OPERATION AND MAINTENANCE MANUAL

GLOW

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NOTICE

Contact Us

Glow Research welcomes requests for information, comments, and inquiries about its products.
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Trademarks

Preface

Intended Audience

The *GLOW Installation, Operation, and Maintenance Manual* is the primary reference and operating guide for GLOW Plasma System. This information is intended for the following:

- Individuals
- Equipment Operators
- Technicians/Maintenance Engineers
- Process Engineers
- Optical Lab Staff

The *GLOW Operation, and Maintenance Manual* provides a complete reference to all system controls. All user-level hardware, interfaces and directions are described, along with their associated operating procedures.

Organization of the Manual

The *GLOW Operation, and Maintenance Manual* contains the following chapters:
Chapter 1 – Introduction provides an overview of the GLOW and the plasma process.
Chapter 2 – Safety provides safety guidelines that should be followed when operating, maintaining, and servicing the GLOW.
Chapter 3 – Unpacking describes how to inspect your delivery for damage and how long term storage should be handled for the GLOW.
Chapter 4 – Installation provides instructions for assembling and initially starting up the system.
Chapter 5 – Equipment Orientation explains space needs for the GLOW and how the controls and indicators are used.
Chapter 6 – Theory of Operation explains the basic elements of Plasma Treatment.
Chapter 7 – Operation Procedures explains the standard operating procedures for the GLOW.
Chapter 8 – Service and Maintenance recommends basic maintenance procedures for ensuring proper system operation. It also talks about system troubleshooting procedures.
Appendix – describes how to set up a plasma process, lists of consumables,
Glossary – describes terms used in this manual.

Symbols: The following symbols are used in Warning and Caution notes to indicate potentially safety hazards while performing task described in this manual.

Electrical Hazard Warning—Warns personnel that special caution must be exercised. A caution alert stresses the importance of following proper operating or maintenance procedures. Otherwise, equipment reliability could be affected. This label is located on the back panel, left and right covers of the GLOW.

RF Radiation Hazard—Warns personnel of an RF energy radiation hazard. The GLOW unit uses an RF generator, which produces RF energy at levels that may cause burns. Improper connections or operations without protective covering may result in RF radiation exceeding safety standards. This label is located on or next to the load door, left and right covers.

Thermal Hazard—Warns personnel of hot surfaces inside the machine that may cause burns if touched. It should be on or next to the load door.

Wear Protective Gloves—Warns personnel that hazards exist that require them to wear protective gloves. It should be on or next to the load door.

UV Warning—Warns personnel that looking into the UV light may be hazardous. The GLOW has UV shielding on the outside the view port window. This warning label is located on or next to the load door.

Disconnect the GLOW before Removing Cover—Warns users that only authorized personnel should open the cover due to hazardous voltage. This warning label should be on the left cover and on the vacuum pump access cover.

1. INTRODUCTION

This manual is broken down into sections dealing with all issues related to the GLOW Plasma System.

This includes detailed installation instructions, specifications, and a full description of the equipment and all controls and indicators on the equipment components.

A safety hazards and precautions section points out any risks involved with equipment operation along with recommendations for safely operating and maintaining the system. The safety features included with the system are also outlined.

A section on theory of operation explains the principals behind plasma generation and the variables that are under operator control during process development and optimization. The goal is to give the beginning plasma process engineer a starting point for developing plasma treatments for various applications using the GLOW equipment. The user should contact Glow Research if more detailed process development assistance is required for a specific application.

Another section gives the step by step details for operation of the equipment.

The service information section contains the information on warranties, trouble shooting, equipment repair, and parts replacement.

The appendix lists a detailed explanation of the effect of changing the variables in the plasma process and a characterization of some aspects of the system.

A glossary defines the terms used in the manual.

Textural conventions used in the manual are as follows:

- In the Installation Instructions section, parts that the installer needs to attach to the main unit are listed in all CAPITAL LETTERS.
- In operating procedures. call-outs for buttons the operator is instructed to actuate are listed in all CAPITAL LETTERS.
- Section headings are in **bold print and underlined**.

Nomenclature for data entry in this manual and on the system itself uses **Torr** in reference to pressure, **Watts** (w) for power. and **seconds** (secs) or **minutes** (mins) for time.

Overview:

The GLOW plasma system is a tabletop plasma chemistry reactor designed to provide the optical, medical, scientific and educational community with a plasma system at moderate cost. The GLOW plasma system is designed to provide repeatable plasma processing for improving the wetabiliy of contacts, lenses and various substrates.

OPTIONAL EQUIPMENT:

VACUUM PUMP
The system is offered with an optional external 6-7 cfm scroll pump, or oil vacuum pump. It is recommended that the oil pump be prepared for Fomblin type oil if the user plans to use oxygen or fluorine gas.

CAUTION: The oil vacuum pump must have oil to operate. Damage to the vacuum pump could result if the oil level is too low. Check the oil level every 3 months.

NOTE: The sound pressure level of the optional Fomblin oil pump is <75 dB(A). The optional dry scroll pump is rated a < 52 dB(A).

PUMP OIL MIST ELIMINATOR
Collects and condenses the oil mist generated during pump operation. This leads to lower pump oil consumption and a cleaner operation.

Note: If the system is to be run with a fluorine based process gas, a special mist eliminator is suggested when using an oil based vacuum pump.

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OPTIONAL SPARE PARTS KIT
Includes spare parts that may be required for normal service or repair. Includes chamber door “o” ring seal, chamber “o” ring, viewport window.

OPTIONAL GAS VALVES ON BACK OF GLOW SYSTEM
Allows two gases to be plumbed into the back of the GLOW system. On/Off valve for each gas, so that one or both gases can be metered through the flowmeter on the front of the system.

Optional two valves on back of GLOW

STANDARD EQUIPMENT:

GAS CONTROL FLOWMETER

A flowmeter is provided to regulate the flow of gas into the chamber. The vacuum pressure of the chamber is regulated by the flow of gas into the chamber. The more flow, the higher the pressure.

Note: There is a gas solenoid valve on the gas inlet of the flowmeter. As a safety feature, this solenoid valve will only open when all safety interlocks are engaged and the RF is on.

Note: Incoming pressure into the back of the GLOW plasma system from the gas bottle should be at 10 psi. This allows maximum flow when the user is not using compressed gasses.

The rotameter units are in cc/min of air.

The measurement on the valve is a relevant measurement and not an absolute measurement. This is due to the positive pressure at the input port (compressed gas), and the negative pressure on the output port (going to the chamber). This rotameter replaces the older Porter flowmeter. This new rotameter has a much wider range than the older Porter meter.

Process pressure should be adjusted to the reading on the digital display. This is reading the actual pressure of the chamber. The position of the ball in the rotameter simply tells us that

there is gas flow through the rotameter, pressure adjustment should be made according to the desired pressure of the chamber.

NOTE: If you run your GLOW system using room air (without regulated gas at 10 psi) the operating pressure will be lower compared to operating with pressurized gas going into the back of the GLOW. Typically around .4 to .6 Torr when using room air as a process gas.

RF GENERATOR

A low frequency, 50 Watt, 100 kHz RF generator is installed as part of the system.

Fixed Matching Transformer

There is no RF tuning required for the GLOW system. The fixed matching transformer changes the impendence output of the matching network to match the input impendence of the chamber. There are no moving parts on the Fixed Matching Transformer. The impendence is set at Glow Research. This module does not require any maintaince.

An audible alarm will activate if for some reason there is a disruption of the current between the RF generator and the chamber.

NOTE: If you hear the audible alarm, you should call Glow Research Customer Support.

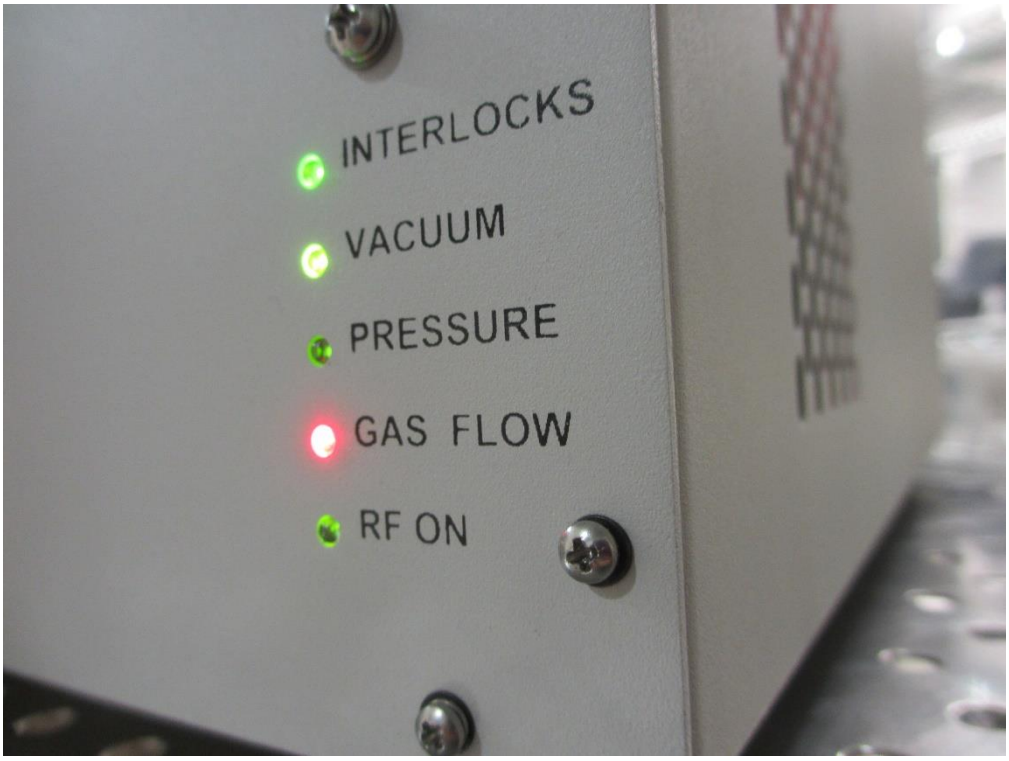
PRESSURE INDICATOR

A Pirani pressure gage is mounted on the back of the chamber—and will collect pressure readings from the chamber.

The GLOW has an anodized aluminum chamber and will report the actual pressure reading (accurate within 2 mTorr) on the front PRESSURE display. This pressure reading will give a reading of the chamber pressure. After the PROCESS START button has been depressed, the pressure sensor signals the system logic to start the process (RF and gas flow) when a pressure of .5 to .3 Torr has been achieved. The pressure sensor is designed to allow processing from between .25 Torr and 1.2 Torr. The PRESSURE INDICATOR does not display a reading until reaching a pressure of 1.5 Torr. as the system is pumping down to a lower pressure. The suggested process pressure envelope is from .5 to 1.2 Torr.

DIAGNOSTIC LED DISPLAY INDICATORS

Five LED display indicators are located on the lower front panel of the GLOW System. The LED's, when illuminated, provide the user confirmation that all the system modules are functioning correctly.



(above) LED Display

TIMER

The GLOW timer will only start and keep count of elapsed time when the system is tuned and in a working mode. This proprietary design means that the set time is the actual amount of time that the samples were exposed to a working plasma. Many competitive plasma systems merely start the timer when the system starts tuning—not when the system is actually processing samples with active plasma.

(above) Process time can be set in minutes and seconds. RF processing will automatically stop at the set time limit.

The timer displays a selectable range of minutes/minutes/seconds/seconds or a maximum of 99 minutes and 59 seconds. If necessary, the timer can be changed at the factory to allow for longer periods of processing.

NOTE: It is suggested to depress the PROCESS START button as the system starts to pump down.

When the "PROCESS START" switch is depressed, an internal 24 second timer is started. This internal timer allows the system 24 seconds to validate the safety interlock system and ensure that the chamber achieves its threshold pressure of 350-500mT. When both of these conditions are satisfied, the electronic valve for the incoming gas is opened and RF is delivered to the chamber. When the forward/reflected power is within limits (stabilization), the process timer will start.

When the process completes, the process timer resents itself to what the Operator programmed into it. If the process is completed before the internal 24 second timer runs out, the system will go through its internal checklist again--seeing that everything is ready, and the internal timer still counting--a process will start. During this 2nd process the internal 24 second timer runs out. (That is why you will not see a 3rd process started). If you program the process to run longer than 25 seconds, you will only have 1 process run per request.

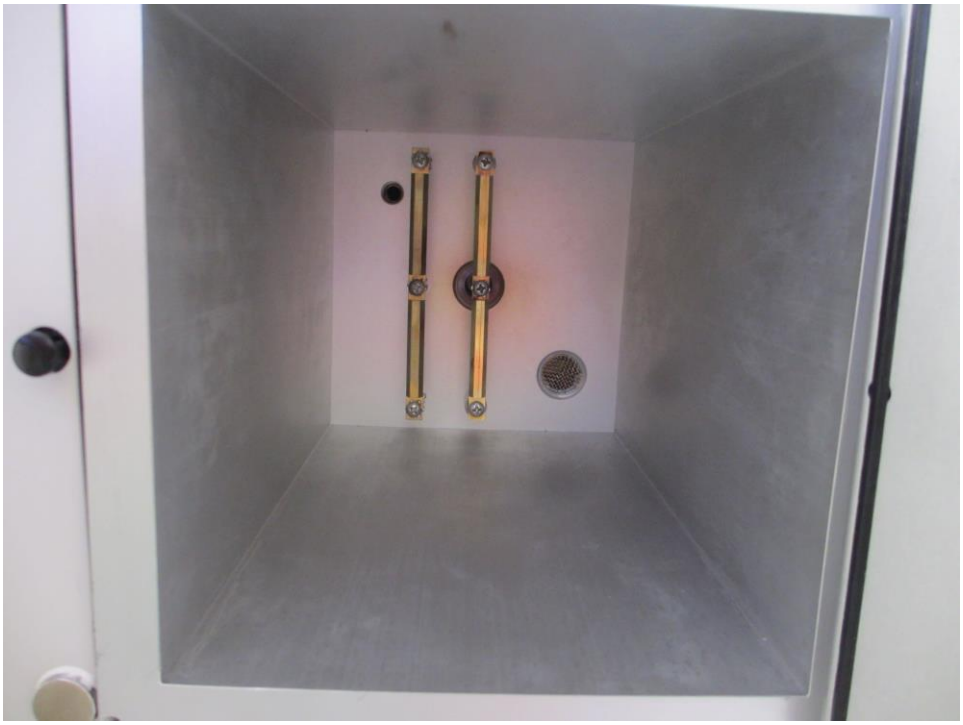
ALUMINUM CHAMBER

A custom designed RF feedthrough, in the back side of the aluminum chamber, provides low frequency RF to the chamber. The sample rack attached to the back of the chamber and makes contact with the RF connection. This provides an extremely efficient and uniform chemical plasma in the entire chamber. A special grade of 6061-T6 Aerospace grade of aluminum is used for the chamber and chamber door. If the aluminum chamber is not properly connected to the RF feed through, the FRONT DOOR will not close. The aluminum chamber is anodized for durability and process consistency.

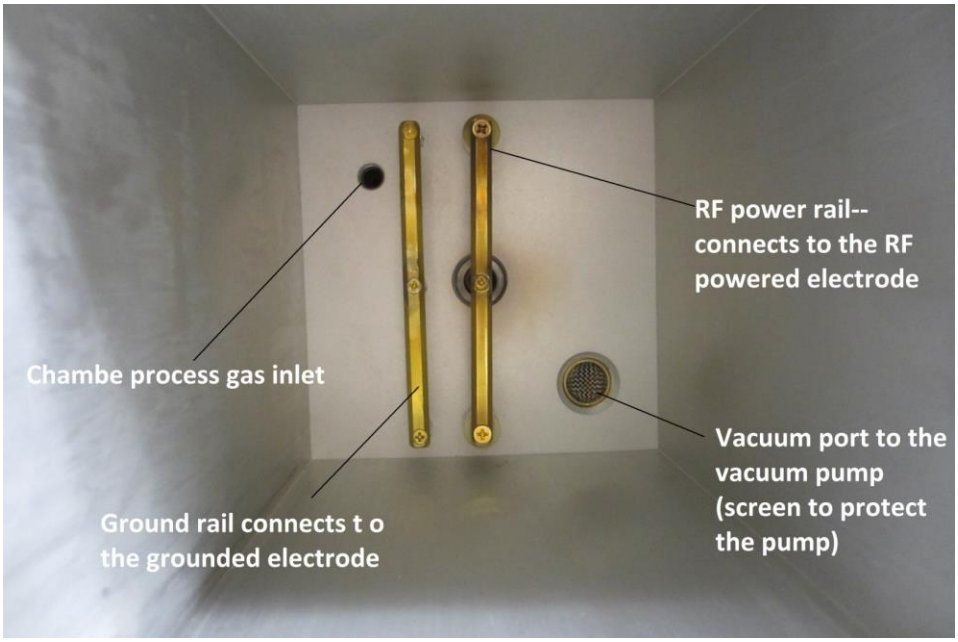
ALUMINUM CHAMBER and SAMPLE HOLDER

A sample holder is provided—the top shelf is the powered top electrode for RIE type processing and the other shelf (bottom shelf), is used for plasma processing.

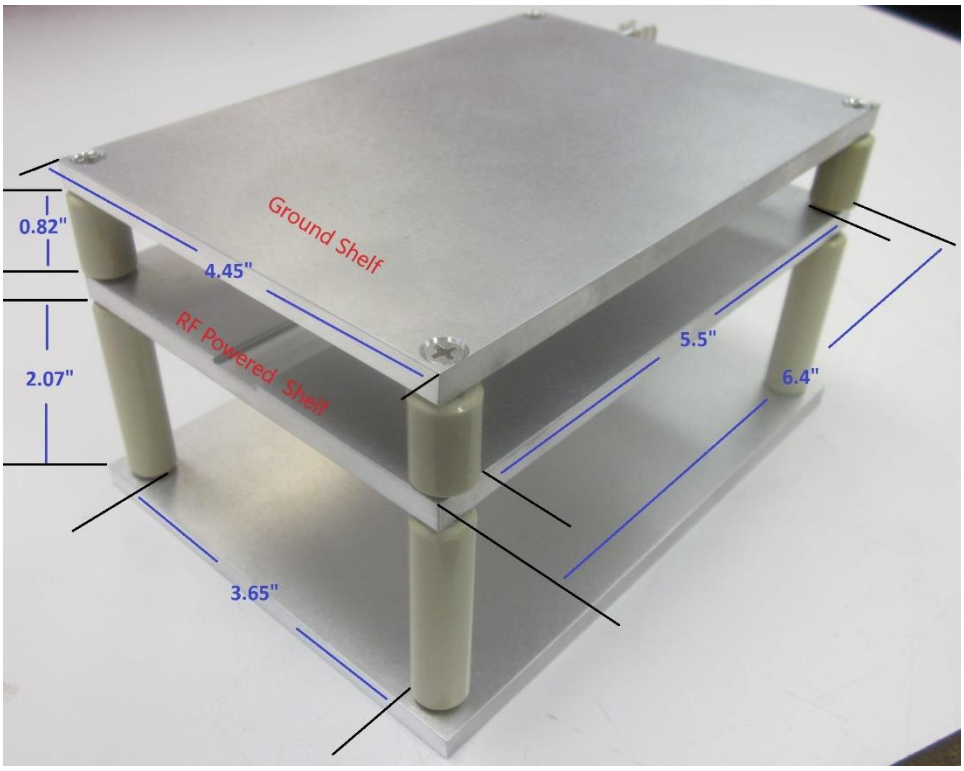
Glow Research designed RF feed through rails, on the inside-back of the chamber, provide RF and ground to the sample holder by way of two small rail clamps. The sample holder is inserted into the chamber and makes contact with the RF connection in the back center of the chamber. The ground is provided by a ground rail connection on the back of the chamber. As you face the chamber, the rail on the left is the ground, and the rail on the right is the RF connection.



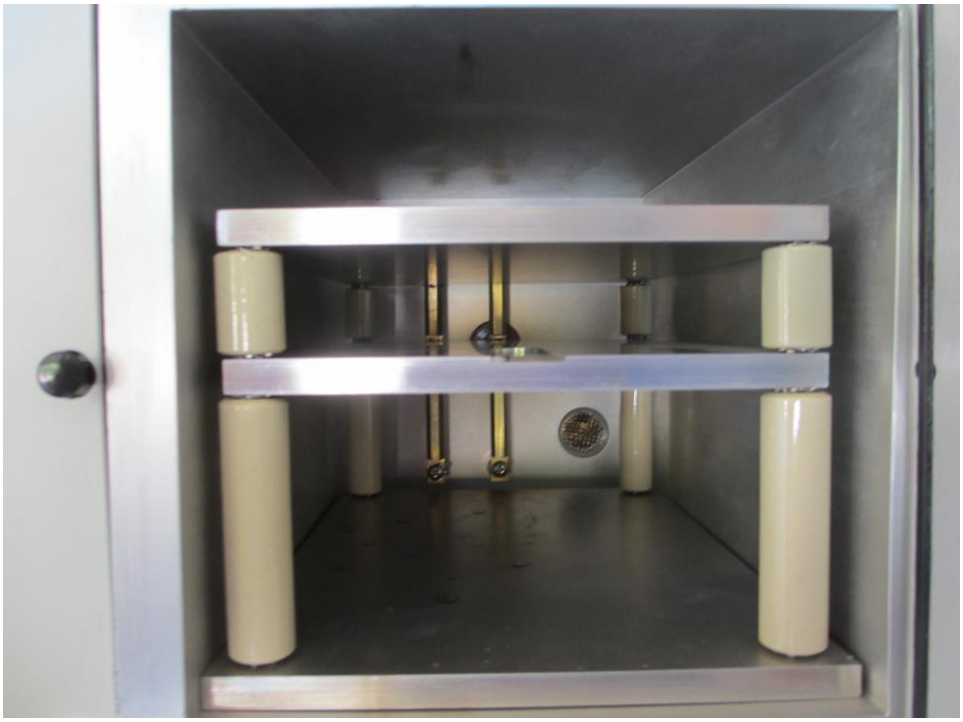
(above) Ground Rail on the Left and Powered Rail on the Right



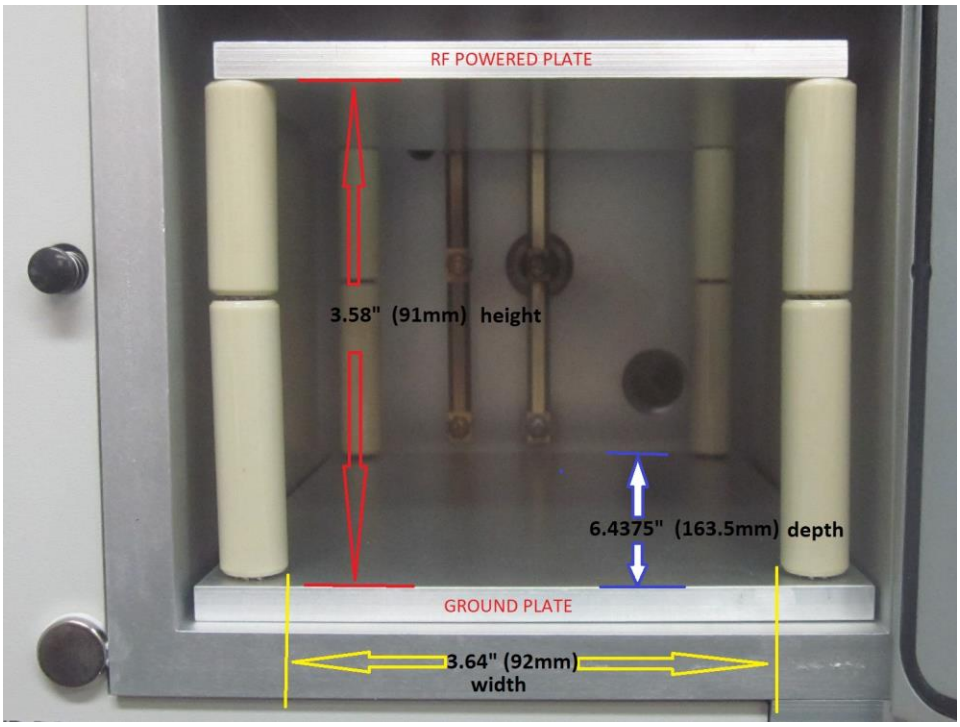
(above) Anodized Aluminum Chamber—no welds (no leaking)



(above) Standard Carrier with dimensions



(above) Top Shelf is Grounded, Middle Shelf is Connected to the RF Power, and the Bottom Shelf is floating.



Shown above: Shelf arrangement for large sample size. Top shelf is RF powered, bottom platform is grounded. Samples placed on the bottom platform will see “plasma” conditions.

NOTE: Sample Holders can vary in design materials and spacing.

Incoming process gas is feed into the chamber by the port on the top left of the chamber (when viewed from the front of the system). The screened outlet in the bottom right leads to the vacuum valve and thus to the vacuum pump.

A special grade of 6061-T6 Aerospace grade of aluminum is used for the chamber and chamber door. The aluminum chamber has been anodized with a proprietary process that improves the durability of the chamber and improves the reliability of plasma or RIE processing. This anodized process is proprietary and the thickness is closely monitored and measured to ensure repeatable plasma processing. This is the same anodization procedure used in million dollar plus production plasma systems used in the manufacture of semiconductors.

NOTE: The GLOW system is not designed to be run without a sample carrier. The sample holder should not be removed for any reason.

Back of GLOW system—KF-25 flange connection for vacuum, AC input, process gas input and breaker shown in the off position

Back of Glow system showing KF-25 flange connection with vacuum hose

2. SAFETY

This section covers the safety issues associated with the GLOW. It describes the system safety features. Any inherent equipment hazards are outlined. Details on necessary precautions for safe operation are provided.

Alerts containing the words-**NOTE, CAUTION and WARNING** are used in various advisories in this manual. **CAUTION** implies that the action could possibly cause damage to equipment or injury to personnel if the proper procedures are not followed. Use of the word **WARNING** implies that the action places the operator in a situation that has a possibility of injury or death if the proper procedures are not followed. **NOTE** are advisories that point out important information that is not obvious to the reader, but will not lead to any hazardous situations or immediate equipment damage if not followed.

WARNINGS AND PRECAUTIONS

When used properly, your GLOW plasma system is very safe and has been tested to comply with CE standards. The purpose of this advisory is simply to point out possible hazards resulting from misuse of the equipment and to suggest ways of operating the equipment as safely as possible.

SAFETY FEATURES

The following is a description of the safety features designed into the system.

SAFETY INTERLOCKS

There are two double interlock switches on the GLOW system case (on the top of the left side cover and on the top of the back-right pump cover), and one single interlock switch that is activated when the chamber door is closed. **DO NOT OVERRIDE THESE SAFETY INTERLOCKS.** These interlocks are engineered into the GLOW to prevent injury to operating personnel. These will shut off RF power if they are not activated. The chamber door must be closed for the RF to activate.

NOTE: If all safety interlocks are connected, you will hear the fan activate when closing the chamber door.

Care should be taken when replacing the electronics covers. The top cover interlock switches are sturdy, but if broken, the system will not activate the RF. The double interlock switches should be tested periodically.

An additional safety interlock is provided electronically through the VACUUM VALVE to prevent the RF from activating unless the pressure system confirms that the GLOW chamber is under vacuum.

WARNING: DO NOT OVERRIDE THIS SAFETY INTERLOCK IN THE VACUUM VALVE ELECTRONICS.

WARNING: DO NOT OVERRIDE THIS SAFETY INTERLOCK IN THE VACUUM VALVE ELECTRONICS.

ELECTRICAL

As with all electrical equipment, caution is warranted whenever external panels are removed and/or electrical wiring is exposed. *Only qualified technicians should perform maintenance, repair or installation on the equipment.* All electronics are designed with safety in mind and conform to common voltage directives and +12 /- 12 volts, or 24 volts maximum inside the system. The circuit breaker on the back of the system is designed to cut off the flow of electricity if the current demand is over 10 amps. To reset the system, simply push this Circuit Breaker lever to the “ON” (or up) position.

RADIO FREQUENCY RF EXPOSURE

A hazard from RF exposure exists if the system is operated without the door closed and/or the exterior panel in place. This would require defeating safety interlocks and is not recommended. The GLOW operates at a low frequency of 100 kHz and a maximum power of 50 Watts.

CHAMBER TEMPERATURE

The plasma CHAMBER can become quite hot during some processes. Exercise caution to prevent burns.

CHEMICAL HAZARD

The pump oil can be a skin and eye irritant. Gloves and eye protection should be used when changing or adding pump oil.

PROCESS GASES

The GLOW was designed for use with oxygen, argon or similar gases.

Some users choose to use room air. Dry room air is primarily made up of nitrogen (78.09%) and oxygen (20.95%). The remaining 1% is made up of argon (0.93%), carbon dioxide (0.03%) and other

trace gases (0.003%). Water vapor (water in its gaseous state) is also present in air in varying amounts.

Certain process gases that the operator may select for use with this equipment may be hazardous. Some may require special precautions. These precautions vary depending on the gas. Consult with your safety officer to ensure proper precautionary steps are taken before bringing any new gas into your facility. Toxic or flammable gases should never be used in the GLOW.

Gas line integrity can be confirmed simply by opening the valve on the gas cylinder then quickly closing it again. If the pressure reading on the regulator drops within one minute, there is a substantial leak that could be dangerous.

CAUTION: If the owner chooses to use oxygen, “NO SMOKING” signs should be posted near the instrument and the no smoking ban observed.

NOTE: Do not block the ventilation openings on the GLOW system. Room air is drawn into the system through the two vents on either side of the system and out through the upper fans on the back top of the system. Blocking the vents or preventing proper air flow could cause the system to overheat and malfunction.

NOTE: The GLOW system is designed to be used in a temperature range of 55-85 degrees Fahrenheit and with a relative humidity of 10-90% noncondensing. The IP rating is IP20.

3. UNPACKING

The GLOW Plasma System is completely tested and inspected at the factory before shipping. Inspect the crate before unpacking. If there is any reason to suspect damage to the carton or its contents, make note of the damage, take pictures and report it to the shipping company. All pictures and information should be sent to Glow Research as well. All systems are shipped with tilt indicators. Your shipping department should inspect the crate and all tilt indicators prior to accepting the shipment.

Using the included packing list, check to ensure that all listed components have arrived at your facility. Unpack the shipping cartons carefully and inspect the main plasma unit and all other system components for any damaged or missing items.

If any component is damaged or missing, notify the shipper and notify the Glow Research Customer Service Department by TELEPHONE 480-621-8405 USA immediately. Claims based on late notification of shipping damage will be denied.

Keep all shipping containers and materials in case it should be necessary to return any item to Glow Research. All service and warranty work is done at the manufacturer’s site.

Place the system components on the selected work surfaces. Remove all packing materials including any that might be present in the CHAMBER of the system. Please view the video on the proper start-up of your GLOW before starting your system.

LONG TERM STORAGE

If the plasma system and vacuum pump are to be placed in long term storage, take the following precautions in order to keep the equipment in good working condition. All system components should be placed in protective packaging. A desiccant should be placed in the packaging to minimize moisture exposure. Storage should be in a room with humidity less than eighty percent.

Before packaging and storing the vacuum pump, fill the pump reservoir with oil to the proper level and run the pump for five minutes to lubricate the seals. During the time the pump is stored, you will also need to run the pump for five minutes every three months in order to keep the seals lubricated.

4. INSTALLATION

This Manual outlines the requirements for system installation, work area allowance, and initial startup procedure. The installer should refer to Safety Warnings and Precautions and Unpacking Instructions on the previous pages before beginning installation. The installer should refer to the video (provided by Glow Research) to understand how to set up the GLOW plasma system for processing.

FACILITIES REQUIREMENTS:

The specifications and requirements for the system and applicable options are listed as follows. The power cord is supplied by Glow Research. Customer must specify type of cord required for their specific electrical requirements.

US standard: Single Phase 115VAC.10 amp 60 Hz. 16 AWG, 3 wire.

European standard: Single Phase, 230VAC, 10 amps, 50 Hz, 16 AWG, 3 wire

Process Gas: 25” O.D. Stainless Steel or Teflon tubing (Supplied by purchaser). PFA Tubing, 1/4" OD x 0.062" wall thickness.

External Gas Fittings: fittings .25" FPT (not required for room air)

The nut and furrule set that will connect the tubing to the plasma system is as follows:
https://products.swagelok.com/en/c/nut-ferrule-sets/p/B-400-NFSET?q=b-400

1/4" PFA tubing is:
https://products.swagelok.com/en/c/pfa-flexible-tubing/p/PFA-T4-062-100

Dimensions (Door Closed):13.75" W x 13.5"H x 19.5"L. (349.25 mm W x 342.9 mm H x 495.29 mm L)

INTERNAL RF POWER MODULE:
Power Supply (powered by the system)
Power Output: 50 Watts +/-10%@ full load output into 50 Ohm impedance.
Internal RF board fuse: 250 Volt, 5 amp fast acting

NOTE: IF CUSTOMER RUNS GASES OTHER THAN ROOM AIR--ALL CONNECTIONS FOR PROCESS GAS BETWEEN GAS BOTTLES, THE GAS CONTROL MODULE AND GLOW MUST BE

MADE USING CORROSION RESISTANT MATERIALS SUCH AS TEFLON OR STAINLESS STEEL. OTHER MATERIALS CAN CORRODE GENERATING PARTICULATE MATTER WHICH WILL CLOG GAS SHUTOFF VALVES.

NOTE: Do not block the ventilation openings on the GLOW system. Room air is drawn into the system through the two vents on either side of the system and out through the upper fans on the back top of the system. Blocking the vents or preventing proper air flow could cause the system to overheat and malfunction.

RECOMMENDED WORK AREA ALLOWANCE FOR NORMAL OPERATION

NOTE: You will need approximately 23" in the back of the system when you change the pump oil.

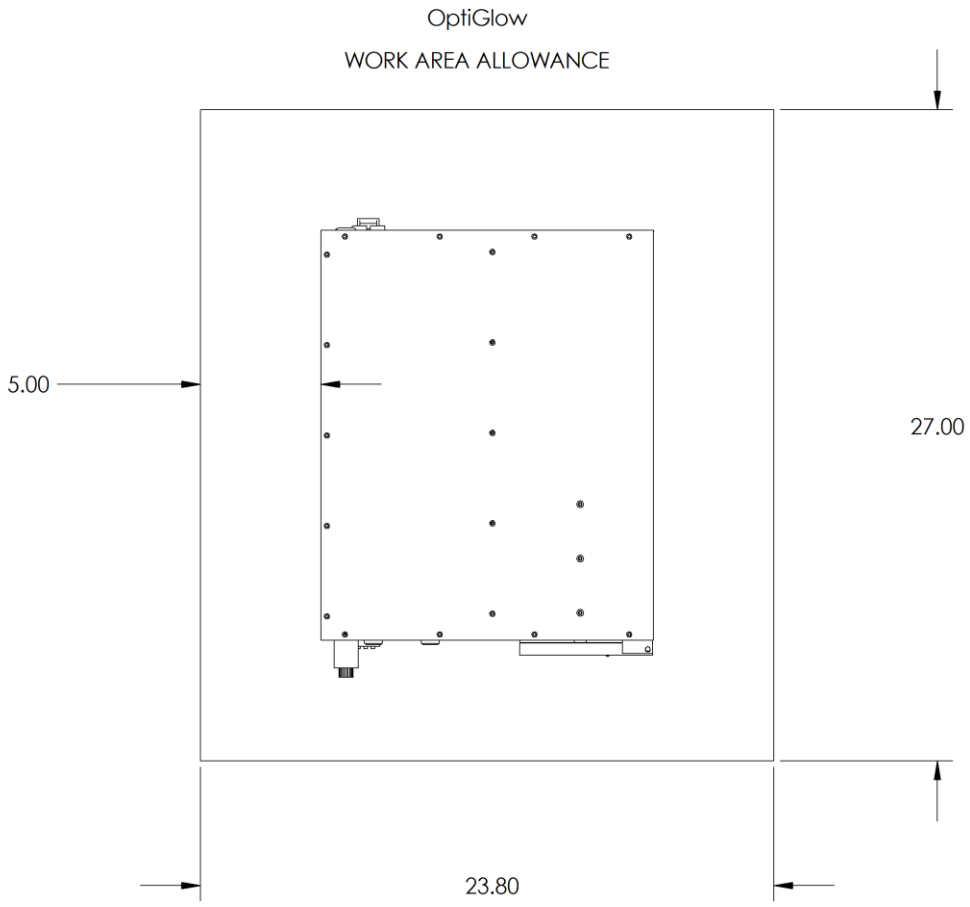


Figure 1

START-UP OPERATION PROCEDURES

After the machine has been properly installed, and you have put the required amount of pump oil into the vacuum pump, you can begin operation by following the steps detailed below:

SYSTEM CONNECTIONS:

A) Plug in the AC cord.
B) Make sure the breaker on the back of the GLOW is in the up (on) position.
C) Make sure the pump has been charged with oil (if you have an oil based pump).
D) Connect vacuum pump to the system with a vacuum hose and a KF25 flange connection (see below picture).

1) Make sure the power cord is connected to the GLOW
2) Put your sample on top or bottom shelf in CHAMBER
2) Push AC ON
3) Set timer for the desired process time
4) Push VACUUM after closing the CHAMBER DOOR
5) CHAMBER DOOR will be pulled in as the chamber pumps down
6) Press PROCESS START button—the light on this button will illuminate when the crossover pressure conditions allow the RF to turn on, and the process gas is allowed into the CHAMBER (when the pressure reaches .5 to .35 Torr).
7) You will see a glow discharge through the view port window
8) Adjust the FLOWMETER to allow gas into the chamber
9) Adjust the FLOWMETER to set the PRESSURE to the reading you desire (the system is designed to operate from .50 to 1.2 Torr). Increasing the flow of gas will increase the chamber pressure.
10) Timer will shut off the RF power and gas flow, and end the plasma process
11) Conclusion. An internal valve will shut off the gas flow into the CHAMBER when the process is ended or aborted
12) Press the VACUUM button to vent the CHAMBER (this will close the vacuum valve).
13) When the CHAMBER vents to atmosphere, the CHAMBER DOOR will open automatically (this will take one to two munities)
14) Open CHAMBER DOOR completely and remove the sample
15) You may turn the system off by depressing the AC ON button.

Vacuum Check

When first starting a vacuum system, it is advisable to check its vacuum integrity. To do so:

1. Depress the VACUUM switch to commence pumping down the Reactor CHAMBER.
2. Observe the Reactor CHAMBER pressure level on the display; it should read .2 Torr in less than 5 minutes.
3. Wait 20 minutes to allow any residual moisture to exit the system.
4. Note the ultimate pressure. If a front panel pressure reading below .2 Torr is not reached, check CHAMBER for cleanliness and/or commence leak detection procedure (detailed in SYSTEM TROUBLESHOOTING

Gas Flow

Gas flow into the CHAMBER must be controlled to achieve proper operating pressure. This is easily accomplished through use of the system flowmeter. The gas solenoid valve will not allow gas into the CHAMBER unless all system safety conditions have been met.

The system process pressure envelope is .5 to 1.2 Torr. **If you process at lower pressures, you will see the flowmeter ball bounce more than normal. Some bouncing of the flow indicator ball is normal. The flowmeter will allow you to control the pressure of the processing chamber.**

Pressure Determination

The GLOW provides a means of monitoring CHAMBER pressure. A Pirani pressure gage is mounted in the rear port of the GLOW CHAMBER, and will report a pressure reading on the front DISPLAY. This pressure reading will gauge the chamber pressure. The operator will need to note the pressure readings on the DISPLAY and know the relationship of the displayed number to the process required.

Normal operating pressure will range between .5 Torr and 1.2 Torr.

Gas Flow

Gas flow into the CHAMBER must be controlled to achieve proper operating pressure. This is easily accomplished through use of the system flowmeter. The gas solenoid valve will not allow gas into the CHAMBER unless all system safety conditions have been met.

5. EQUIPMENT ORIENTATION

This section includes a general description of the plasma system as well as a more detailed description of the controls and indicators.

GENERAL DESCRIPTION

The GLOW™ system is a tabletop plasma chemistry reactor designed to provide the medical, scientific, and educational and microelectronics community with plasma technology at a moderate cost. Glow Research is able to provide such capability by providing a simple to operate instrument which can perform repeatable plasma chemical reactions.

The GLOW™ is equipped with an internally housed, solid-state RF Power Supply. This module contains an RF power amplifier which generates up to 50 watts of power at 100 kHz. The RF generator is a solid state crystal controlled oscillator designed to provide up to 50 watts of continuous wave 100 kHz power to the reaction CHAMBER. The frequency of 100 kHz is one of a limited number of frequencies permitted by the Federal Communications Commission (FCC) for plasma applications.

Maximum power transfer from the power supply to the reaction CHAMBER is accomplished by matching the output impedance of the amplifier to the input impedance of the reaction CHAMBER.

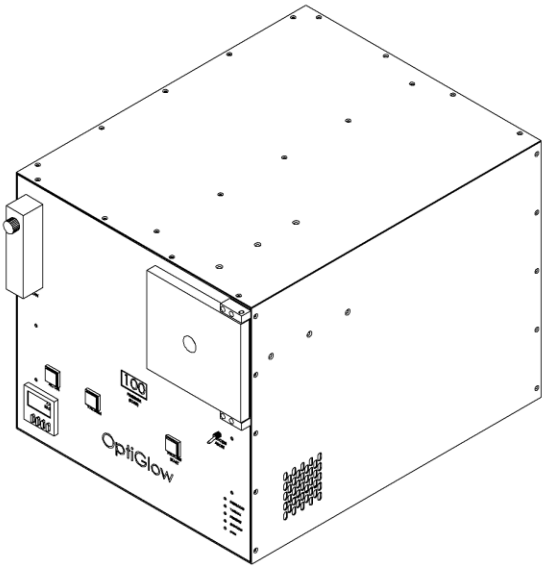


Figure 2 (the GLOW is the same size as the OptiGlow)

The front of the GLOW consists of a front control panel containing the function controls, abort switch, diagnostic LED's and timer. The main PC board that controls the GLOW system functions is mounted

directly behind the front display. In order to allow for easy and modular repair, the front panel can be removed and replaced with a different front panel and PC board, if needed.

The back panel has the utility supply, and breaker. Inside the GLOW enclosure is a system controlled gas feed solenoid valve, a vacuum port system, PC boards and the impedance matching network which ensures efficient transfer of power from the RF power supply to the reactor CHAMBER. The front loading CHAMBER and CHAMBER DOOR are made from aluminum. The backside of the aluminum sample holder is designed to connect to the RF FEEDTHROUGH that protrudes from the back center of the aluminum chamber.

NOTE: THE ALUMINUM SAMPLE HOLDER IS ATTACHED TO THE RF FEEDTHROUGH FOR PROPER PLASMA PROCESSING.

The reaction CHAMBER is accessed by opening a hinged door. The CHAMBER DOOR is held in place when the system is put under vacuum, and a gasket around the rim of the CHAMBER ensures vacuum-tight sealing between the CHAMBER DOOR and the rest of the CHAMBER. The CHAMBER and CHAMBER DOOR material is manufactured from 6061-T6 high grade aerospace aluminum. The chamber is extruded metal and is not welded—this ensures good vacuum integrity. The front door and the rear plate are sealed by a compressed “o” rings.

The vacuum system includes a VACUUM PORT (to which the vacuum pump is attached), VENT VALVE and EXHAUST MANIFOLD. The VENT VALVE is a “normally open” valve that will allow the chamber to vent to atmosphere whenever the VACUUM PUMP is not activated. This “normally open” vent valve is also a safety feature.

When the VACUUM switch is released or turned off (no illumination), the CHAMBER is isolated from the pump and the VENT VALVE allows air to pass into the vacuum CHAMBER through the VENT VALVE, venting the system to atmospheric pressure.

The GLOW has an electronically controlled gas solenoid valve that will open to allow gas into the CHAMBER when the RF comes on. If the process is stopped, timed out or aborted, the gas inlet solenoid valve will close. It is a normally closed valve, and in case of loss of electrical power, it will close preventing gas from entering the chamber.

SPECIFICATIONS

The GLOW system specifications are listed below.

Exterior GLOW Dimensions
- Dimensions (Door Closed):13.75" W x 13.5"H x 19.5"L. (349.25 mm W x 342.9 mm H x 495.29 mm L)

Weight
- *System weight*: 30 Lbs

CHAMBER Material
- 6061-T6 high grade aerospace aluminum

CHAMBER Interior Dimensions.
- CHAMBER: 4.25" (ID) Diameter x 6" (ID) Deep (107.94 mm x 152.39 mm)

Installation Working Surface
- Designed for use on table top or counter.

RF Power Generator
- 50 watt RF power level

- 100 kHz operating frequency
- Solid state circuitry
- Automatic impedance matching

CONTROLS AND INDICATORS

This section describes the controls and indicators on the front and rear of the GLOW Reaction CHAMBER module.

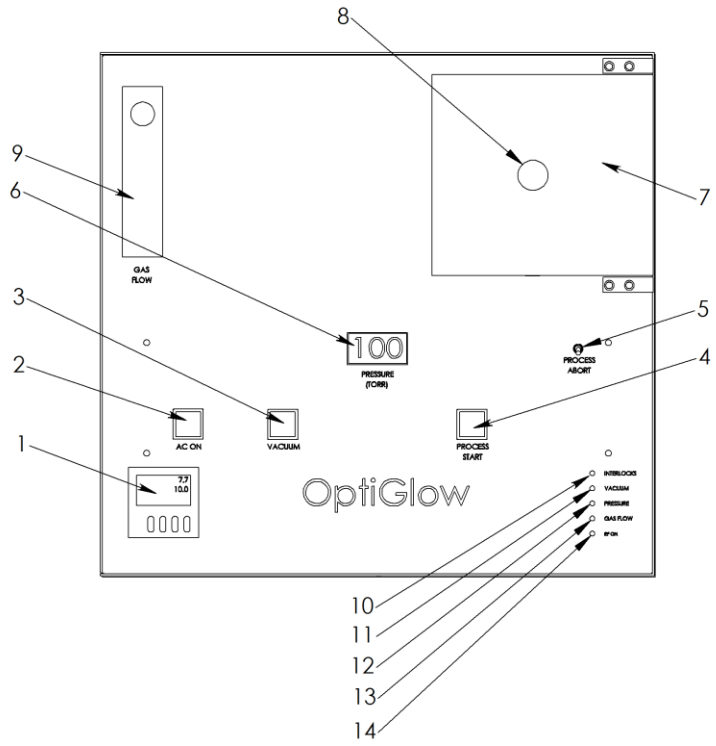


Figure 3 (same control as the OptiGlow)

Figures 5 and 6 illustrate the location of the controls and indicators on the Reaction CHAMBER Module.

1. **TIMER** – Will start once you release your finger from the RF ON switch.

2. **AC ON** – The AC power switch is a push-button lamp switch, which is illuminated when the main power is on.

3. **VACUUM** – The vacuum switch is a push-button lamp switch, which is illuminated when the chamber is under vacuum. In the “on” position, the vacuum pump is activated and the vent valve is closed. When the switch is off, the vacuum pump is off and the vent valve is open; thus venting the chamber to atmospheric pressure.

4. **PROCESS START–** This switch will start the process by delivering RF power and gas to the CHAMBER. This switch will also activate the TIMER when the RF comes on**.**

5. **PROCESS ABORT**—Stops the process and turns off the RF and Gas supply. This button will also clear the timer and performs a system reset.

6. **PRESSURE DISPLAY** – Displays the chamber pressure in Torr.

7. **Chamber Door**—This hinged door will allow access to the vacuum chamber. The dynamic hinge allows the chamber door to be drawn in with equal force along the entire surface upon pump down. This increases vacuum integrity in the chamber.

8. **Viewport window**—This UV treated window allows the user to view their samples and the plasma during processing.

9. **GAS FLOW**—Flowmeter that gives a relative measure of process gas flowing into the chamber. The system process pressure envelope is .5 to 1.2 Torr. **If you process at lower pressures, you will see the flowmeter ball bounce more than normal. Some bouncing of the flow indicator ball is normal.**

GLOW LED DIAGNOSTIC LIGHTS

The GLOW LED DIAGNOSTIC LIGHTS will give the user a visual display and confirm that the various modules are functioning correctly.

10. **INTERLOCKS**—there are three interlocks on the GLOW (CHAMBER DOOR, LEFT PANEL, and BACK-LEFT PANEL). If any of the interlocks are not engaged, the system will not allow the RF to activate; thus not allowing any process to be run. When all three of the interlocks are engaged, the INTERLOCK LED will be illuminated (if the AC ON is activated).

11. **VACUUM**—after the AC ON has been activated the VACUUM LED will illuminate when the VACUUM button has been depressed. This tells the user that the vacuum valve has turned on and the vent valve has closed—the chamber will start to pump down to a lower pressure (you will hear the vacuum pump as well). The vent valve is a normally open valve for safety reasons. If your facility power is lost, the system will automatically vent the chamber.

12. **PRESSURE**—this LED will illuminate when you depress the PROCESS START button and will stay illuminated for 25 seconds. This lets you know that the system is ready and waiting for the cross-over pressure to reach .5 to .35 Torr.

13. **GAS FLOW**--this LED will illuminate when the all conditions have been met (AC ON has been depressed, VACUUM has been depressed, the PROCESS START has been depressed and the system has reached a vacuum pressure of at least .5 to.35 Torr. This LED tells the user that the gas flow solenoid valve has opened and gas will now flow into the VACUUM CHAMBER.

14. **RF ON**—When this LED is illuminated the RF generator is applying power to the chamber. For this light to illuminate, several preconditions must be met. The AC ON has been depressed, VACUUM has been depressed, the PROCESS START has been depressed and the system has reached a vacuum pressure of at least .5 to.35 Torr.

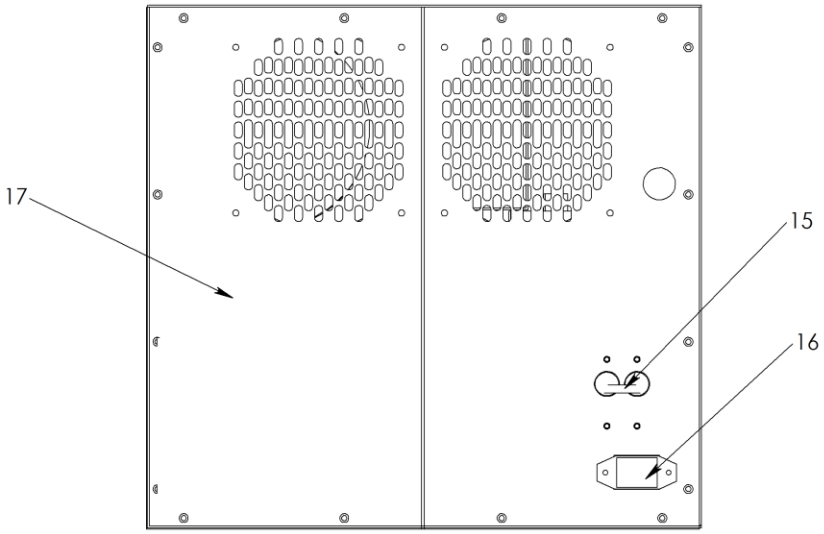


Figure 4

15. **CB1** – This circuit breaker is designed to cut off the flow of electricity if the current demand is over 10 amps. To reset the system, simply push this Circuit Breaker lever to the “ON” (or up) position.

16. **AC1** – This IEC60227 male AC Power plug allows for 110V to 230V connection to the GLOW. Requires a grounded three prong plug with a minimum conductor size of 1.31mm^2 (Various plugs can be provided depending on local electrical requirements).

17. **VACUUM PUMP CONNECTION**

6. THEORY OF OPERATION

This chapter gives an overview of plasma and plasma processes. It outlines the basic requirements to create a plasma and what variables are under operator control.

THE PLASMA PROCESS: AN OVERVIEW

A gas plasma consists of a collection of ions, free radicals, and electrons produced when a gas is transformed to a high energy, excited state by exposure to an energy source under the right physical conditions. Natural plasma examples include lightning, fire, and the Aurora.

Plasma treatment is a process by which the surface of a material is modified in some way through the actions of the dissociated molecular components of a gas. Because these components are in such a high energy state, they are very chemically reactive and can easily affect changes to the surface of materials. The changes that occur are complex and dependent on many variables including gas chemistry, process pressure, and the surface chemistry of the material being processed. The process occurs near ambient temperatures without employing toxic chemicals.

Surface activation processes work by altering the first several molecular layers of the bulk material through incorporation of chemical functional groups that increase the surface energy of the material. This leads to improvements in the adhesion and wetability of the treated material.

TYPICAL PLASMA PROCESS

Plasma processing in the GLOW is accomplished through the use of a low pressure, RF induced gaseous discharge. The material or specimen is loaded into the reaction chamber. The chamber is evacuated to a mild vacuum (.25 – 1.2 Torr) by a mechanical vacuum pump. A process gas is drawn through the chamber over the specimen increasing the chamber pressure to between .5 -1.2 Torr (or higher), depending on the application. RF power is applied to the chamber at a frequency of 100 kHz. This excites the process gas atoms or molecules and dissociates them into chemically active species. These species are very short lived and recombine to form the original gas molecules as soon as they are carried out of the reaction chamber.

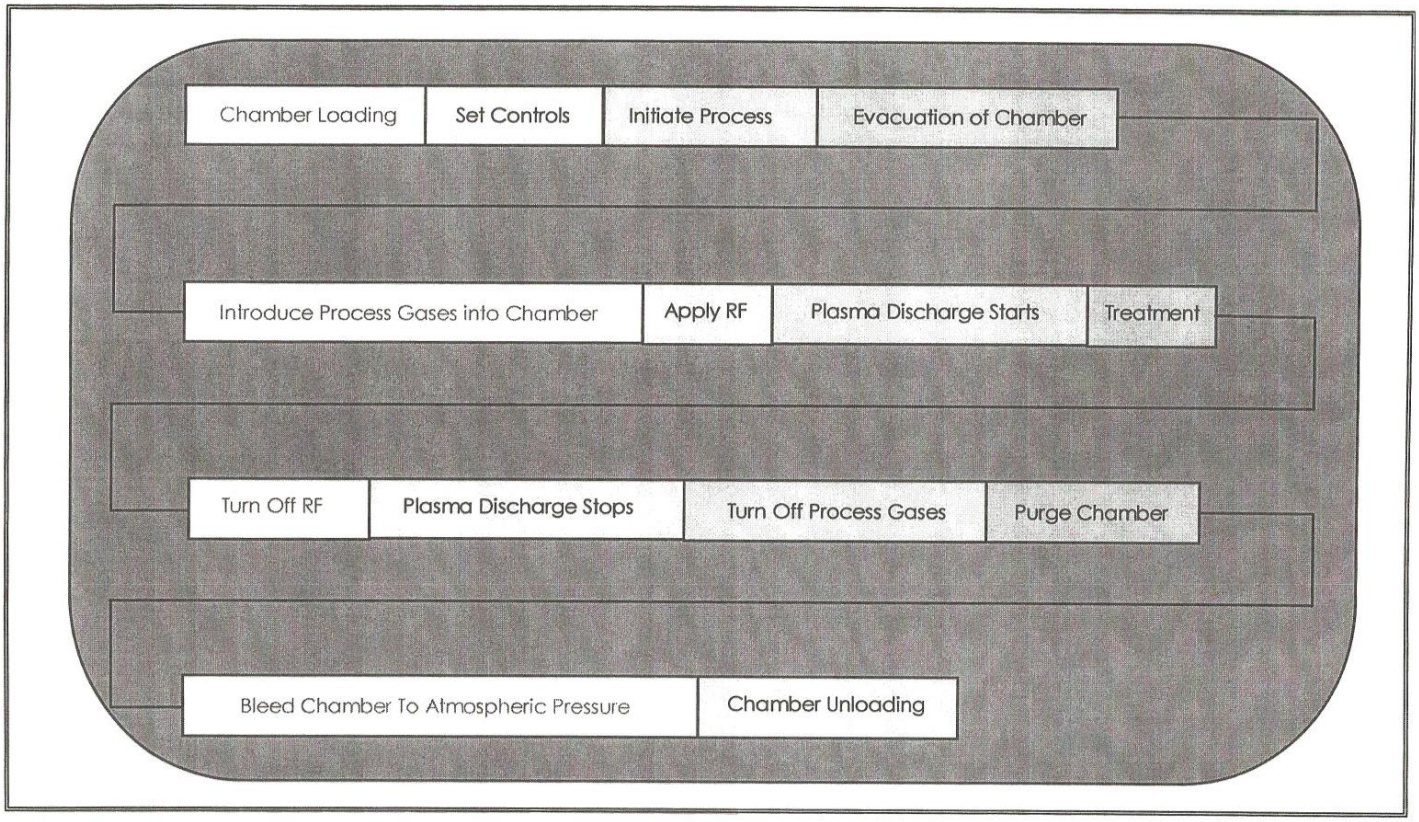
BASIC ELEMENTS OF PLASMA TREATMENT

These steps are flowcharted on the next page.
In order to develop and optimize a plasma process for a given material, the operator
Has the ability to alter the following parameters:

- Process gas(es) selected for use.
- Flow rate/pressure of selected gas(es).
- Amount of RF energy applied to the vacuum CHAMBER.
- Amount of time material is exposed to the plasma.

Process pressure, RF power, and treatment time are the primary factors that affect the intensity of the treatment. For example, a high energy treatment would be run under conditions of relatively low pressure, high power, and long treatment time. Conversely, a low energy treatment would be run under conditions of relatively high pressure, low power, and a short treatment time. Since every material has different treatment requirements and many factors need to be taken into account, it is difficult to say what type of treatment will give the desired results.

A general rule would be that energetic processes are better for cleaning and etching applications; more moderate processes are better for surface activation applications.



Plasma System Operational Sequence

7. OPERATION PROCEDURES

SYSTEM CONNECTIONS:

A) Plug in the AC cord.
B) Make sure the breaker on the back of the GLOW is in the up (on) position.
C) Make sure the pump has been charged with oil.

1) Make sure the power cord is connected to the GLOW.
2) Put sample holder in CHAMBER
2) Push AC ON
3) Push VACUUM after holding the CHAMBER DOOR closed.
4) Wait for the door to be held closed by the chamber vacuum suction
5) Set timer for the desired process time.
6) Press PROCESS START button—the light on this button will illuminate when conditions allow the RF to turn on, and the process gas is allowed into the CHAMBER (when the pressure reaches .30 Torr).
7) You will see a glow discharge through the view port window
8) Adjust the FLOWMETER to allow gas into the chamber
9) Adjust the FLOWMETER to set the PRESSURE to the reading you desire (the system is designed to operate from .5 to 1.2 Torr).

10) Timer will shut off the RF power and gas flow, and end the plasma process.
11) Conclusion. An internal valve will shut off the gas flow into the CHAMBER when the process is ended or aborted.
12) Press the VACUUM button to vent the CHAMBER (this will turn off the internal vacuum pump).
13) When the CHAMBER vents to atmosphere, the CHAMBER DOOR will open automatically
14) Open CHAMBER DOOR completely and remove the SAMPLE CARRIER
15) You may turn the system off by depressing the AC ON button.

NOTE: After processing, you should leave the system on for a few minutes to allow the fans to cool the system.

TUNING

An audible alarm will sound if the reflected power is too high. The factory presets the stepped matching network. Please refer any service to Glow Research personnel. No adjustment should be required.

8. SERVICE AND MAINTENANCE

This section gives information on the warranty and details on servicing the equipment. Recommended maintenance and part replacement procedures are outlined. A trouble shooting guide is also included.

WARRANTY

This warranty is expressly in lieu of all warranties expressed or implied, including any implied warranty of merchantability or fitness for a particular purpose unless otherwise agreed to in signed correspondence from Glow Research. Glow Research, shall not be responsible for any damage caused by improper installation, use, servicing or testing of its equipment.

Glow Research will make a preliminary review of the warranty claim. If it is deemed by Glow Research that a legitimate warranty issue is found, Glow Research will send a replacement (ONLY AFTER THE ORIGIONAL SYSTEM IS IN TRANSIT) in line with the following WARRANTY:

(a) GLOW RESEARCH warrants Equipment to be free from defects in material and workmanship provided the Equipment is used and maintained in accordance with GLOW RESEARCH'S instructions. The base warranty period is (1) one year from first use, or (ii) 14 months from shipment, whichever occurs first. All warranty and service work is performed at the GLOW RESEARCH factory. GLOW RESEARCH reserves the right to communicate and discuss all warranty issues prior to BUYER returning the Equipment. Every effort will be made on the part of Glow Research and the BUYER to resolve the problem with a replacement part or module.

(b) GLOW RESEARCH must issue a RMA number before Equipment or part can be returned to the Factory.

(c) Normal wear items ("0" rings, seals, gaskets, electrodes, etc.) are not covered by this warranty.

(d) In the event of non-compliance with this warranty, GLOW RESEARCH shall at its option modify, adjust, repair or replace the Equipment. GLOW RESEARCH will, at its option absorb return shipping charges. GLOW RESEARCH reserves the right to charge for warranty service in the event Equipment is initially shipped or thereafter is transshipped to a location other than the "ship to" location identified in Buyer's purchase order or purchase document.

(e) The above warranty does not extend to Equipment damaged after date of shipment where the damage is not directly due to a defect in material or workmanship, nor does it apply to Equipment altered or repaired in an unauthorized manner.

(f) Using non-GLOW RESEARCH or non-approved repair or replacement parts can be detrimental to safe and proper operation of the Equipment. Any damage to or failure of Equipment arising from use of such parts will not be covered by this warranty. Any customer modification of this equipment or any repairs undertaken without the prior consent of Glow Research shall render this warranty void.

(g) The sole liability of GLOW RESEARCH and the exclusive remedy of Buyer arising out of the performance of services or supply or use of the Equipment whether arising under contract, tort (including negligence), strict liability or otherwise shall be the modification, adjustment, repair or replacement of Equipment, re-performance of services or refund of the purchase price.

(h) GLOW RESEARCH AND BUYER AGREE THAT, IN CONSIDERATION OF THE ABOVE EXPRESS WARRANTY ALL OTHER WARRANTIES AND GUARANTEES, OTHER THAN TITLE, EITHER EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXCLUDED FROM THE CONTRACT.

SERVICING

All warranty and service work is done at the Glow Research site.

If a unit is to be returned to Glow Research for service or for any other reason, the following procedures must be followed: Obtain a Return Material Authorization number (RMA) through the Glow Research Customer Service Department, US (480) 621-8405 Display this number on your shipping label. A unit Received without an RMA number visible will be rejected.

PRIOR TO CRATING, REMOVE THE VACUUM PUMP AND DRAIN ALL OIL FORM THE PUMP. ENSURE THAT THE OIL IS REMOVED BY TILTING THE PUMP TO REMOVE RESIDUAL OIL. Replace the pump in the GLOW and reconnect the back panel.

Re-pack the system in its original shipping container. If this is no longer available, take special precautions to avoid damage to the system. An approved shipping container may be purchased by calling Glow Research, US 480-621-8405.

If the system is under warranty, the only charges are shipping costs. If the system is out of warranty, a purchase order will be required and you will be billed for all parts and service.

If you have any questions, please call the Glow Research Customer Service Department.

USER PREVENTIVE MAINTENANCE

User-performed maintenance required for GLOW Plasma System is minimal. However, regular attention to the suggested maintenance tasks listed below will help to ensure proper operation of the system. To ensure maximum performance and process repeatability, the following items should be checked at regular intervals.

CLEANING THE CHAMBER

Note: Make sure you unplug the GLOW before cleaning the chamber.

The CHAMBER should be cleaned periodically. The cleaning schedule will depend on frequency of use, type of materials processed, and choice of process gas.

The inside of the reaction chamber should be cleaned regularly with isopropanal alcohol or another suitable cleaning agent. After cleaning the chamber, always generate a plasma for at least five minutes to remove any residual contamination. One means of determining chamber cleanliness in the absence of visual indications is to pump the chamber down to its minimum achievable base pressure and record that value, and then generate a plasma for a 5 minute period. Pump the chamber down to its minimum achievable base pressure a second time and record that value. Compare this value to the first value. If there has been a notable decrease from the first pump-down to the second it is an indication that cleaning of the chamber has occurred while running the plasma. Repeat this process until no notable difference is noted in minimum base pressure from one test to the next.

VACUUM PUMP Oil

Many of the problems with the vacuum system are associated with the vacuum pump oil. It is important that the oil condition be checked periodically to verify that it is at the proper level and free of contaminants. Dirty or insufficient oil can result in poor vacuum pump performance. Dirty oil can also lead to possible chamber contamination due to the increased vapor pressure back streaming into the chamber from the contaminated oil.

Some plasma processes may create a larger degree of pump oil contamination than others. Additional personal protective equipment may be necessary in some cases. The end user of this equipment should conduct industrial hygiene sampling in accordance with NIOSH, or other nationally recognized standards or test procedures, during the changing of the pump oil. Do not allow this pump oil to flow down the sewer drain.

Pump oil should be changed at least once a year. If the system is getting a lot of use and the process being used creates a large amount of contamination, the oil may need to be changed as often as every three to four months. If the pump oil appears visually dirty, it needs to be changed. Check the pump oil at least once a month. A competent technician should be able to change the pump oil in about one hour.

SAFETY INTERLOCKS

Check the safey interlocks periodically. They can be tested by pushing them in and out.

GLOW SYSTEM MAINTENANCE CHECKLIST

DATE:									
CHAMBER CLEANING									
PUMP OIL CHECK									
PUMP OIL CHANGE									

SYSTEM TROUBLESHOOTING

The following trouble shooting section is designed to help the operator identify and solve the most common instrument problems. Any major equipment repairs should be performed by Glow Research service engineers. If you are unable to identify a problem, call the Glow Research service department.

LOCATING VACUUM LEAKS

The procedure outlined below is for locating and fixing vacuum leaks. A leak may be present if the system will not pump down. The GLOW system is designed for use with room air, so minor leaks should not create processing issues.

1.) Check to see if the O-ring on the inside of the CHAMBER DOOR is in good condition and is seated properly. Replace the O-ring if necessary.

2.) Check the VIEWPORT WINDOW gasket to see if it is in good condition and is sealing properly.

3) Tighten all external fittings on the GLOW if they have been added.

It is possible to locate a very small leak by squirting all external fittings and sealing ports, one at a time, with IPA (alcohol). When IPA is sprayed over the connection that is leaking, the chamber pressure should rise slightly as the alcohol vapor is sucked into the chamber. Leaks can be repaired by replacing o-rings, CHAMBER seals, hoses, fittings, and by replacing Teflon tape at various joints.

TROUBLESHOOTING GUIDE

1. Panel lights do not illuminate when reactor chamber module AC switch is depressed.
   - Are system power cords connected to power outlet?
   - Is the breaker on the back of the system in the on or up position?

2. Chamber will not evacuate when VACUUM switch is depressed and illuminated:
   - Is vacuum pump operating?
   - Can you hear the vacuum pump?

3. System will not pump-down to minimum base pressure (below .30 Torr)
   - Is the chamber door “o” ring dirty? If so, clean the chamber door “o” ring. Replace “o” ring if damaged.
   - Is chamber door property positioned and sealed?
   - Will system pump-down with process gas turned off? If so, leak is located in gas supply line. Leaks can be located using procedure detailed earlier in this section.
   - Is vacuum line free of restrictions or kinks? You may need to open the back pump panel to inspect the pump lines.
   - Is vacuum pump operating correctly? Is oil clean and at correct level?
   - Have leaks developed in any of the internal or external gas or vacuum lines and/or fittings?
   - Have the vacuum pump or vent valves failed?

4. The GLOW will not bleed back to atmosphere when VACUUM switch is released and lamp Extinguishes:
   - Has the vent valve failed?

5. The GLOW CHAMBER appears contaminated upon completion of processing:

- Is material being processed out gassing? After cleaning CHAMBER (as detailed earlier) run process without material in CHAMBER to see if contamination still occurs.
- Are process gas lines contaminated or corroded internally?
- Is pressure sensor line contaminated or corroded internally?
- Is vacuum line contaminated or corroded internally?
- Is the vacuum pump being allowed to pump the CHAMBER down for excessive periods of time, leading to back-streaming of pump oil into the CHAMBER? The pump foreline loop should prevent this from happening.

The GLOW system has been designed with two fans in the rear of the system to draw cool air into the lower-front of the system, across the electronics and out the top-back of the system. This ensures that the electrical components are kept cool during operation.

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www.glowresearch.org

Please know that we are at YOUR service!