



## **Plasma Reactor**

**Model**

# **PR500**

## **Instruction Manual**

**- Second Edition -**

- Thank you for purchasing " Plasma Reactor, PR 500" of Yamato Scientific Co., Ltd.
- To use this unit properly, read this "Instruction Manual" thoroughly before using this unit.  
Keep this instruction manual around this unit for referring at anytime.



**WARNING!:**

Carefully read and thoroughly understand the important warning items described in this manual before using this unit.

**Yamato Scientific Co. LTD.**

This paper has been printed on recycled paper.



◆ Cautions in Using with Safety .....	1
• Explanation .....	1
• Table of Illustrated Symbols .....	2
• Fundamental Matters of “WARNING!” and “CAUTION!” .....	3
◆ Before Using this unit .....	4
• Requirements for Installation .....	4
◆ Description and Function of Each Part .....	7
• Main Unit .....	7
• Control Panel .....	8
◆ Installation Method .....	10
• Cable tube connection .....	10
• Principle of operation .....	11
• Preparation for operation .....	12
◆ Operation Method .....	14
• Operation Procedure .....	14
◆ Handling Precautions .....	18
◆ Maintenance Method .....	20
• Daily Inspection and Maintenance .....	20
◆ Long storage and disposal .....	21
• When not using this unit for long term / When disposing .....	21
◆ In the Event of Failure .....	22
◆ After Service and Warranty .....	23
◆ Specification .....	24
◆ Wiring Diagram .....	25
◆ Replacement Parts Table .....	26
◆ Reference .....	27
• List of Dangerous Substances .....	27

## Explanation


### MEANING OF ILLUSTRATED SYMBOLS


#### Illustrated Symbols

Various symbols are used in this safety manual in order to use the unit without danger of injury and damage of the unit. A list of problems caused by ignoring the warnings and improper handling is divided as shown below. Be sure that you understand the warnings and cautions in this manual before operating the unit.

---

---

 **WARNING!** If the warning is ignored, there is the danger of a problem that may cause a serious accident or even fatality.

 **CAUTION!** If the caution is ignored, there is the danger of a problem that may cause injury/damage to property or the unit itself.

---

---

#### Meaning of Symbols



This symbol indicates items that urge the warning (including the caution).  
A detailed warning message is shown adjacent to the symbol.



This symbol indicates items that are strictly prohibited.  
A detailed message is shown adjacent to the symbol with specific actions not to perform.



This symbol indicates items that should be always performed.  
A detailed message with instructions is shown adjacent to the symbol.

## Table of Illustrated Symbols

### Warning



Warning,  
generally



Warning,  
high voltage



Warning,  
high temperature



Warning,  
drive train



Warning,  
explosive

### Caution



Caution,  
generally



Caution,  
electrical shock



Caution,  
scald



Caution,  
no road heating



Caution,  
not to drench



Caution,  
water only



Caution,  
deadly poison

### Prohibit



Prohibit,  
generally



Prohibit,  
inflammable



Prohibit,  
to disassemble



Prohibit,  
to touch

### Compulsion



Compulsion,  
generally



Compulsion,  
connect to the  
grounding  
terminal



Compulsion,  
install on a flat  
surface



Compulsion,  
disconnect the  
power plug



Compulsion,  
periodical  
inspection

## Cautions in Using with Safety

### Fundamental Matters of “WARNING!” and “CAUTION!”

#### **WARNING!**

##### **Do not use this unit in an area where there is flammable or explosive gas**

Never use this unit in an area where there is flammable or explosive gas. This unit is not explosion-proof. An arc may be generated when the power switch is turned on or off, and fire/explosion may result. (Refer to page27 “List of Dangerous Substances”.)

##### **Always ground this unit**

Always ground this unit on the power equipment side in order to avoid electrical shock due to a power surge.

##### **If a problem occurs**

If smoke or strange odor should come out of this unit for some reason, turn off the power key right away, and then turn off the breaker and the main power. Immediately contact a service technician for inspection. If this procedure is not followed, fire or electrical shock may result. Never perform repair work yourself, since it is dangerous and not recommended.

##### **Do not use the power cord if it is bundled or tangled**

Do not use the power cord if it is bundled or tangled. If it is used in this manner, it can overheat and fire may be caused.

##### **Do not process, bend, wring, or stretch the power cord forcibly**

Do not process, bend, wring, or stretch the power cord forcibly. Fire or electrical shock may result.

##### **Substances that can not be used**

Never use explosive substances, flammable substances and substances that include explosive or flammable ingredients in this unit. Explosion or fire may occur.

##### **Do not disassemble or modify this unit**

Do not disassemble or modify this unit. Fire or electrical shock or failure may be caused.

#### **CAUTION!**

##### **During a thunder storm**

During a thunderstorm, turn off the power key immediately, then turn off the breaker and the main power. If this procedure is not followed, fire or electrical shock may be caused.

## Requirements for Installation

### **WARNING!**

#### 1. Always ground this unit



- Connect the power plug to a receptacle with grounding connectors.
- Do not forget to ground this unit, to protect you and the unit from electrical shock in case of power surge. Choose a receptacle with grounding connectors as often as possible.



- Do not connect the grounding wire to a gas pipe, or by means of a lightning rod or telephone line. A fire or electrical shock will occur.

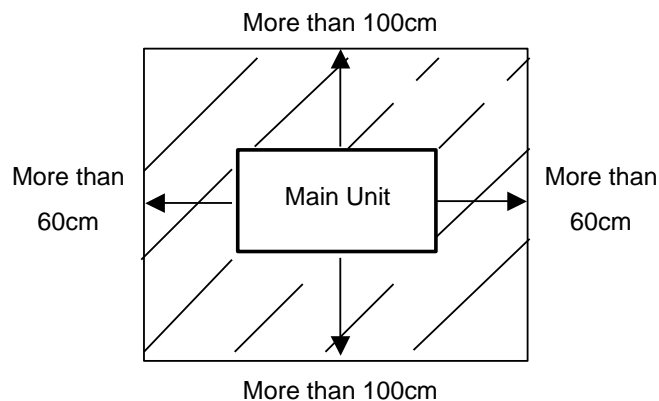
#### 2. Choose a proper place for installation



- Do not install this unit in a place where:
  - ◆ Rough or dirty surface.
  - ◆ Flammable gas or corrosive gas is generated.
  - ◆ Ambient temperature exceeds 35°C.
  - ◆ Ambient temperature fluctuates violently.
  - ◆ There is direct sunlight.
  - ◆ There is excessive humidity and dust.
  - ◆ There is a constant vibration.



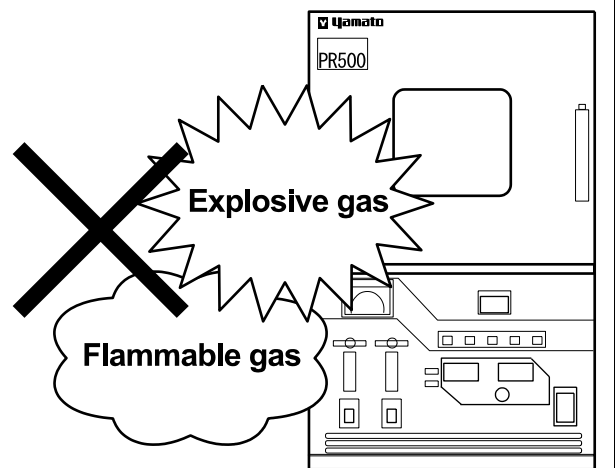
- Install this unit on a stable place with the space as shown below.



#### 3. Do not use this unit in an area where there is flammable or explosive gas



- Never use this unit in an area where there is flammable or explosive gas. This unit is not explosion-proof. An arc may be generated when the power switch is turned ON or OFF, and fire/explosion may result.

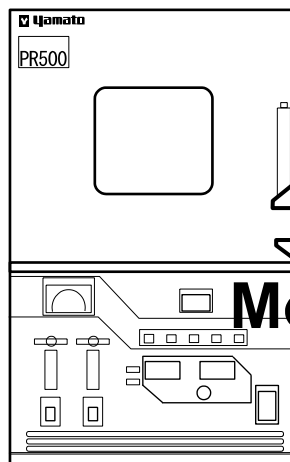


## Requirements for Installation

### 4. Do not modify



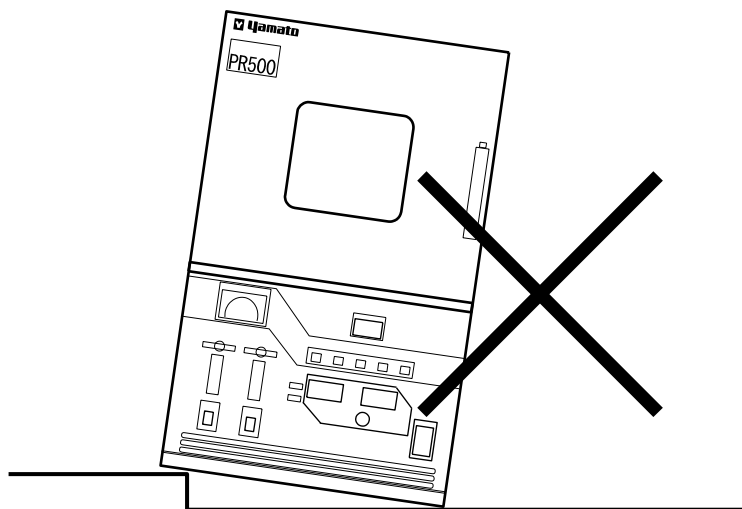
- Modification of this unit is strictly prohibited. This could cause a failure.



### 5. Installation on horizontal surface



- Set this unit to the flattest place. Setting this unit on rough or slope place could cause the vibration or noise, or cause the unexpected trouble or malfunction.





### Requirements for Installation

#### **CAUTION!**

#### 6. Choose a correct power distribution board or receptacle



- Choose a correct power distribution board or receptacle that meets the unit's rated electric capacity.

**Electric capacity:** 100V AC, 15A

**NOTE)**

There could be the case that the unit does not run even after turning ON the power. Inspect whether the voltage of the main power is lowered than the specified value, or whether other device(s) uses the same power line of this unit. If the phenomena might be found, change the power line of this unit to the other power line.

#### 7. Before/after installing



- It may cause injury to a person if this unit falls down or moves by the earthquake and the impact. etc..To prevent, take measures that the unit cannot fall down, and not install to busy place.
- Touching the unit may cause a burn during and just after the operation. To prevent, take measures that putting up a notice of operating etc..

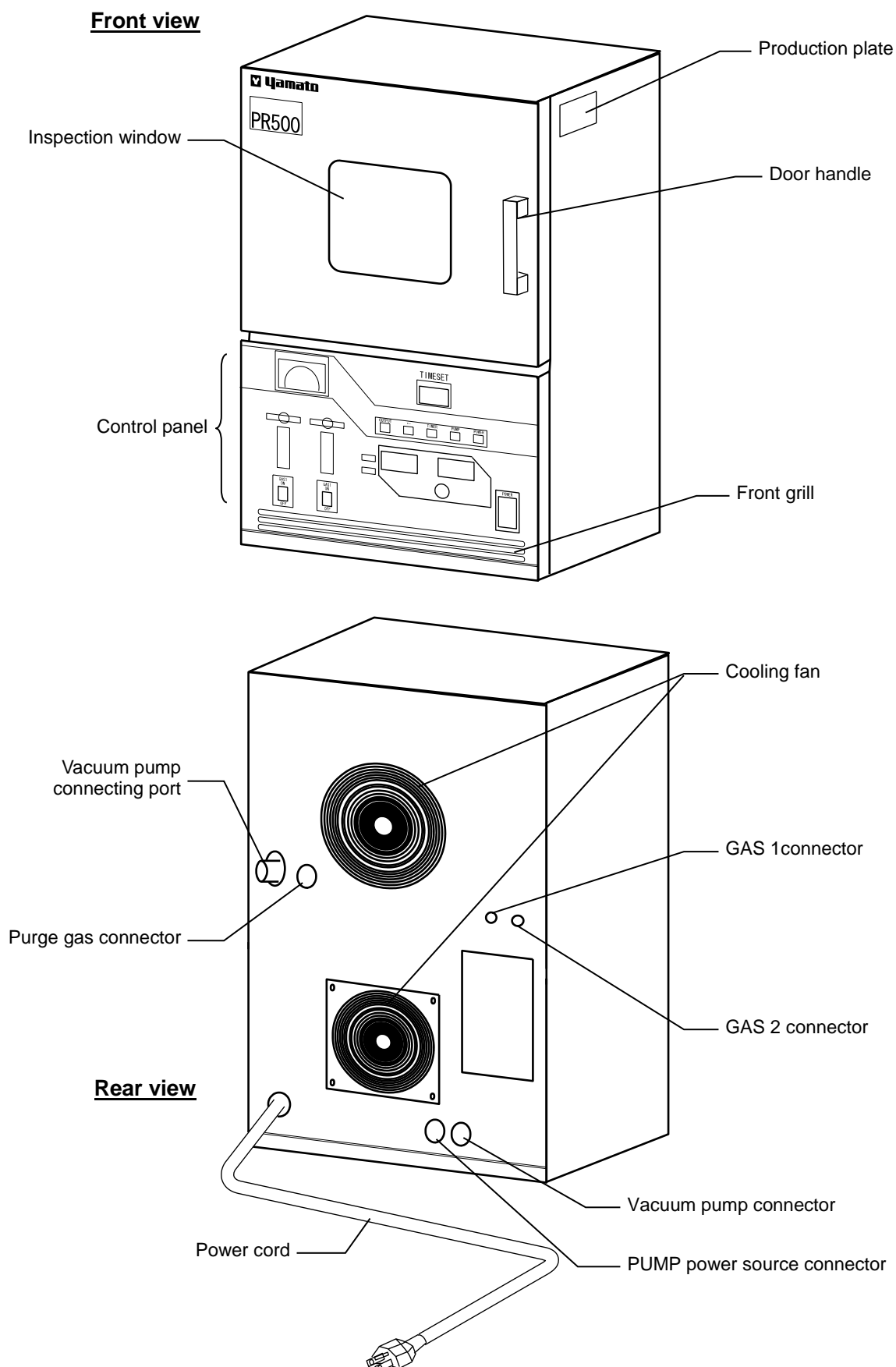
#### 8. Connection to vacuum pump



- Use the vacuum pump with the displacement of 250 to 500 ℓ /min.

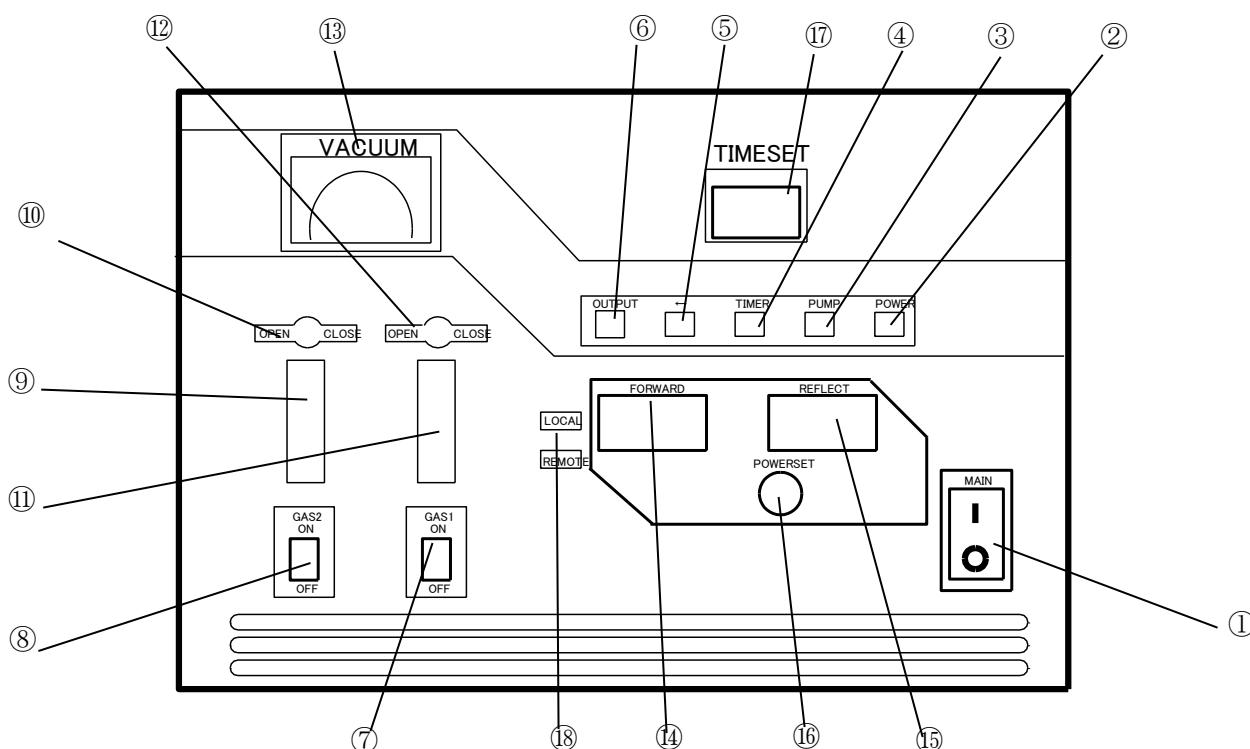
# Description and Function of Each Part

## Main Unit



# Description and Function of Each Part

## Control Panel



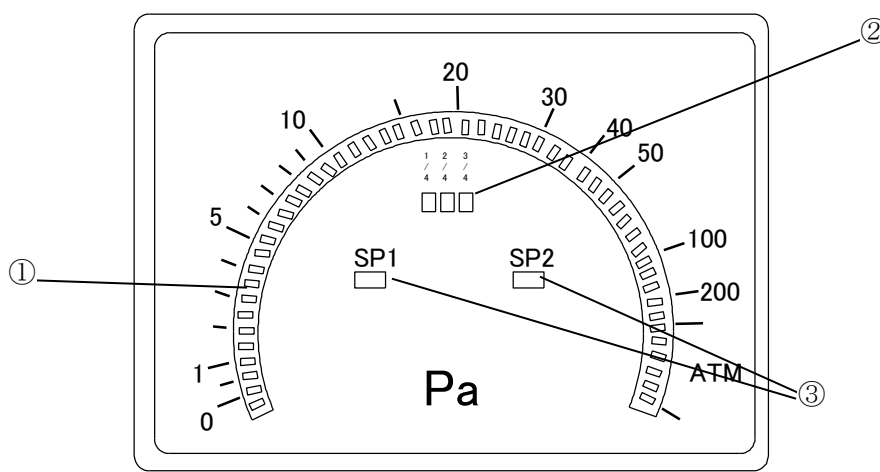
① Main Switch:	Switches the main power supply and functions as a circuit protector, too. When over current is detected, it turns off the power supply.
② Power Switch:	Starts to operate cooling fan when it is turned on. The lamps light on. The solenoid valve for leak is also turned on.
③ Pump Switch:	The switch to drive the vacuum pump. The pump starts to operate when this switch is turned on. At the same time the solenoid valve for leak is turned off. The lamp lights on.
④ Timer Switch:	Used to apply high-frequency power for definite period of time. Normally turn the switch to OFF. The lamp lights on when the switch is turned to ON.
⑤ Ready Lamp:	Lights on after three minute has passed since the pump switch ON. The output switch is possible to be set to ON after the lamp lights on.
⑥ Output Switch:	ON/OFF switch for high-frequency power. The lamp lights on when this switch is turned to ON
⑦ Gas Valve 1 (CF <sub>4</sub> ) Switch:	ON/OFF switch for solenoid valve for supplying CF <sub>4</sub> gas.
⑧ Gas Valve 2 (O <sub>2</sub> ) switch:	ON/OFF switch for solenoid valve for supplying O <sub>2</sub> gas.
⑨ Flow Meter (O <sub>2</sub> ):	Indicates the flow rate of O <sub>2</sub> gas inside the reaction tune.
⑩ Needle Valve Knob (O <sub>2</sub> ):	Adjusts the flow rate of gas that is taken into the reaction tube while monitoring ⑨ above.
⑪ Flow Meter (CF <sub>4</sub> ):	Indicates the flow rate of CF <sub>4</sub> gas inside the reaction tune.
⑫ Needle Valve Knob (CF <sub>4</sub> ):	Adjusts the flow rate of gas that is taken into the reaction tube while monitoring ⑪ above.
⑬ Vacuum Meter (Refer to Page 9.):	Indicates the pressure inside reaction tube by Pa (0~200) .

## Description and Function of Each Part

### Control Panel

⑭ <b>Output Power Knob:</b>	Indicates the output power (0 to 500W).
⑮ <b>Reflected Power Meter:</b>	Indicates the reflected power to the output in ⑭.
⑯ <b>Output Control Valve:</b>	Controls the output power within the range from 0 to 500 watts.
⑰ <b>Timer:</b>	Sets the timer of high-frequency applying period.
⑱ <b>Power Switch for High-frequency Power Source:</b>	The power is on at RF ON. The power is off at RF OFF. Normally use this switch at ON.

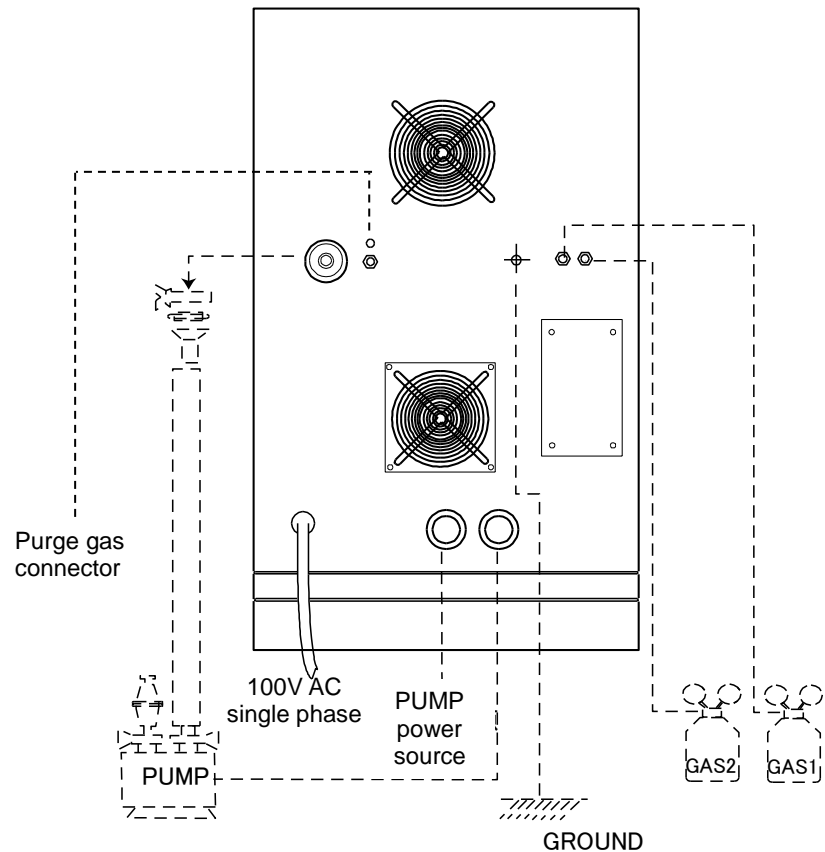
### Enlarged View of Vacuum Meter



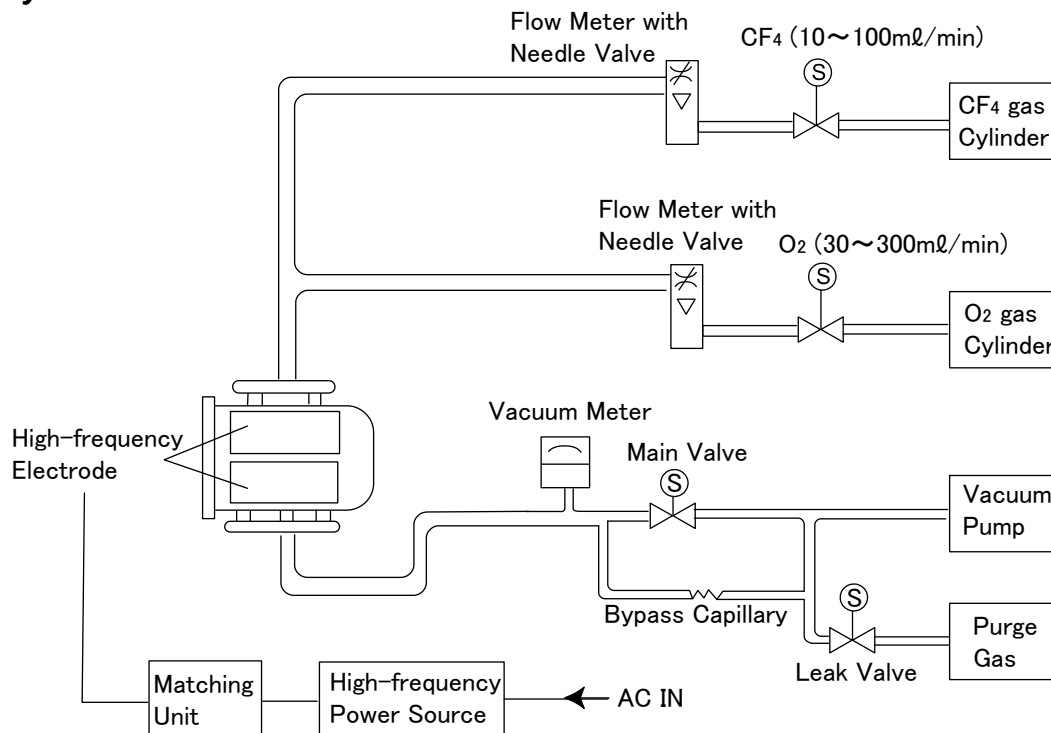
① <b>Scale LED</b>	Scale displays of the Pa output state with the LED lamp
② <b>Auxiliary Scale</b>	Displays the output state between memories in ① (LED lamp) by 1/4, 2/4 and 3/4.
③ <b>Pressure Set Point Output</b>	Corresponds with custom-build specifications only. It can not be used in the standard specification.

## Cable tube connection

- Connect the cable tube according to the right figure.
- Refer to the connection of vacuum pump and gas piping for the page 12.
- ❖ The parts enclosed with the dotted line indicate optional accessories.



## Piping System View

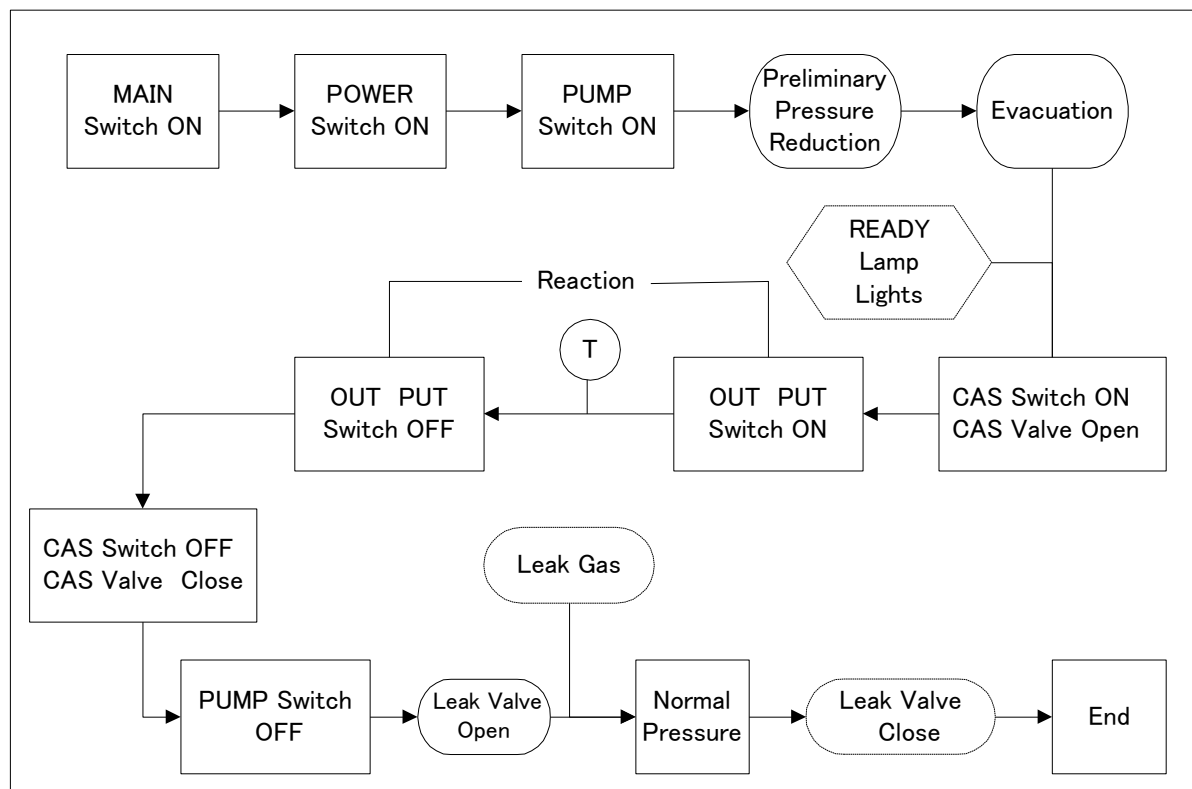


## Principle of operation

(Refer to the operation flow chart below.)

- The controller supplies the high-frequency power of 13.56MHz generated by crystal oscillation to the reaction section. The output range is from 0 to 500W that can be set to desired value with the wattmeter attached.
- Two kinds of gas, O<sub>2</sub> (30~300mℓ/min) and CF<sub>4</sub> (10~100mℓ/min) can be supplied to the reaction tube with the flow meter. The flow rate can be set to desired value.
- The gas is changed into plasma by high-frequency energy applied to the high-frequency supplying electrode.
- The gas exhaust is carried out through the main valve on vacuum meter, bypass, and leak valve. Turning the pump switch to ON starts pressure reduction through the bypass. After around 2 minutes, the main valve opens to increase the reduction speed. Turning the pump to OFF closes the main valve and opens the leak valve. The pressure in the reaction tube is intensified to normal pressure.

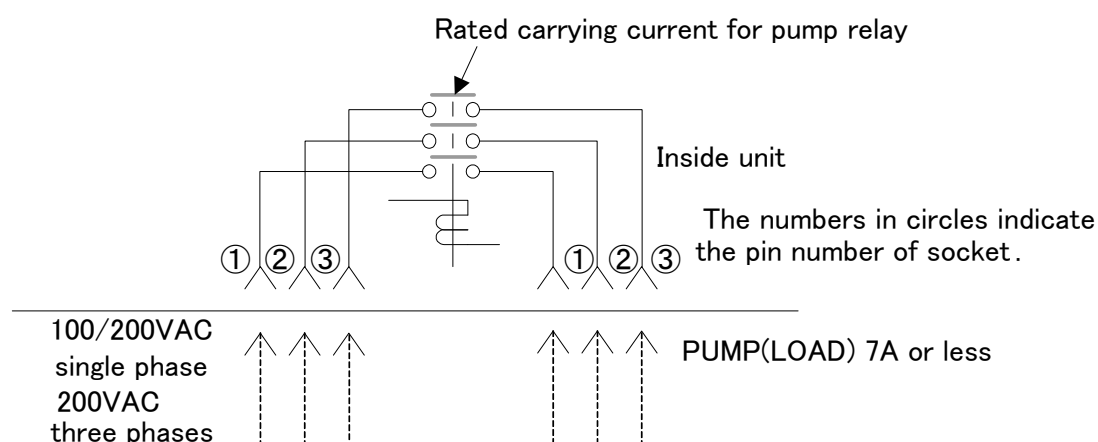
## Operation flow chart



## Preparation for operation

### Connection to vacuum pump

- Use the vacuum pump with the displacement of 250~500 ℓ /min (7A or below).
- A NW 25 flange type is used to connect the unit and vacuum pump. In case a vacuum hose is used for connection, a rubber tube adapter, center ring and clamp are needed.
- Attaching an oil mist eliminator such as a trap at the exhaust opening of vacuum pump prevents smoke. When vacuuming the reaction by CF<sub>4</sub>, mix it with N<sub>2</sub> gas to exhaust, or make a clearance of 0.5 to 1m between the oil mist eliminator and pump to prevent corrosion. Exhaust gas should be exhausted outside room (hoses are not attached.).
- Relays for pump are inside the unit. Wire connect to the metal connector attached referring to the figure below for the connection to pump



Note: Pump cable is optional.

### Gas piping

- The gas inlet uses 1/4" swagelok. Prepare the tube with outer diameter of 1/4" for connection. The types of gas used in the unit are O<sub>2</sub> and CF<sub>4</sub>. Prepare the gas container with capacity of 1.5 to 7m<sup>3</sup>. The gas container with single pressure adjuster is useful.
- Adjust the secondary pressure to 1Kg/cm<sup>2</sup> if used.
- Before using the gas other than O<sub>2</sub>, check its properties and understand them. Make sure to connect the exhaust gas hose when using harmful gas.

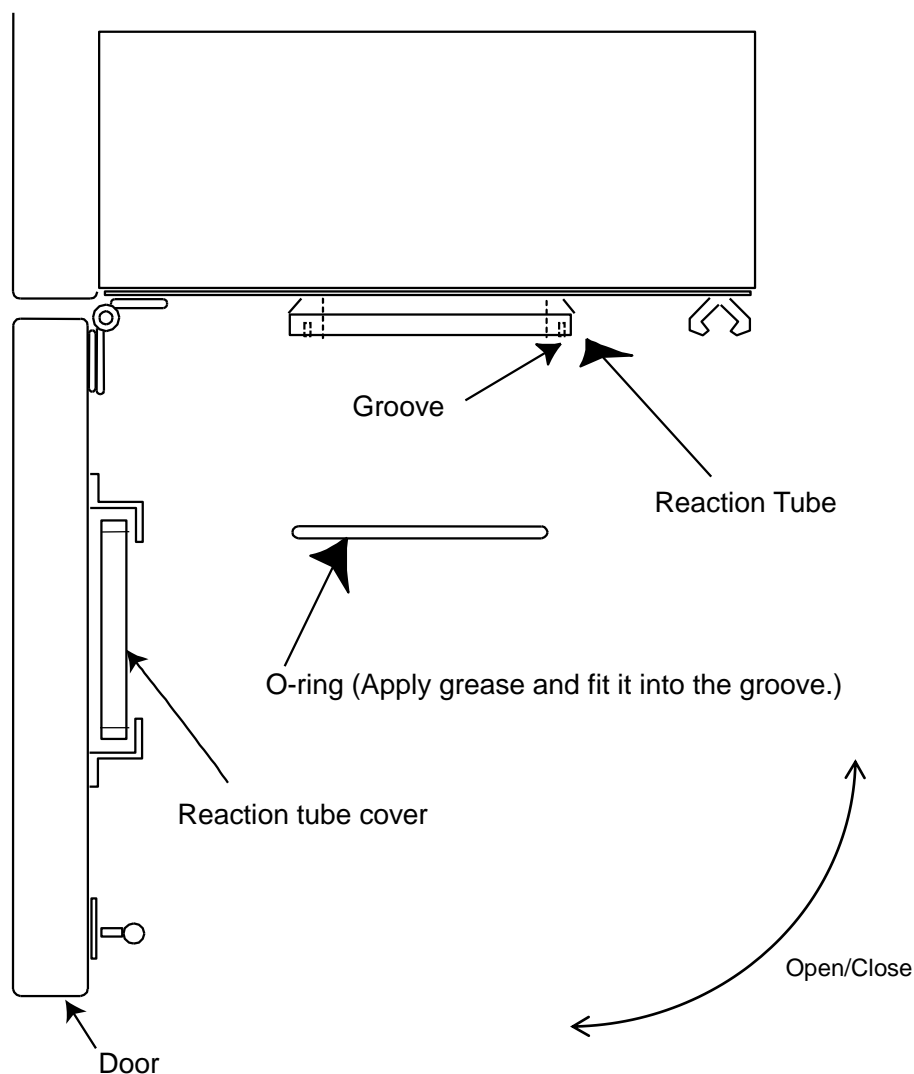
## Preparation for operation

### Sample setting

1. Place the samples on the sample tray so they are placed evenly as possible. Use the well-dried samples. If they contain much moisture or are wet, the vacuum degree becomes unstable, that may result in tuning failure (sample tray: optional accessory) .
2. Push the front door at the top of handgrip to open it. Put the sample tray in the reaction chamber.
3. Apply attached silicon grease on the O ring at reaction tube. Fit the ring into the groove on the reaction tube. Do not apply too much grease on the ring. It may be removed from the groove.
4. Cover the cap on reaction tube and then close the door.



There is a possibility that silicone grease may enter into the reaction tube.



Top View with Door Opened



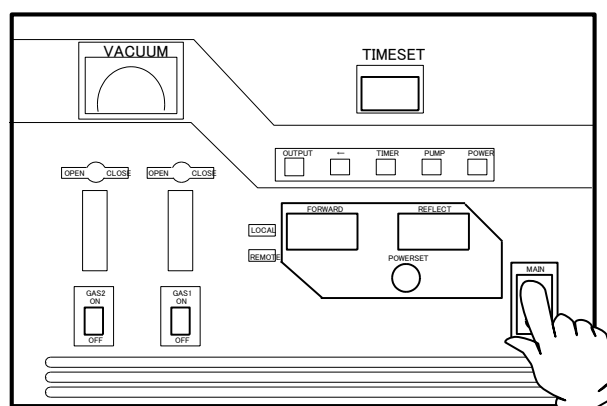
## Operation Procedure

Check the followings before starting operation.

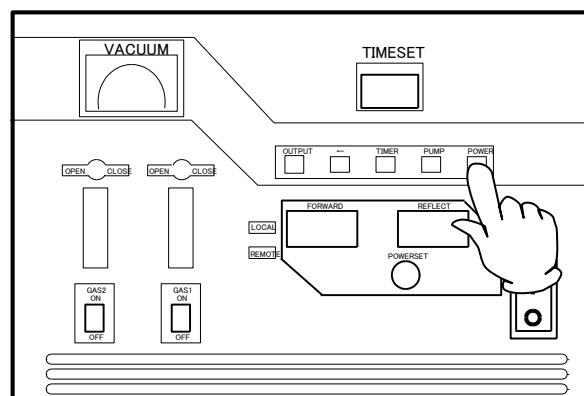
- Turn all switches and knobs to “OFF”, “MIN” or “CLOSE”.
- The ground of unit is surely connected.
- Gas piping is provided from the gas container to the inlet of O<sub>2</sub> or CF<sub>4</sub> gas. Adjust its secondary pressure to 1kg/cm<sup>2</sup>.
- Check that the power source to be used complies with specification of vacuum pump.
- Connect the power source of unit to 100VAC (50/60Hz).

### 1) Operation start

1. Turn the MAIN switch to ON.

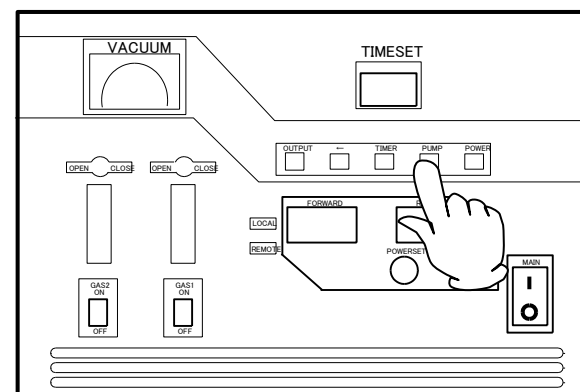


2. The lamp lights on and the cooling fan starts to operate as the POWER switch is turned to ON. The solenoid valve for leak is turned to ON, too.



3. Evacuation starts and the lamp lights on as the PUMP switch is turned to ON. Pressure reduction is carried out at the glass capillary first, and then inside the reaction tube. After around two minutes, the main valve opens and reduction speed increase. After one minute, the yellow ready lamp lights on, where the OUTPUT switch is possible to be turned to ON.

NOTE) In normal condition, the indicating needle on the vacuum meter swings as the PUMP switch is turned to ON. If the O-ring and cover on the reaction tube do not contact closely, it does not swing. In this case open the door and check that if the O-ring is fitted securely in the groove. If removed, apply grease on the ring and fit it to the groove again.



## Operation Procedure

### 2) Generation of plasma

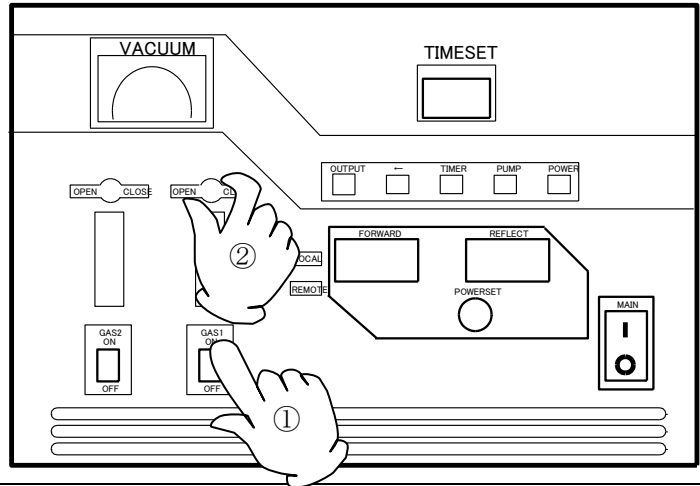
1. After the yellow ready lamp lights on, check that the vacuum meter reads 10Pa or less with the gas valve switch turned to OFF. Turn the gas valve switch to ON and needle valve knob to OPEN to adjust the flow rate (around 1/3 of output).

300W → 100 ml /min

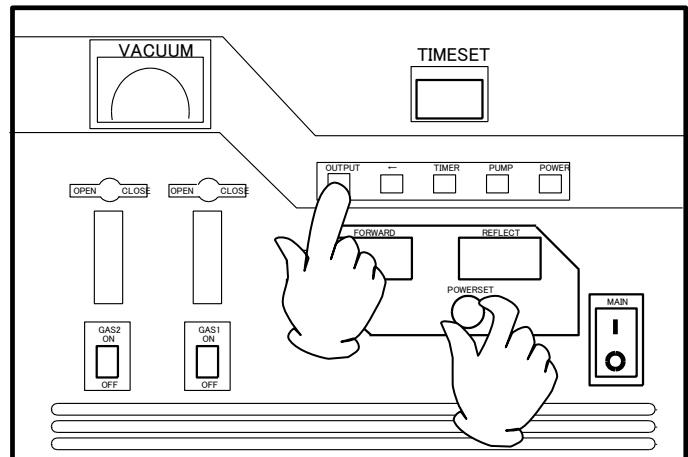
200W → 70 ml /min

100W → 30 ml /min

NOTE) When a vacuum pump with low displacement is used, an area with low degree of vacuum exists though the ready lamp lights on. Please wait until it becomes 10 Pa or less.

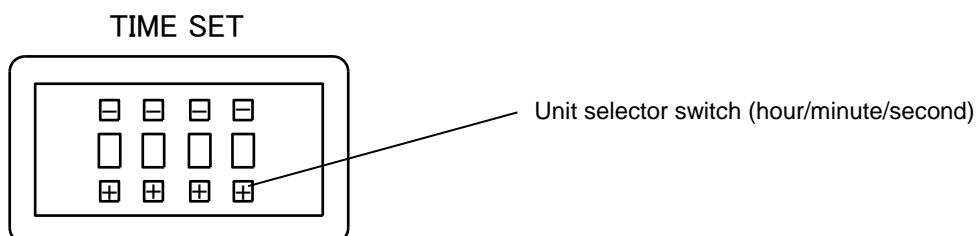


2. Turn the red OUTPUT switch to ON and generally turn the output control knob to MAX side. Set desired output with the FORWARD POWER meter.



### 3. Timer

To apply high-frequency power for the definite period of time, set the desired period by setting the timer. Press the unit selector switch on the right edge to select the desired unit to be edited (hour/minute/second). Enter the numeric value with the switch. Turn the TIMER switch to ON after the setting is completed.



Press the unit selector switch to change the unit to be edited.  
It changes in the order of "0.1s→s→0.1m→m→0.1h→h→10h".

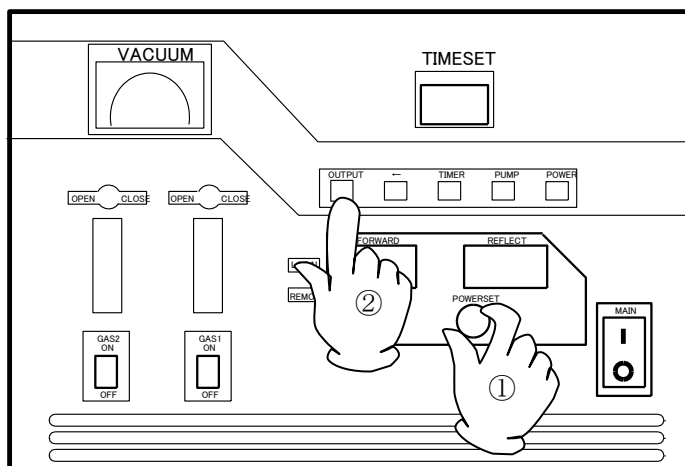
## Operation Procedure

### 3) Sample unloading

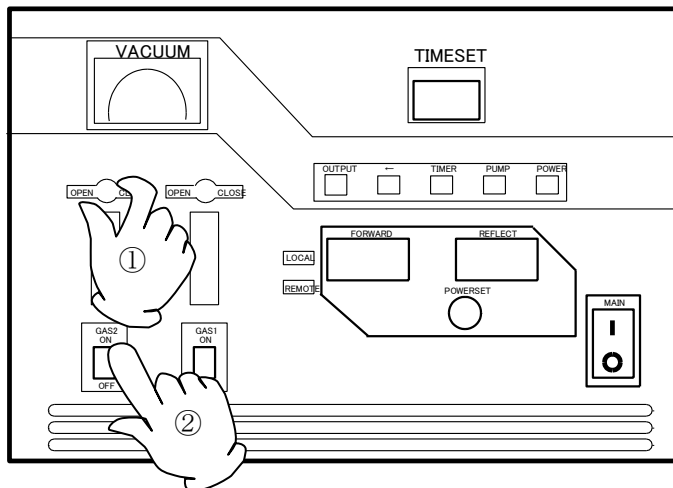
The power of unit is turned to OFF and both the OUTPUT and ready lamps light off when the time is over if used.

The switches for vacuum pump and gas valve, however, remain to ON. Turn them to OFF and stop supplying gas before unloading the sample. The unloading procedures are as follows;

1. Turn the output control knob (OUTPUT) fully to the MIN and turn the OUTPUT switch to OFF.

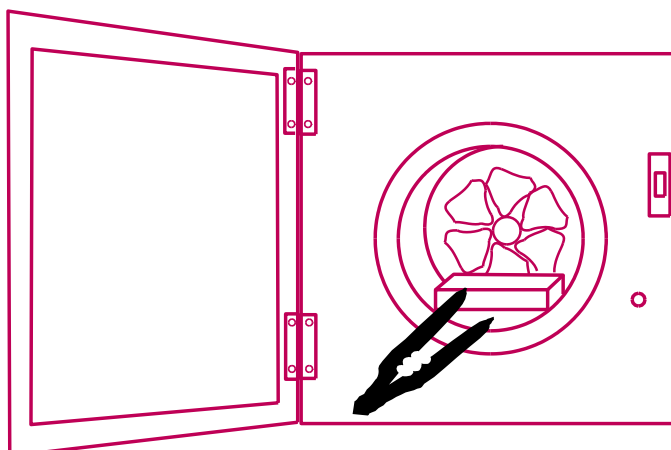


2. Turn the TIMER switch to OFF if used.
3. Turn the needle valve fully to CLOSE. Do not turn it too hard because the needle may be broken. Turn the gas valve switch to OFF.



## Operation Procedure

4. Turn the PUMP switch to OFF. The leak valve opens to reduce the pressure in the reaction tube to normal in two minutes.
5. After the pressure in the reaction tube is returned to normal, open the door of unit and unload the samples per carrier with tweezers. Be careful not to burn your skin because the temperature inside the unit is so high.



Be careful not to burn your skin because the temperature inside the unit is so high. Close the door after unloading the samples.

6. To treat other samples continuously, repeat the operation above. To end the operation, turn the POWER and MAIN switches to OFF.

## 4) Sample treatment

### 1. Treatment methods

- Removal of photo resist ( $O_2$  gas is used)
- Etching of  $SiO_2$  and  $Si_3N_4$  ( $CF_4$  gas is used)
- Surface treatment of polymer resin such as plastic ( $O_2$  gas is used)
- Surface cleaning of material ( $O_2$ ,  $N_2$  and  $CO_2$  gas is used)
- Low temperature ashing of organic matter ( $O_2$  gas is used)

### 2. Treatment conditions

The rate used for the removal of photo resist or etching of  $SiO_2$  and  $Si_3N_4$  varies with the following factors. Find the optimum conditions by conducting experiments.


- RF output, flow rate of gas and degree of vacuum in the reaction tube (pump displacement)
- The number of wafer, its size, loading interval, and loading position in the reaction tube.
- Difference in generation of  $SiO_2$  and  $Si_3N_4$  and area
- Photo resist type, application thickness and baking temperature




The unit door is not open if the POWER switch is turned to OFF before the pressure inside the reaction tube completes to return to normal pressure because of the vacuum condition inside the tube. It may be broken if opened by force. In this case, turn the POWER switch to ON again and completely return the vacuumed pressure inside the tube to normal.

### **WARNING!**

#### **If a problem occurs**


-  If smoke or strange odor should come out of this unit for some reason, turn off the power key right away, and then turn off the breaker and the main power. Immediately contact a service technician for inspection. If this procedure is not followed, fire or electrical shock may result. Never perform repair work yourself, since it is dangerous and not recommended.

#### **Substances that cannot be used**


-  Never use explosive substances, flammable substances and substances that include explosive or flammable ingredients in this unit. Explosion or fire may occur. (Refer to page 27 "List of Dangerous Substances".)

### **CAUTION!**


#### **Overload capacity**

-  Do not put too much samples in the unit in order to achieve its performance sufficiently. The load (sample quantity) should be 5% or less of chamber capacity.


#### **Do not step on this unit**

-  Do not step on this unit. It will cause injury if this unit fall down or break.


#### **Do not put anything on this unit**

-  Do not put anything on this unit. It will cause injury if fall.


#### **During a thunder storm**

-  During a thunderstorm, turn off the power key immediately, then turn off the breaker and the main power. If this procedure is not followed, fire or electrical shock may be caused.


#### **Do not touch high-temperature parts**

-  Some parts of this unit become hot during and just after operation. It may cause burns.


#### **Do ventilation**

-  Depending on the gas used, plasma may generate ultraviolet ray, which acts on oxygen in air and may generate ozone. Do sufficient ventilation inside room or provide a duct at the exhaust fan on the chamber.

#### **Adjust gas pressure**

-  Adjust the gas pressure with a pressure controller so its secondary pressure be less than 1Kg/cm<sup>2</sup> when supplied from the gas container to the inlet.

#### **Do not make impact**

-  Do not make an impact on the reaction tube or unit with the tube vacuumed. The tube may burst.

### Effect of high-frequency wave



When operating other devices in parallel with this unit, they may be affected with high-frequency wave. Leave them as long distance as possible from this unit if unavoidable. Do not use the same power supply line as that for this unit.

### As for gas to use



Depends on the use of gas ultraviolet rays will be send out because of plasma and there will be the possibility to have ozone evolution reacting against enzyme in air. In this case keep the room be well-ventilated or installing duct or other kind of equipment on this devise to exhaust the air outside.

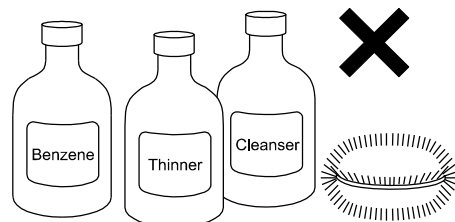
### Daily Inspection and Maintenance

#### **WARNING!**

- Disconnect the power cable from the power source when doing an inspection or maintenance unless needed.
- Perform the daily inspection and maintenance after returning the temperature of this unit to the normal one.
- Do not disassemble this unit.

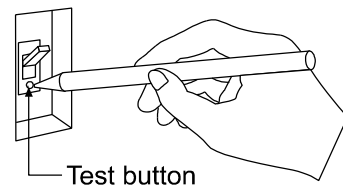
#### **CAUTION!**

- Use a well-drained soft cloth to wipe dirt on this unit. Do not use benzene, thinner or cleanser for wiping. Do not scrub this unit. Deformation, deterioration or color change may result in.



### Monthly maintenance

- Check the earth leakage breaker function.
  1. Connect the power cord.
  2. Turn the breaker on.
  3. Push the red test switch by a ballpoint pen etc.
  4. If there is no problem, the earth leakage breaker will be turned off.



### Oil exchange on vacuum pump

- Clean the vacuum pump and exchange the oil once in one or two months (the period depends on the frequency/pressure of use). If not, the performance of pump and its efficiency may degrade.

For any questions, contact the dealer who you purchased this unit from, or the nearest sales division in our company.

### When not using this unit for long term / When disposing

#### **CAUTION!**

##### When not using this unit for long term...

- Turn off the power and disconnect the power cord.

#### **WARNING!**

##### When disposing...

- Keep out of reach of children.
- Treat as large trash.

### ***Environmental protection should be considered***

We request you to disassemble this unit as possible and recycle the reusable parts considering to the environmental protection. The feature components of this unit and materials used are listed below.

Component Name	Material
<b>Parts of Main Unit</b>	
Exterior	Iron steel plate
Interior	Stainless steel, SUS304, Quartz, Aluminum
Production plates	Polyethylene (PET) resin film
Knob	Resin Rubber, SUS304
<b>Electrical Parts</b>	
Switch, Relays	Resin, Composites of copper and other
Boards	Composites of grass fiber and other
Power Cord	Composites of synthetic rubber, copper, nickel etc.
Fan motor	Composites of synthetic aluminum, copper, resin etc.
Piping parts	Stainless steel, Teflon, Silicon



### Trouble Shooting

Condition	Check the following
Pump does not operate though PUMP switch is pressed.	<ul style="list-style-type: none"><li>• Check if the power source for vacuum pump is turned to ON.</li><li>• Check if the door of chamber is closed.</li><li>• Check if the cable for pump is connected securely.</li></ul>
Degree of vacuum not good	<ul style="list-style-type: none"><li>• Check if the reaction tube and cover contacts closely.</li><li>• Check if vacuum leakage exists.</li></ul>
No RF output	<ul style="list-style-type: none"><li>• Check if the door of chamber and/or top board is closed.</li></ul>
Matching is not provided.	<ul style="list-style-type: none"><li>• Check if the degree of vacuum is good.</li></ul>

In the case if the error other than listed above occurred, turn off the power switch and primary power source immediately. Contact the shop of your purchase or nearest Yamato Scientific Service Office.

### In Case of Request for Repair

If the failure occurs, stop the operation, turn OFF the power switch, and unplug the power plug. Please contact the sales agency that this unit was purchased, or the Yamato Scientific's sales office.

#### < Check following items before contact >

- ◆ Model Name of Product
  - ◆ Production Number
  - ◆ Purchase Date
  - ◆ About Trouble (in detail as possible)
- } See the production plate attached to this unit.

### Minimum Retention Period of Performance Parts for Repair

The minimum retention period of performance parts for repair of this unit is 7 years after discontinuance of this unit.

The "performance part for repair" is the part that is required to maintain this unit.

<b>Model</b>	PR500
<b>High-frequency power</b>	0 to 500W continuous variable
<b>Oscillation frequency</b>	13.56MHz crystal oscillation
<b>Output impedance</b>	50 $\Omega$
<b>End element</b>	FET (field effect transistor)
<b>Timer</b>	0.1sec to 999h can be set.
<b>Attached instruments</b>	Output power meter (0 to 500W) Reflected power meter (0 to 500W) Vacuum meter (0 to 200Pa) Flow meter (O <sub>2</sub> 30 to 300 ml / min ) (CF <sub>4</sub> 10 to 100 ml / min )
<b>Tuning method</b>	Automatic tuning method
<b>Used gas</b>	O <sub>2</sub> , CF <sub>4</sub>
<b>Gas inlet</b>	1/4" swagelok
<b>Protection circuit</b>	Protection of build-in power supply (shut down) at load unconformity (power down) and at over power of circuit breaker
<b>Power supply</b>	100V AC (1 $\phi$ 50/60Hz) 15A
<b>Reaction tube</b>	Quartz
<b>Reaction tube dimensions</b>	$\phi$ 215 $\times$ 310 L mm
<b>Structure of electrodes</b>	Capacitor type, four-divided
<b>Control system</b>	Automatic pressure reduction, auto leak valve
<b>Piping material</b>	SUS304, 316 and Teflon piping
<b>Leak gas inlet</b>	1/4" swagelok
<b>Vacuum pump inlet</b>	NW25 flange type
<b>External dimensions</b>	438(W) $\times$ 520(D) $\times$ 760(H) mm
<b>Weight</b>	Approx. 53Kg
<b>Standard accessories</b>	Vacuum grease(1), O ring for reaction tube(1), Plug for pump cable(2), Instruction manual,

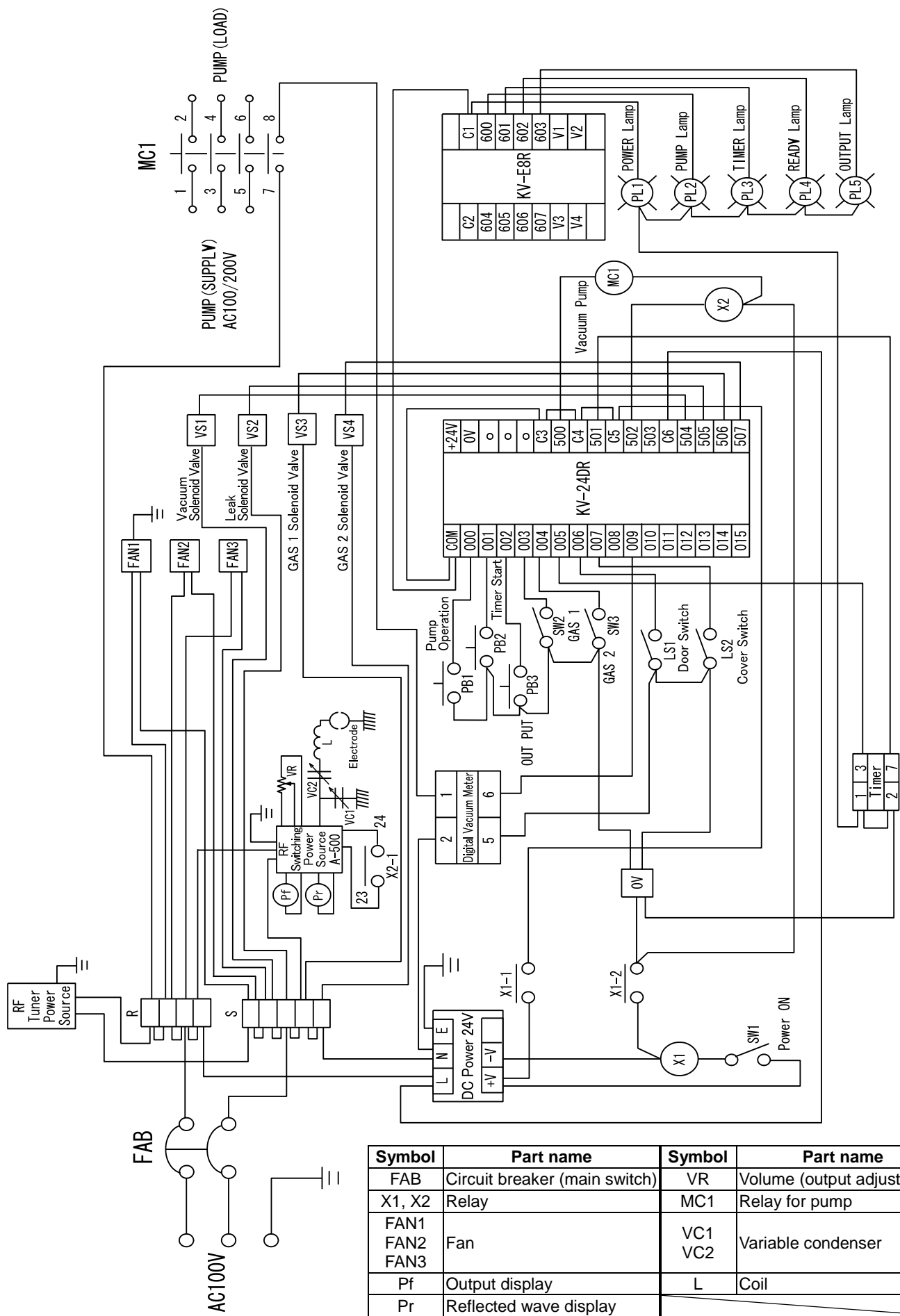
## Optional Accessories

		Displacement		Power supply	
<b>Vacuum pump</b>	Standard	2015SD	250 $\ell$ / min	AC100/200/200	3 $\phi$
	Chemical	2015C2	250 $\ell$ / min	AC100/200/200	3 $\phi$
<b>Vacuum hose</b>	Silicon: $\phi$ 20 $\times$ $\phi$ 40 $\times$ 1000 $\ell$ m Flexible tube: NW25 flange equipped 0.5/1.0/1.5/2m				
<b>Rubber tube adapter</b>	NW25				
<b>Center ring</b>	NW25 Neopullen — A $\ell$ NW25 Byton — SUS304				
<b>Sample frame</b>	Quartz 2~5" wafer frame Multipurpose angle frame				
<b>Etching tunnel</b>	Made by A $\ell$ $\phi$ 180 (Max.)				

## Peripheral devices

- Oxygen gas container: 7000  $\ell$  including gas
- Freon container: 1500 $\ell$  including gas
- Pressure regulator for oxygen/freon: (made by SUS)
- Motor lorry to carry gas container: (large size: 7000  $\ell$  )
- Gas container frame: (frame for two containers, installed on floor)

Wiring Diagram



Symbol	Part name	Symbol	Part name
FAB	Circuit breaker (main switch)	VR	Volume (output adjustment)
X1, X2	Relay	MC1	Relay for pump
FAN1 FAN2 FAN3	Fan	VC1 VC2	Variable condenser
Pf	Output display	L	Coil
Pr	Reflected wave display		

## Replacement Parts Table

Part Name	Code No.	Specification	Manufacturer
Reaction tube	9583	Quartz	Yamato Scientific
Reaction tube cover	9584	Quartz	Yamato Scientific
Capillary	9585	Quartz	Yamato Scientific
Solenoid valve (main)	9592	HVB612-12F-8B-AC100V	CKD
Gauge head	9594	TG-550	Anelba
Solenoid valve (gas leak)	9591	HVB112-6N-5 AC100V	CKD
Fan	9577	MU1225S-11	Orientalmotor
Limit switch	9502	D4MC-5000	Omron
High-frequency power source	9571	RF-500 PR500	Yamato Scientific
DC power source	9556	KV-U3	Keyence
Vacuum meter	9595	MTG-011	Anelba
Flow meter	9514	RK1200-12-SS-1/4-O <sub>2</sub> 300 ml / min -1K-O-U	KOFLOC
Flow meter	9515	RK1200-12-SS-1/4-CF <sub>4</sub> 100 ml / min -1K-O-U	KOFLOC
Digital timer	9507	H3CA-8 DC24V	Omron
Command switch (power, pump, timer)	9500	A3SA-90D1-24EW	Omron
Command switch (output)	9501	A3SA-90D1-24ER	Omron
Locker switch	9574	JW-S11RKK	Nikkai
Circuit breaker	9506	BAM2-15-031	Panasonic
Contactor	9557	J7AN-E3 DC24V	Omron
Cooling fan for coil	9578	109-311	Sanyo Denki
Relay	9575	MY2N-DC24V	Omron
Limit switch	9503	V-56-1A4	Omron
O ring (*)	9520	P230	Yamato Scientific

\*: Expendables

Refer to the described code No. for the part to be replaced.

## List of Dangerous Substances



Never use explosive substances, flammable substances and substances that include explosive or flammable ingredients in this unit.

### EXPLOSIVE

<b>EXPLOSIVE:</b>	Ethylene glycol dinitrate (nitro glycol), Glycerin trinitrate (nitroglycerine), Cellulose nitrate (nitrocellulose), and other explosive nitrate esters
	Trinitrobenzene, Trinitrotoluene, Trinitrophenol (picric acid), and other explosive nitro compounds
	Acetyl hydroperoxide (peracetic acid), Methyl ethyl ketone peroxide, Benzyl peroxide, and other organic peroxides

### FLAMMABLE

<b>IGNITING:</b>	Lithium (metal), Potassium (metal), Sodium (metal), Yellow phosphorus, Phosphorus sulfide, Red phosphorus, Celluloid compounds, Calcium carbide, Lime phosphate, Magnesium (powder), Aluminum (powder), Powder of metals other than magnesium and aluminum, Sodium hydrosulfite
<b>OXIDIZING:</b>	Potassium chlorate, Sodium chlorate, Ammonium chlorate, and other chlorate
	Potassium perchlorate, Sodium perchlorate, Ammonium perchlorate, and other perchlorate
	Potassium peroxide, Sodium peroxide, Barium peroxide, and other inorganic peroxide
	Potassium nitrate, Sodium nitrate, Ammonium nitrate, and other nitrate
	Sodium chlorite and other chlorites
<b>INFLAMMABLE LIQUID:</b>	Calcium hypochlorite and other hypochlorites
	Ethyl ether, Gasoline, Acetaldehyde, Propylene chloride, Carbon disulfide, and other flammable substances having a flash point of lower than -30°C
	Normal hexane, ethylene oxide, acetone, benzene, methyl ethyl ketone, and other flammable substances having a flash point of -30°C or higher but lower than 0°C
	Methanol, Ethanol, Xylene, Pentyl acetate (amyl acetate), and other flammable substances having a flash point of 0°C or higher but lower than 30°C
<b>FLAMMABLE GAS:</b>	Kerosene, Light oil (gas oil), Oil of turpentine, Isopentyl alcohol (isoamyl alcohol), Acetic acid, and other flammable substances having a flash point of 30°C or higher but lower than 65°C
	Hydrogen, Acetylene, Ethylene, Methane, Propane, Butane, and other flammable substances which assume a gaseous state at 15°C and 1 atm

(Source: Appendix Table 1 of Article 6 of the Industrial Safety and Health Order in Japan)



## Responsibility

Please follow the instructions in this document when using this unit. Yamato Scientific has no responsibility for the accidents or breakdown of device if it is used with a failure to comply. Never conduct what this document forbids. Unexpected accidents or breakdown may result in.

## Note

- ◆ The contents of this document may be changed in future without notice.
- ◆ Any books with missing pages or disorderly binding may be replaced.

Instruction Manual for

**Plasma Reactor**  
**Model PR500**

Second Edition     June. 10, 2011

Revised             October. 28, 2013

---

**Yamato Scientific Co., Ltd.**

2-2-1 Nihonbashi Muromachi, Chuo-ku,  
Tokyo, 103-0022, Japan  
<http://www.yamato-net.co.jp>