited to uniform heating. Being sealed in a quartz glass tube, these infrared lamps permit clean heating without generating gas from the heating element. The furnace body is made of aluminum and is cooled with water so that the sample can be heated up to a high temperature.

3.1.2 Sample assembly

The sample assembly is sealed airtight with O-rings on both ends of a transparent quartz glass tube and is fixed to a water-cooled aluminum alloy flange, as shown in Fig. 1. The sample is set on the transparent quartz glass holder of the moving flange, put into the transparent quartz glass tube and heated by radiation from the near- or far-infrared lamp on the outside of the transparent quartz glass tube.

The near-infrared lamp is suited to a high-temperature, short-time process because more than 95% of the energy in the wavelength range ($\approx 0.9 \mu\text{m}$ or more) of the radiation from the near-infrared lamp transmits the transparent quartz glass tube and heats only the sample by radiation.

On the other hand, the far-infrared lamp heats the quartz glass tube and the atmosphere in the sample assembly because more than 90% of the energy of $5 \mu\text{m}$ or more in the wavelength range ($\approx 3 \mu\text{m}$ or more) of the radiation from the far-infrared lamp is absorbed by the transparent quartz glass tube. Since the sample is heated by heat conduction from these parts, response is slower than that of radiation heating by the near-infrared lamp, but it is suited to a process for heating a glass substrate with high efficiency and high temperature uniformity.

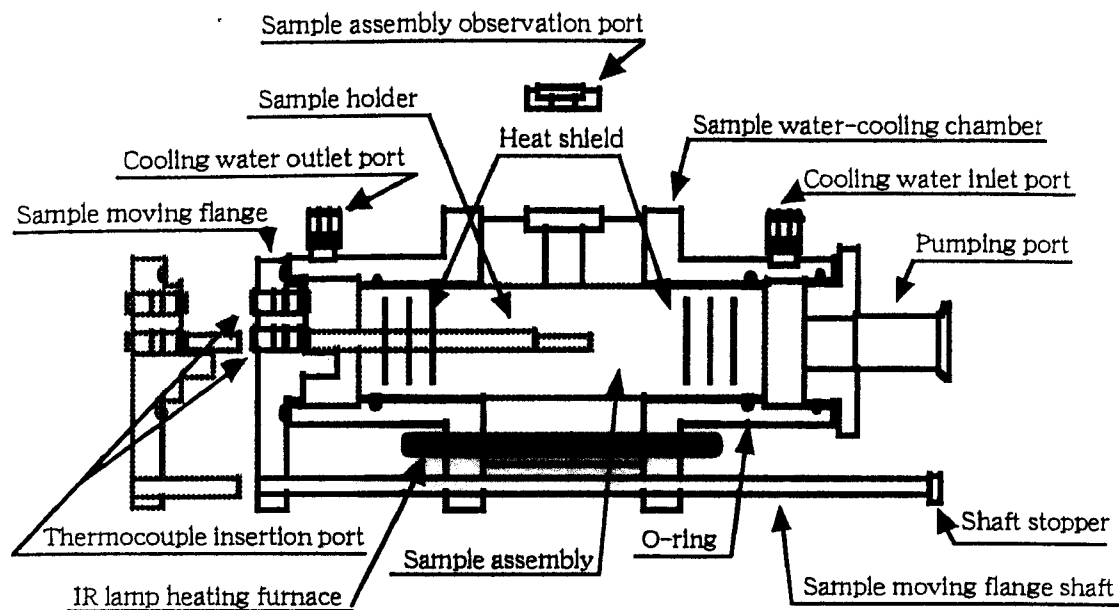


Fig. 1 Schematic diagram for sample assembly

3.1.3 Temperature control system (P type)

This system uses the Model ES100P-AAH digital controller made by OMRON for temperature control. Ramp is set by "temperature" vs. "time" and maximum 99 steps can be registered per pattern and maximum 99 patterns can be registered. (However, the total number of steps is maximum 400.) Also a variety of other modes is available.

* Refer to the instruction manual for the OMRON digital controller ES100P for more information about the temperature controller.

3.2 Vacuum Pumping System (Optional)

Ultimate pressure: 10^{-4} Pa (at room temperature, under no load, at pump head)

Pumping pressure: Air-cooled oil diffusion pump 50 l/sec
Oil rotary pump 20 l/min

Power requirements: 100 V, single phase, 0.35 kW

Weight:

Approx. 16 kg

Outside dimensions: 346mm wide × 316mm deep × 350mm high

3.3 Heated Sample Observation System (Optional)

Components: CCD camera, macro lens, XYZ adjustment stage,
14-inch color monitor, video deck, observation port

Effective No. of picture elements of CCD camera: 390,000

Magnification on monitor: Maximum 130× (on 14-inch monitor)

3.4 Gas Flow Unit (Optional)

Float type flowmeter (with stand)

* To be fabricated after receipt of customer's specifications, such
as the type of gas and gas flow rate.

3.5 Cooling Water Circulating Unit (Optional)

High temperature type:

Cooling capacity: 1700/1900 kcal/hr

Power: 200 V, three phase, 50/60 Hz

Power capacity: 3.5 kVA

Weight: Approx. 85 kg

Outside dimensions: 550W × 450D × 950H (mm)

Uniform heating type:

Cooling capacity: 770/880 kcal/hr

Power: 100 V, single phase, 50/60 Hz

Weight: Approx. 80 kg

Outside dimensions: 550W × 450D × 950H (mm)

3.6 Flow Switch for Cooling Water (Optional)

Installed at the furnace body cooling water outlet.

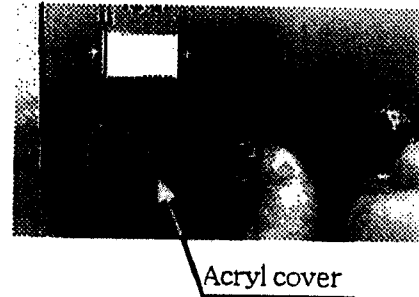
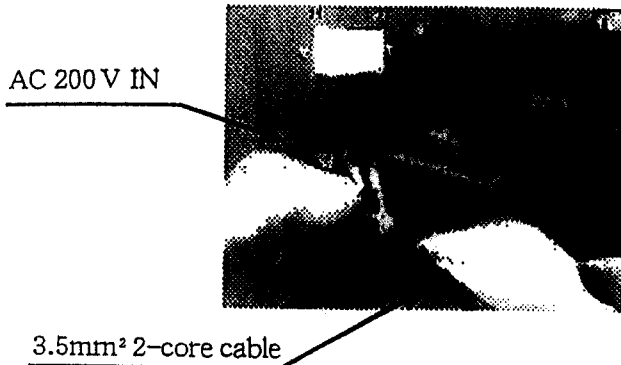
Turns OFF heating when cooling water supply is stopped or the
flow rate is below the set level.

4. CONNECTING UTILITIES

CAUTION: Before connecting utilities, turn OFF power on your switchboard and stop supply of cooling water.

- (1) Connect your power switch board and the AC200V IN terminal on the rear of the system by means of the supplied power cord.

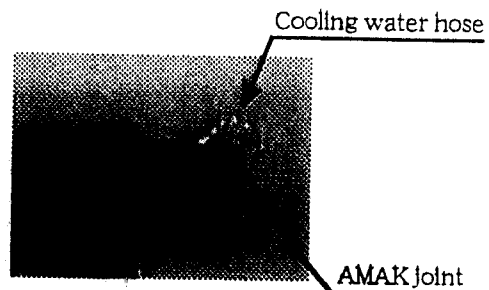
* After connection, be sure to install the acryl cover to the AC200VIN terminal.



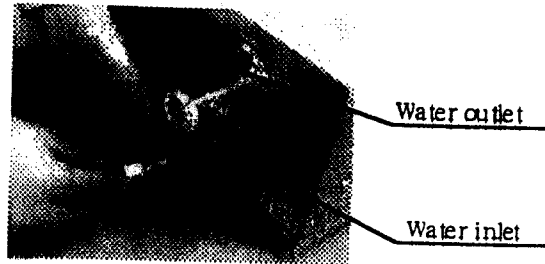
- (2) Connect earth wire from your switchboard to the earth terminal on the rear of the system. (ground resistance less than 100 ohms)

* Be sure to connect the earth wire for safety.

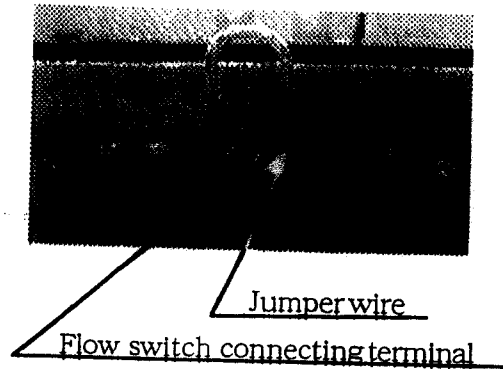
- (3) Securely connect the water cooling hose (11mm-OD × 6mm-ID) to WATER INLET on the rear of the system with the Amak joint so that cooling water can be fed from the faucet (for cooling water supply).



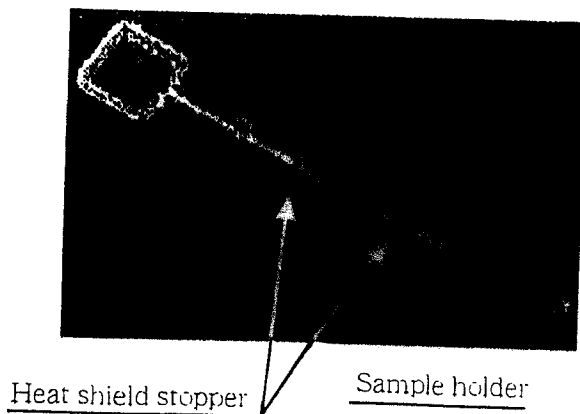
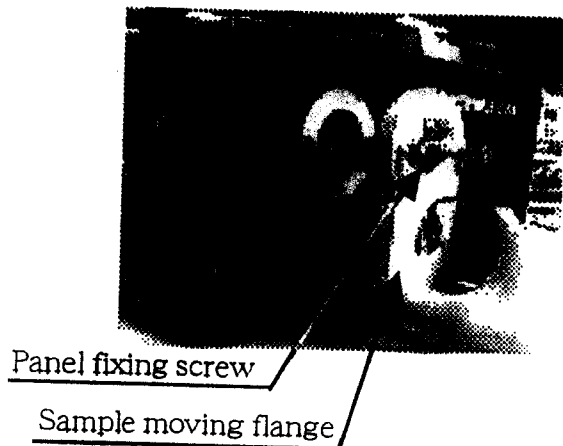
- (4) Connect the water cooling hose to WATER OUTLET on the rear of the system in the same manner so that water can be drained through your water drain port.



- (5) Connect the FLOW switch terminal to the FS terminal on the rear of the system. If the flow switch was not ordered, make sure that the FS terminals are connected by a jumper.

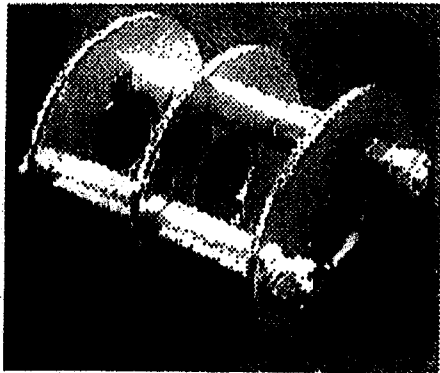


- (6) Installing the sample holder Loosen the setscrew on the front panel of the sample moving flange located on the front panel of the system and pull out the sample moving flange. Remove the sample holder clamp.

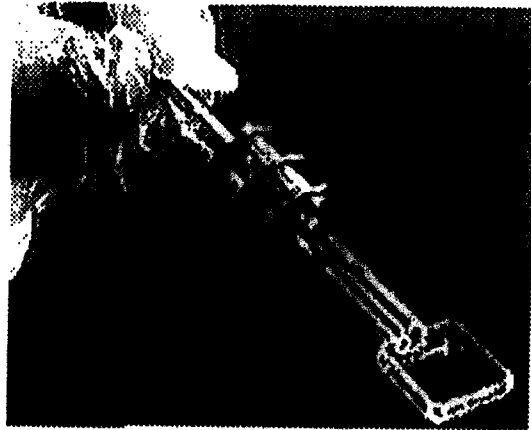


Pass the sampleholder through the heat shield.

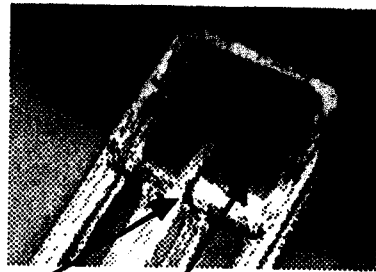
State the heat shield between the heat shield stopper of sample hold.



Heat shield



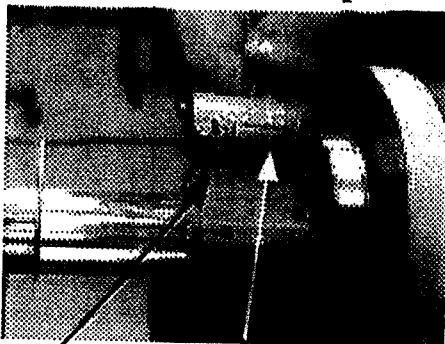
Pass the thermocouple attached to the sample moving flange through the sample holder and pull out the Pt ribbon on the end of the thermocouple onto the sample stage.



Sample stage

Pt ribbon on the end of thermocouple

Wind felt around the sample holder and fix the sample holder with the sample holder clamp so that the stage is in a horizontal position.

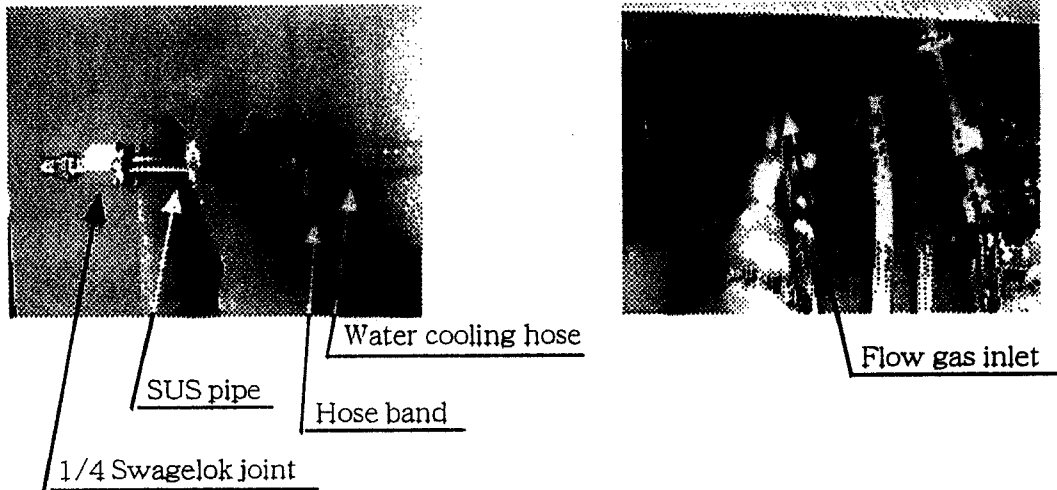


Felt

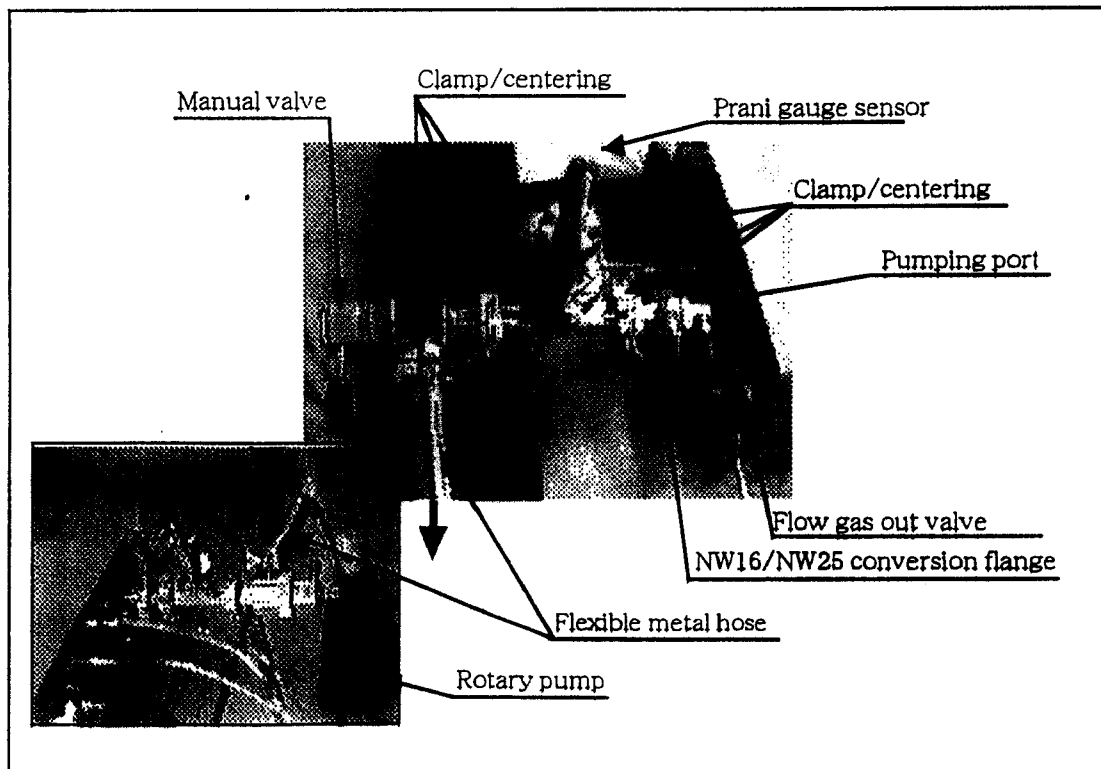
Sample holder clamp

CAUTION: Exercise great care in handling the quartz parts and thermocouple. Quartz will be evitrified if it is contaminated and heated. Besure to wear clean gloves when touching it.

- (7) Before feeding flow gas, connect the gas hose to the gas inlet on the rear of the system by means of a 1/4 Swagelok joint.
(Example of connection)



- (8) Before setting the vacuum pumping system, connect the vacuum pump to the pumping port (NW-16) in the rear of the system.
(Example of connection)



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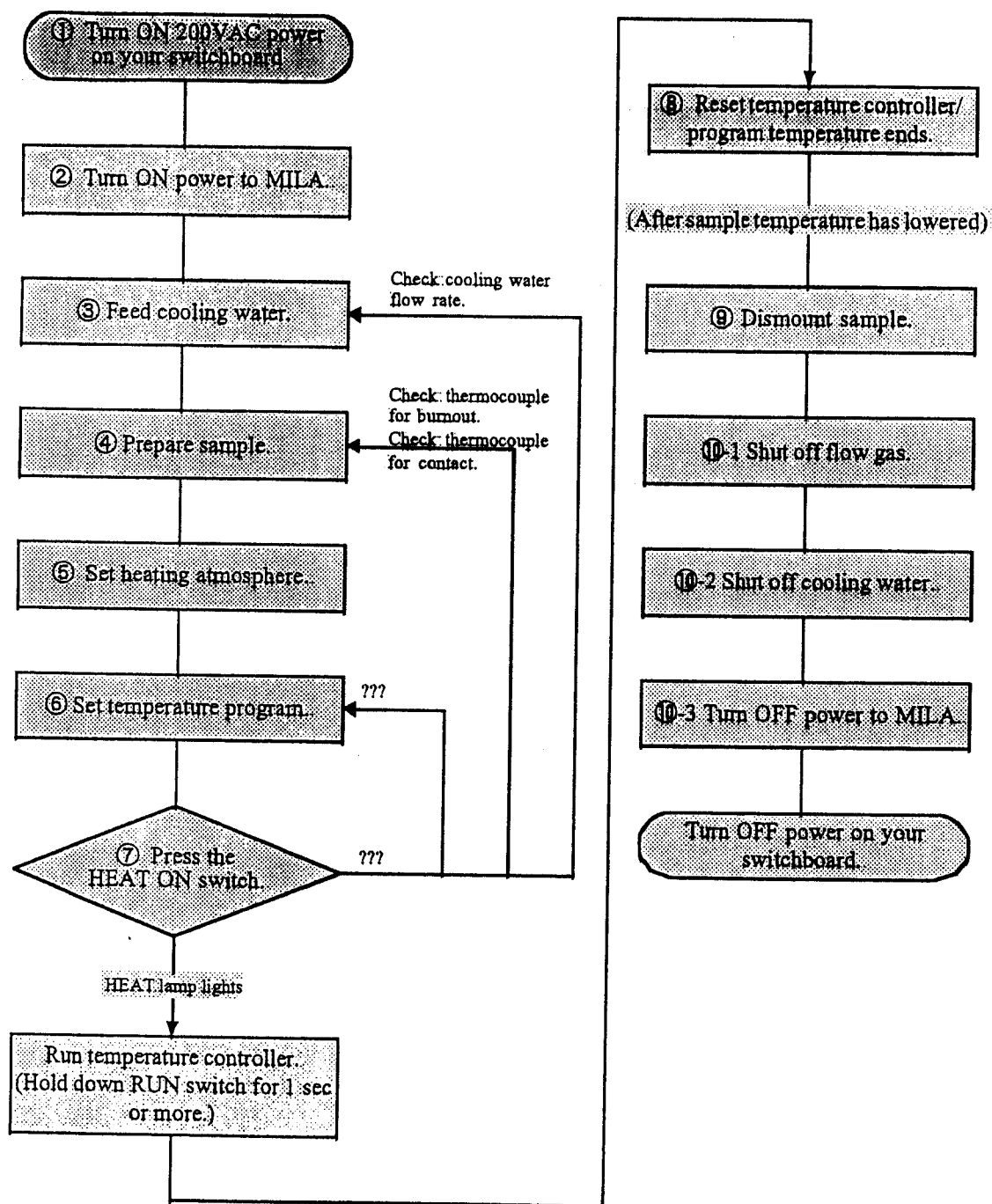
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- (9) For recording on the recorder, connect the TC terminal on the rear of the system to the recorder by means of a 2-core cable.
- CAUTION: Securely connect utilities (cord, hose, gas piping, vacuum piping).



Thermocouple output terminal for recorder

5. OPERATIONFLOWCHART



6. OPERATINGPROCEDURE

- (1) Turn ON 200VAC power on your switchboard.
- (2) Press the power switch on the rear of the system.
- (3) Open your cooling water valve.

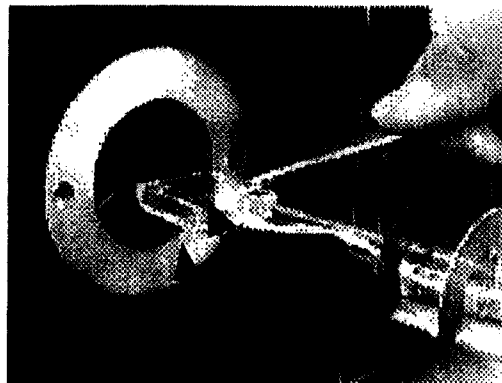
CAUTION: If a flow switch is not provided, make sure that the cooling water flow rate is 4 l/min or more. If the lamp is not cooled sufficiently, it may burst.



Main power switch

(4) Sample preparation

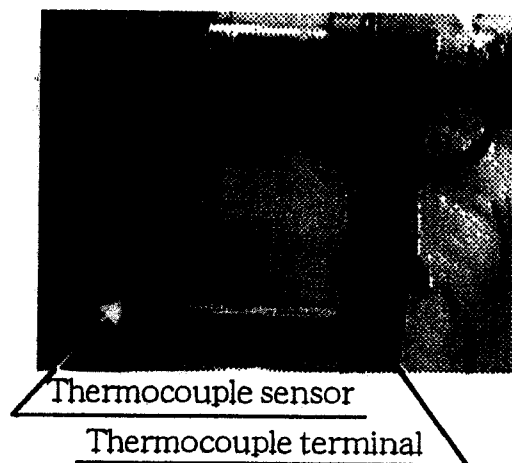
- 1) Loosen the sample moving flange fixing screw on the front of the system and pull out the sample moving flange.
- 2) Place sample on the platinum ribbon on the end of the thermocouple on the 2.20 mm² sample stage.



Sample

Sample stage

- 3) Insert the sample moving flange into the sample assembly by sliding it while taking care that the thermocouple does not interfere with the heat shield, and tighten the sample assembly panel fixing screw after making sure that the thermocouple terminal and the thermocouple sensor are in contact with each other.



- * When the thermocouple terminal and thermocouple sensor are brought into contact with each other, a click will be heard if the thermocouple is intact. The digital controller should show a screen displaying the thermocouple temperature (red) and the set temperature (blue) (thermocouple temperature in the case of manual (M) type).
- * If the error message E400 is displayed (if the thermocouple temperature is not displayed in the case of the M type), the thermocouple wire is broken or in poor contact.

(5) Setting the heating atmosphere

1) Vacuum atmosphere

After making sure that all ports are closed, turn ON the power to the pump and conduct evacuation. Measure vacuum level by vacuum gauges.

2) Flow gas atmosphere

Connect your flow gas feed hose to the FLOW GAS INLET of the system and feed gas. Always keep the flow gas outlet open.

CAUTION: If the pressure in the sample assembly rises excessively, the protective quartz tube may burst. Do not allow the pressure to exceed atmospheric pressure.

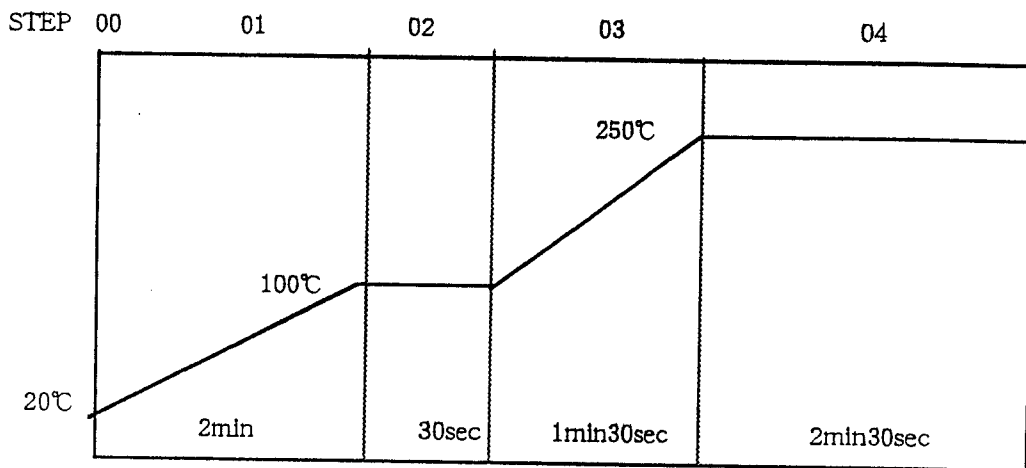
(6) Setting the temperature program (P Type)

The temperature controller permits registration of maximum 99 steps of temperature program by maximum 99 patterns (however, the total number of steps is maximum 400).

* Refer to the "MILA Setting Software Ver. 1.0 for Windows 95 Operation Manual" for more information about the method of setting temperature program. Also refer to the "OMRON digital controller ES100P" instruction manual.

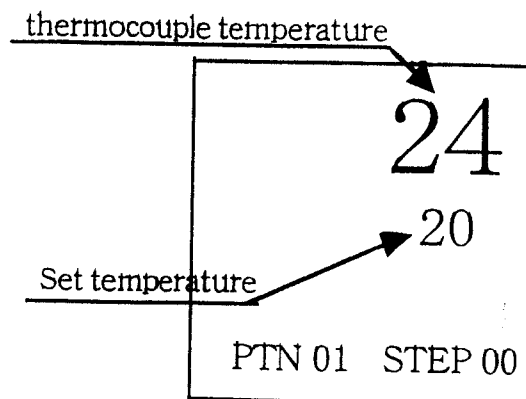
Register the following temperature pattern at pattern 1.

[PTN 1]

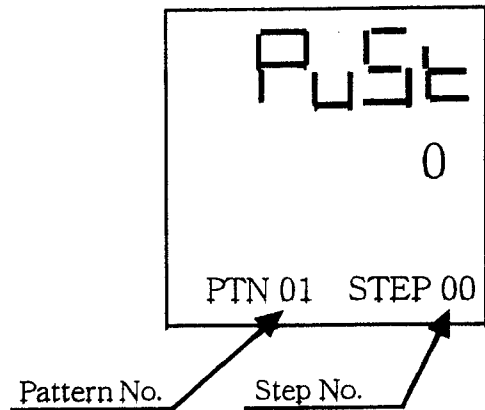


Slop priority / P=1 0, I=4, D=1

- 1) Make sure that the initial screen is displayed. The upper (red) numeral indicates the thermocouple temperature and the lower (blue) numeral indicates the set temperature.

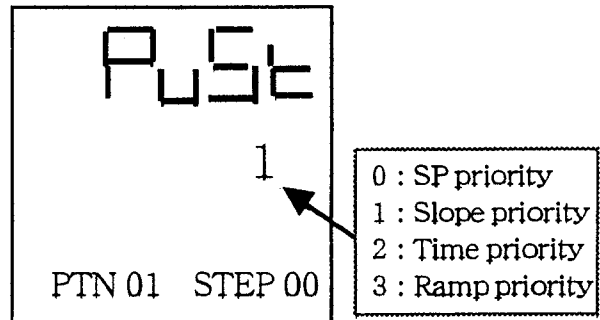




2) Then press the **SET** key on the temperature controller three times to set up the program mode. This program mode can be compared to the table of the spreadsheet software (Refer to the structure of the program mode on page 25.).



3) Select a pattern No. in which temperature program is to be registered. The pattern No. can be compared to the sheet No. of spreadsheet. This pattern No. can be switched over with **PTN** key on the temperature controller.

4) Select priority item at the time of program run. For example, if priority is given to slope as shown in the figure below (normally, run in





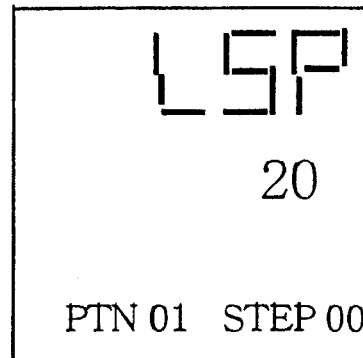
(normally, run in the slope priority mode), set the value below the PuSt display to "1" with the up key  or down key  and press the **ENT** key to register it.

CAUTION: Press the **ENT** key whenever registering an altered value.




If the altered value is not yet registered, the set value blinks and lights when registered. So check it.

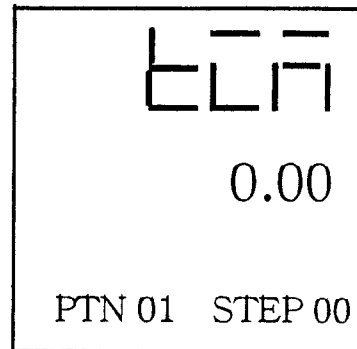
* Refer to the "OMRON digital controller ES100P operation manual" for more information about the priority items and set values.




- 5) Press the right shift key  to display LSP (Local Set Point) of STEP 00. Enter the step temperature (set temperature) at this LSP. To enter it, set the numeral to "20" with the up or down key in the same manner as 4) and press the  key to register it.

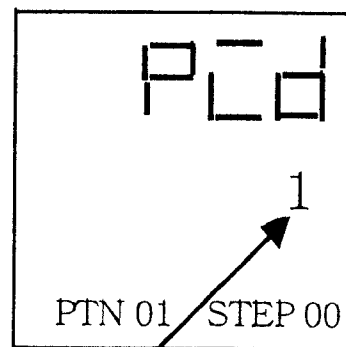


* The set value can be fed rapidly by holding down the up or down key for one second or more.


- 6) Press the down shift key  to display TIM  (time) of STEP 00. Enter the time of STEP 00 here. In the case of the above program, enter "0 00" and press the  key.



- 7) Press the down shift key  to display PID  of STEP 00. Enter the PID set No. at which the combination of PID constants to be used in step is registered and press the  key.



*The method of registering the PID set No. combination of PID constants will be described on page 26. This registers the set temperature and time of STEP 00 and the PID set No.

- 8) To register the set temperature and time of STEP 01 and PID set No., press the up shift key  three times and enter them in the same manner as in 5) and later.

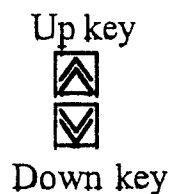
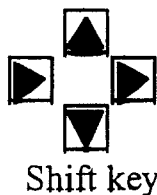
[Structure of program mode]

| | STEP 00 | STEP 01 | STEP 02 | STEP 03 | |
|----------------------------------|----------------------|---------|---------|----------------------|--|
| PID (Program number (PID)) | PID (temperature) | | | PID (temperature) | |
| : | TIM (time) | | | | |
| : | DEPEND | | | | |
| : | : | : | : | : | |
| : | : | : | : | : | |
| : | : | : | : | : | |

Set values required for program registration are entered in the hatched cells. Pressing the shift key changes the screen on the temperature controller. It is as if the cells in this table move. Pressing the right or left shift key changes the screen as if the above table is moved horizontally (moves the step). Pressing the up or down shift key changes the screen as if the above table is moved vertically. (The set item changes.)

If, for example, the right shift key is pressed twice from TIM of STEP 01, the screen of TIM (time setting) of STEP 03 is displayed.

* If no set value is registered in the step, however, control does not proceed to the subsequent steps.



and
enter

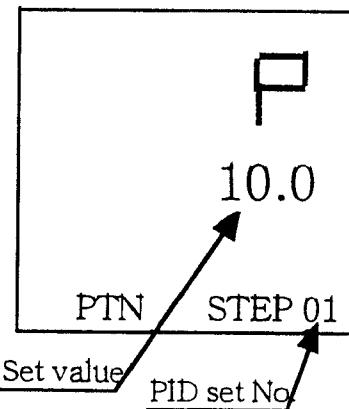
When control has proceeded to the screen for input of the set value, change the set value with the up or down key and press the **ENT** key to register it.

In the case of the above program, set values to be entered are as follows.

| | | STEP 00 | STEP 01 | STEP 02 | STEP 03 | STEP 04 |
|------|-------------------|---------|---------|---------|---------|---------|
| PrSt | LSP (temperature) | 20 | 100 | 100 | 250 | 250 |
| | TIM (time) | 0:00 | 1:00 | 1:00 | 1:30 | 1:30 |
| | PID (set No.) | 1 | 1 | 1 | 1 | 1 |

- * If a program is registered after the step to be used, hold down the edit key **Ⓢ** and **ENT** key simultaneously from the LSP screen of unnecessary step for more than one second. The program after the step is cleared. (In the case of the above program, for example, hold down the edit key **Ⓢ** and **ENT** key from the LSP screen of STEP 05 for more than one second.

- 9) Register a combination of PID constants. Press the **SET** key four times to set up the PID mode. Eight combinations of PID constants can be registered. To select the PID set No. to be registered, press the right or left shift key. PID set No. "1" can be registered when STEP is "01".

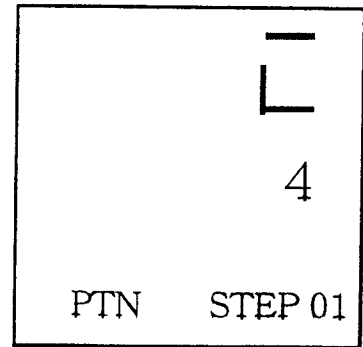


Register the value of "P". Alter the set value with the up or down key and register it with **ENT** key.

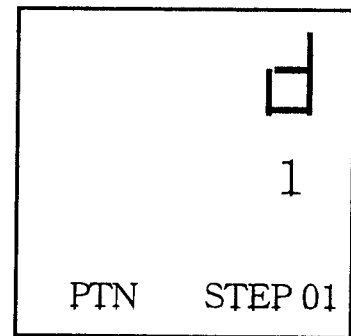
PID value setting range is as follows.

| |
|-------------------|
| P : 0.1 to 999.9% |
| I : 0 to 9999 sec |
| D : 0 to 9999 sec |

Then register the value of "I". Press the down shift key once to display the screen for "I", alter the set value with the up or down key and register it with **ENT** key.



Register the "D" value in the same manner.



The table below gives the structure of the PID mode.

| | STEP 01 | STEP 02 | STEP 03 | STEP 04 | STEP 05 | STEP 06 | STEP 07 | STEP 08 |
|---|---------|---------|---------|---------|---------|---------|---------|---------|
| P | 10.0 | | | | | | | |
| I | 4 | | | | | | | |
| D | 1 | | | | | | | |

* Set values are registered in the hatched cells.

This completes the setting of the temperature program.

- 7) Turning ON the power displays **C001**.
- 8) Advance the display to the time unit setting screen x(C043) with the down shift key.
- 9) Enter the set value "1" of analog input with the up or down key and press the **ENT** key to register it. Entering the set value "1" sets the time unit of the program to "hr/min" unit.
- 10) Upon completion of the setting, turn OFF the power again and pull out the digital controller.
- 11) Turn OFF the DIP switch SW1, insert the digital controller and turn ON the power.

| | | |
|---|----------|---------------|
| 0 | min, sec | 99 min 59 sec |
| 1 | hr, min | 99 hr 59 min |

CAUTION: If the DIP switches SW1 and SW2-3 are turned ON simultaneously, all the settings of the temperature controller will be cleared. Once the settings are cleared, it will be necessary to initialize the disk from the personal computer using the "MILA program" disk or have it initialized by SINKU-RIKO. Do not allow this to happen.

NOTE: How to set overheat temperature (P type)

The overheat temperature is set in the P301 mode. The initial value of the P301 mode is "1.000". If the temperature exceeds the operating range of the K thermocouple used for the MILA-3000, the interlock will be activated and the power to the furnace be turned OFF. If it is desired to set another overheat temperature within the range of 200°C to 1300°C, proceed as follows.

- (1) Press the **SET** key seven times in the initial state when power was turned ON to display **P301** (overheat temperature setting) screen.

- (2) Obtain a setting value corresponding to the overheat temperature to be set using the following equation.

$$\text{Setting value} = \{ 1 \div (\text{K thermocouple max. temperature} - \text{fi minimum temperature}) \} \times (\text{desired overheat temperature} - \text{fi minimum temperature})$$

When it is desired to set the overheat temperature to 300°, for example, substitute the "maximum temperature of thermocouple = 1300°C", "minimum temperature = fi200°C" and "desired temperature = °C" in the above equation. The following value is obtained.

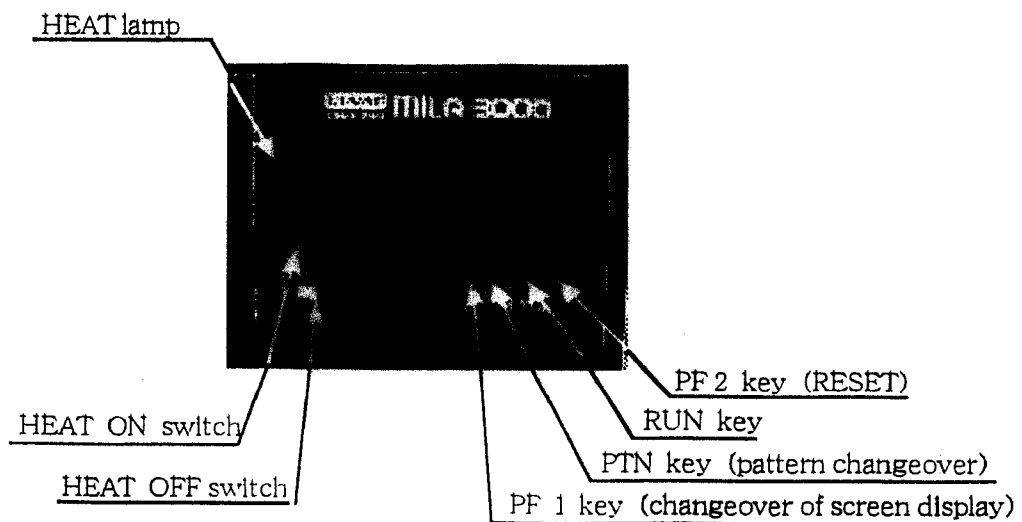
$$0.333 = \{ 1 \div (1300 - (-200)) \} \times (300 - (-200))$$

Enter "0.333" in **P301** using the up or down key and register it with the **ENT** key.

Now, if the control thermocouple temperature exceeds 300 °C after the program is run, the interlock will be activated and the power to the furnace be turned OFF.

- (7) Heating start/temperature program start

Upon completion of preparations, press the "HEAT ON" switch to put the furnace on standby. (If all interlock items are OK, the HEAT lamp lights and the heating furnace is ready for applying power.)



- 1) When operating the P type (program type) directly from the temperature controller
Holding down the "RUN" key on the temperature controller for one second or more outputs power to the furnace, starting the program.
Power is automatically turned OFF when the last step of the temperature program ends.
 - 2) When operating the P type (program type) from the personal computer
Click on the "RUN" button on the MILA program screen to start the program. The power to the furnace is automatically turned OFF when the last step of the temperature program ends.
 - 3) With the M type (manual type)
Turn the output potentiometer to a higher value for heating.
- (8) Pause of temperature program (Stop of furnace output)
- 1) When operating the P type (program type) directly from the temperature controller
Hold down the PF2 key (RESET key) on the temperature controller for one second or more. The temperature program stops, allowing the heating of the furnace to be turned OFF.*
 - 2) When operating the P type (program type) from the personal computer
Click on the "RESET" button on the MILA program screen to stop the program.*
 - 3) M type (Manual type)
Turn the output potentiometer to "0".*
- * Supply of power to the heating furnace can also be turned OFF by pressing the "HEATOFF" switch.

NOTE : Other functions required for program run (P type)

- Changeover of screen display

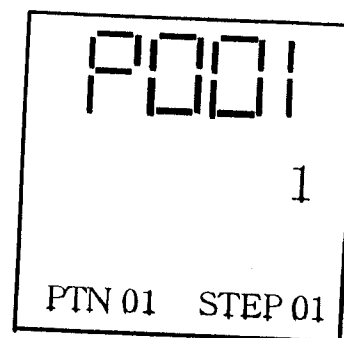
Each press on the PF1 key changes over the display as follows.

- 1) Initial screen : Displays PV (actual temperature) and SP (set temperature)
- 2) MV : Displays the output level 0 to 100%.
- 3) Deviation : Displays the temperature difference between PV (actual temperature) and SP (set temperature).
- 4) TIME : Displays the elapsed time of step.
- 5) TIME : Displays the remaining time of step.
- 6) P : Proportional band set value of proportional control (P)
- 7) I : Integral time set value of integral control (I)
- 8) D : Differential time set value of differential control (D)

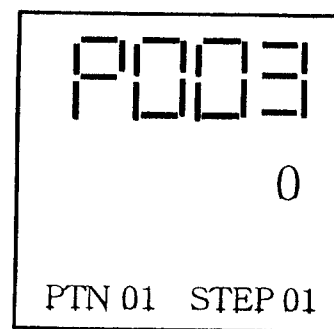
- Holding function

This function is used to hold the program in a certain status during program run. Proceed as follows.

- 1) When the program comes to a point to be held, press the **SET** key once to set the temperature controller in the OPR mode. **P001** is displayed.



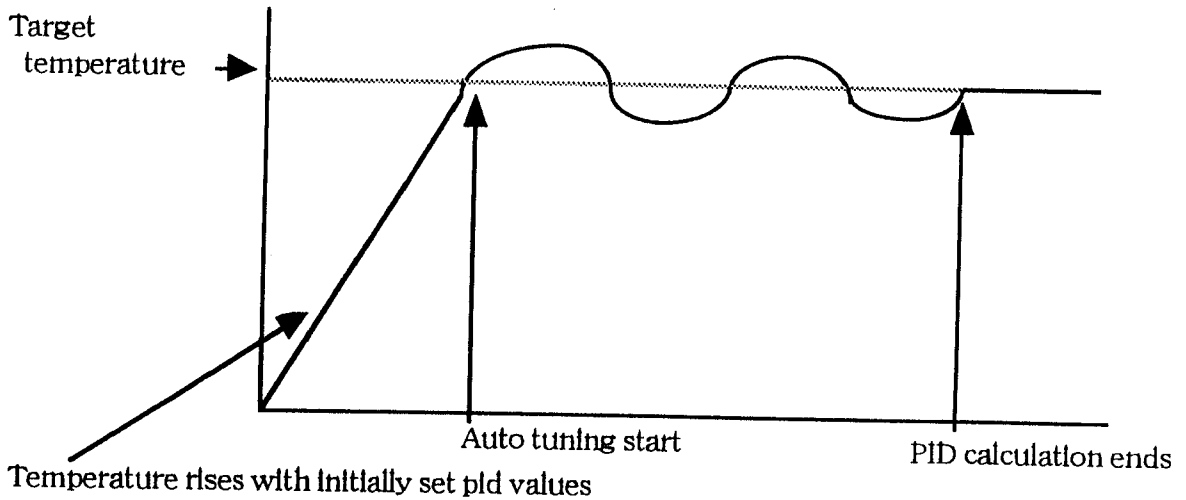
- 2) Display **P003** using the down shift key.
- 3) Press the up key to set the setting value at "1" and press the **ENT** key to set it. The HOLD lamp lights and the hold status is set up.
- 4) Pressing the PF1 key changes over the screen to the run screen.
- 5) Holding down the RUN key for one second or more resets the hold status (HOLD lamp goes out) and the temperature program restarts.



- AT (auto tuning) function

This function calculates and rewrites the optimum set during the run of the temperature program controlled by dummy PID set.

Run the program by the initially set PID values as shown in the figure below and execute AT according to the following procedure when the temperature to be controlled by the program is reached.

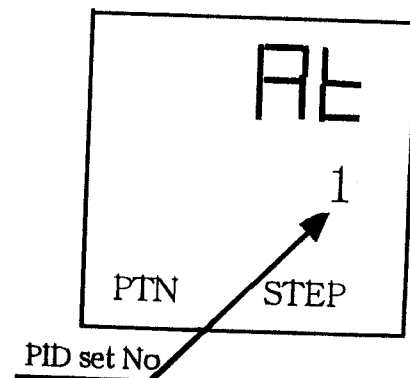


1) Press the **SET** key twice to set the temperature controller at the TUNE mode. **AT** is displayed.

2) Display the PID set for auto tuning and press the **ENT** key.

AT is executed and the optimum PID set is calculated while the AT lamp is blinking. In the meantime, the program is held.

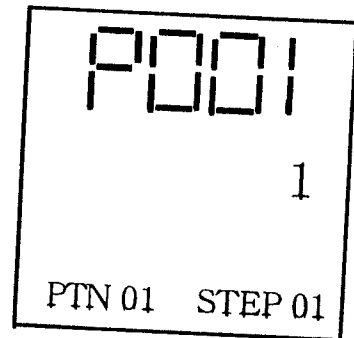
When AT is executed, temperature is increased/decreased to calculate optimum PID constants for a certain time. With completion of the calculation of the optimum PID values, the AT status is reset and the initially set PID values are substituted by the calculated PID values, and the program restarts.



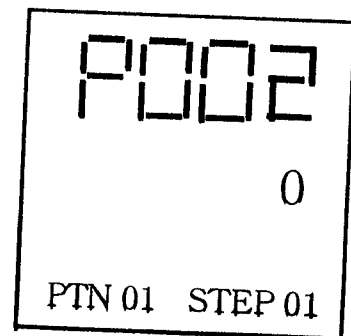
- ADVANCE function

This function advances a step to the next during program run.
Proceed as follows.

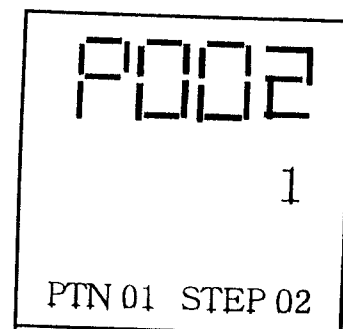
- 1) Press the **SET** key once to set the temperature controller at the OPR mode. **P001** is displayed.



- 2) Display **P002** using the down shift key.



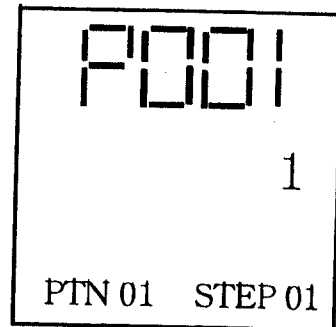
- 3) Press the up key to set the setting value to "1" and press the **ENT** key to set it. The step advances to the next.
- 4) Pressing the PF1 key changes the screen to the run screen.



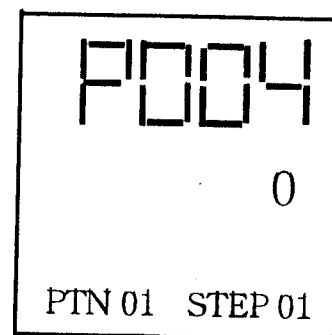
- BACK function

This function returns control to the start step during program run. Proceed as follows.

- 1) Press the **SET** key once to set the temperature controller at the OPR mode. **P001** is displayed.



- 2) Display **P004** using the down shift key.
- 3) Press the up key to set the setting value to "1" and press the **ENT** key to set it. The step returns to the start.
- 4) Pressing the PF1 key changes over the screen to the run screen.



(9) Dismounting the sample

When the sample temperature has lowered to a sufficiently low level, loosen the screw on the sample assembly panel to pull out the sample assembly and change the sample.

When the atmosphere is vacuum, feed flow gas to the sample assembly to vent it to atmospheric pressure and then open the sample assembly.

CAUTION : Do not pressurize the sample assembly to above atmospheric pressure.

(10) Shutdown

1) Shutting off flow gas

Shut off flow gas arbitrarily. If it is desired to cool the furnace quickly, keep flow gas flowing. The furnace will cool down sooner.

2) Shutting off cooling water

Shut off cooling water more than 30 minutes after completion of measurement.

3) Turning OFF the power to MILA3000

Turn OFF the main power switch on the rear of the MILA3000 and then turn OFF the power on your switchboard.

7. INTERLOCKS

(1) Thermocouple (The P type displays the error message E400.)

(2) Furnace body temperature sensor (Power to the furnace is turned OFF at above 50°C.)

(3) Overheat temperature (only P type, P301 setting)

(4) Flow switch (optional. Power to the furnace is turned OFF when the cooling water flow lowers to below 4 l/min.)

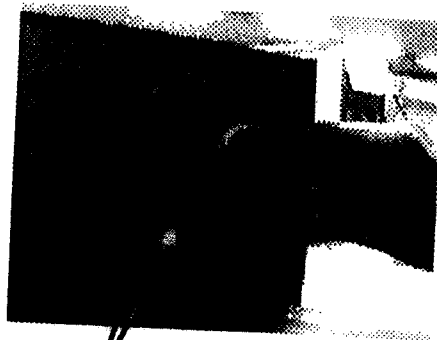
* Power to the furnace will be turned OFF if any of the above items is faulty.

8. REPLACEMENT OF CONSUMABLES

CAUTION: Before replacing parts, turn OFF the power on your switchboard and the power switch on the system.

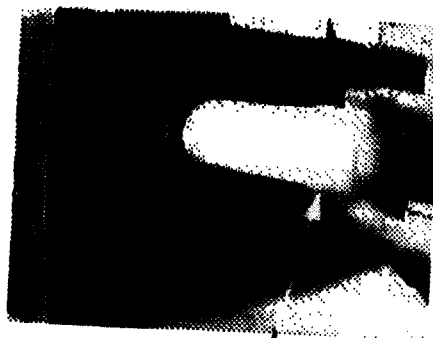
8.1 Dismounting and Remounting the Quartz Protective Tube

- (1) Remove the sample moving flange shaft stopper from the rear of the system.
- (2) Loosen the screw on the sample assembly and pull out the sample assembly from the front of the system.
- (3) Remove the two Allen screws at the pumping port in the rear of the system and pull out the pumping port fixed with an O-ring.



Allen screw

- (4) Remove the black screws in the four corners of the black panel on the front of the MILA to remove the panel.
- (5) Insert the thinner end of the "protective tube removing jig" into the sample assembly and push out the protective tube from its rear. Pull out the protective tube.



Protective tube removing jig

- (6) When inserting the protective tube, push it from the rear while looking into the sample assembly so that it is not caught.
- (7) Push the removed O-ring into the groove taking care not to damage it with a slotted screwdriver or the like.



O-ring

8.2 Removing the Lamp

- (1) Pull out the sample moving flange in the same manner as in NOTE on page 28 and remove the black panel on the front.
- (2) Remove the four screws for the blind plug for the observation port at top of the system and the four screws on the cover for the digital controller to remove the cover.



Cover

- 3) As shown in (3) in 8-1, remove the two Allen screws from the pumping chamber on the rear of the system and pull out the pumping port fixing with O-ring.

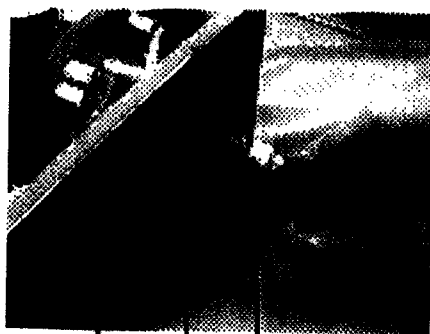
- hile
to
- (4) Remove the two screws that fix the terminal of the lamp to be replaced.



Lamp terminal

- in
on
the
- (5) Stretch the leads (with terminal) on the both ends of the lamp straight and take out the lamp through the clearance between the iron panel on the rear and the sample assembly.

CAUTION : After replacing the lamp, measure the resistance between the terminal block and the chassis by a circuit tester and make sure that they are not shorted before applying power.



Rear iron panel

Sample chamber

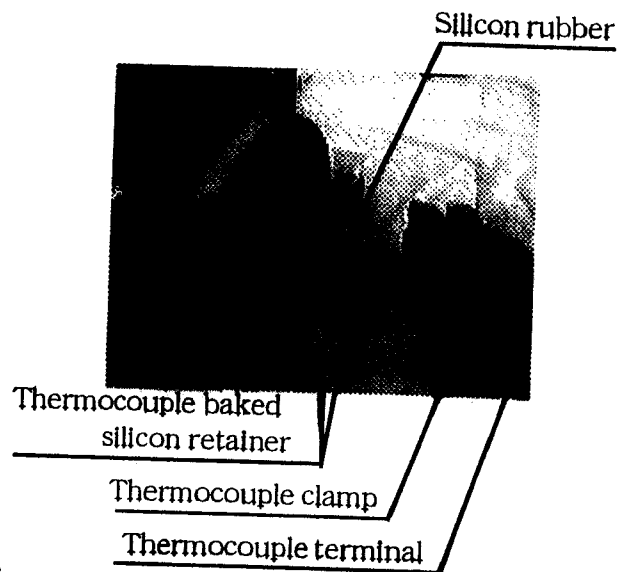
Infrared lamp

he
he

8.3 Replacement of Thermocouple

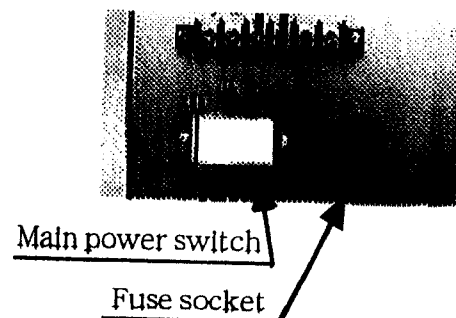
- (1) Remove the thermocouple clamp on the front of the sample assembly.
- (2) Remove the thermocouple terminal.
- (3) Pull out the sample moving flange and remove the sample holder clamp to remove the sample holder.
- (4) Push out the baked silicon rubber retainer from inside on the front of the sample assembly to remove the thermocouple.

CAUTION: Do not mistake the + (plus) side and - (minus) side of the thermocouple.



8.4 Replacement of Fuse

- (1) Remove the black fuse socket beside the main power on the rear of the system with a Philips screwdriver.
- (2) Remove the fuse from the socket, insert a new 40A fuse and install the socket in the original position.



CAUTION: After replacement, install and connect the replacement part securely.

List of Consumables (MILA-3000)

| Description | Drawing No. | Model, material | Qty | Remarks | |
|------------------|--------------------|------------------|-------------------------------|-----------|---|
| Furnace, chamber | | | | | |
| 1 | Near-infrared lamp | #4024539 | 1 kW, 4, 100 V | 4 | Lamp for N type |
| | Far-infrared lamp | | IR100V 250WYD | 4 | Lamp for F type |
| 2 | Protective tube | #4040961 | Transparent quartz | 1 | |
| 3 | Sample holder | #4040127 | Transparent quartz | 1 | |
| 4 | O-ring | | G40 | 2 | Viton |
| 5 | O-ring | | P38 | 3 | Viton |
| 6 | Thermocouple | #6016198 | JIS K ϕ 0.3 | 1 | |
| (7) | ND filter | #4041199 | | 1 | Part for sample assembly observation port |
| (8) | Super cold filter | | 18mm-dia. \times 5 mm thick | 1 | Part for sample assembly observation port |
| Others | | | | | |
| 9 | Fuse | | APS-25 40A | 1 | |
| 10 | Thyristor | | TM 20DA-H | 1 | |
| 11 | Heat shield | #4040965 ~968 | | 1 each | |
| 12 | Felt cushion | #4040986 | | 1 | |

* (7) and (8) are optional parts for sample assembly observation port.

For the price and delivery time of consumables, contact SINKU-RIKO or your local representative.

On your order, give us the name of your equipment and its serial No.

The name of this system is MILA-3000-x-x and its serial No. is MD9xxxxx.