HARRICK PLASMA

www.harrickplasma.com

PLASMA CLEANER

USER'S MANUAL FOR THE EXPANDED PLASMA CLEANER PDC-002 (230V) (AND OPTIONAL PLASMAFLO)

HARRICK PLASMA
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DECLARATION OF CONFORMITY

CE

Harrick Plasma, Inc. hereby declares that the product listed is in conformity with the requirements and provisions of the following European Union CE directives and their respective standards.

EMC Directive:	**89/336/EEC**	
Generic Emissions Standard:	EN 61000-6-4:2001	
Product Specific Emissions:	EN 55011 Group 2 Class A	
Generic Immunity Standard:	EN 61000-6-2: 2001	
Immunity:	EN 61000-4-2	Electrostatic Discharge
	EN 61000-4-3	Radiated Susceptibility
	EN 61000-4-4	Electrical Fast Transient/Burst
	EN 61000-4-5	Surge
	EN 61000-4-6	Conducted Susceptibility
Low Voltage Directive:	**98/68/EEC**	
Standard:	EN 60950	Safety of Information Technology Equipment

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Manufacturer's Name:	**Harrick Plasma**
Manufacturer's Address:	120 Brindley St. Ithaca, NY 14850 USA
Products:	Expanded Plasma Cleaner / PlasmaFlo
Model Numbers:	PDC-002 / PDC-FMG-2

Declaration of Conformity Issued: December 20th, 2006

Signature: _____

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For further information, please contact Harrick Plasma or its authorized distributors:
See www.harrickplasma.com or e-mail info@harrickplasma.com.

ENVIRONMENTAL STATEMENT

Harrick Plasma, Inc. asserts the following statement regarding European Union directives governing disposal and restriction of hazardous substances in relation to the listed products.

Waste Electrical and Electronic Equipment (WEEE) Directive: 2002/96/EC

The products specified below comply with the WEEE Directive (2002/96/EC) marking requirement (shown above). The affixed product label indicates that you *must not discard this electrical/electronic product in domestic household waste.* To return unwanted products, please contact Harrick Plasma, Inc. With reference to the equipment categories in the WEEE directive Annex 1, Harrick Plasma has classified these products as "Monitoring and Control Instruments."

Restriction of Hazardous Substances (RoHS) Directive: 2002/95/EC

Harrick Plasma has classified the products specified below as "Monitoring and Control Instruments," an equipment category currently outside the scope of the RoHS Directive (2002/95/EC). Harrick Plasma is actively working toward transitioning to RoHS-compliant substances in future product iterations.

Environmental Statement Issued: December 20th, 2006

Manufacturer's Name:	**Harrick Plasma**
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SAFETY INFORMATION

The Plasma Cleaner is designed for safe and efficient operation when used properly and in accordance with this manual. Failure to observe the following precautions could result in serious personal injury:

- ⚠ The Plasma Cleaner is an electrical instrument; to avoid electric shock, please observe all standard precautions, such as not operating the device near water and operating the device at appropriate line voltage and frequency.
- ⚠ Do not remove cover plates or housing, except by a certified electronics technician.
- ⚠ Do not open the Plasma Cleaner door when the chamber is under vacuum.
- ⚠ Do not use the Plasma Cleaner near flammable materials.
- ⚠ With respect to vacuum pumps, please refer to the pump user's manual for specific precautions.
- ⚠ If oxygen is used as the process gas in concentrations near or above its flammability threshold, an oxygen service pump must be used.
- ⚠ If corrosive gases are used, make sure the seals and gas connection materials are compatible with the gas. Use a suitable vacuum pump to service corrosive gases.
- ⚠ If toxic gases or gases that ionize to toxic products or intermediates are used, the gases must be properly purged from the chamber prior to venting and the pump exhaust must be properly vented. For safe gas handling procedures specific to your process gas, contact the process gas manufacturer.

UNPACKING

Before installing the Plasma Cleaner make sure all the parts on the included check-off list are present. If any parts are missing or damaged, contact Harrick Plasma immediately.

TECHNICAL SUPPORT

For additional information please contact us between 9 a.m. and 5 p.m. EST:
(USA) 800-640-6380
(Intl) 607-272-5070
or e-mail your questions to:
info@harrickplasma.com

FEEDBACK

Your comments and suggestions are welcome. Please send them to:

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PRINCIPLE OF OPERATION

Plasma, the fourth state of matter, is a distinct processing medium for the treatment and modification of surfaces.

NATURE OF PLASMA

- A plasma is a partially ionized gas consisting of electrons, ions and neutral atoms or molecules.
- The plasma electrons are at a much higher temperature than the neutral gas species, typically around 10^4 K, although the plasma gas as a whole is at near ambient temperature.
- The plasma electron density is typically around 10^{11} cm^{-3}.

PLASMA FORMATION

- A radio frequency (RF) oscillating electric field is generated in the gas region through magnetic induction.
- At sufficiently low pressures the combined effect of the electric field acceleration of electrons and elastic scattering of the electrons with neutral atoms or field lines leads to heating of the electrons.
- When electrons gain kinetic energy in excess of the first ionization threshold in the neutral gas species, electron-neutral collisions lead to further ionization, yielding additional free electrons that are heated in turn.

PLASMA-SURFACE INTERACTION

- The energy of plasma electrons and ions is sufficient to ionize neutral atoms, break molecules apart to form reactive radical species, generate excited states in atoms or molecules, and locally heat the surface.
- Depending on the process gases and parameters, plasmas are capable of both mechanical work, through the ablative effect of kinetic transfer of electrons and ions with the surface, and chemical work, through the interaction of reactive radical species with the surface.
- In general, plasmas can interact with and modify a surface through several mechanisms: ablation, chemical etching, activation, deposition, and cross-linking.

TYPES OF PLASMA-SURFACE INTERACTIONS

ABLATION

- Plasma ablation involves the mechanical removal of surface contaminants by energetic electron and ion bombardment.
- Surface contamination layers (e.g. cutting oils, skin oils, mold releases) are typically comprised of weak C-H bonds.
- Ablation breaks down weak covalent bonds in polymeric contaminants through mechanical bombardment.
- Surface contaminants undergo repetitive chain scission until their molecular weight is sufficiently low for them to boil away in the vacuum.
- Ablation affects only the contaminant layers and the outermost molecular layers of the substrate material.
- Argon is often used for its high ablation efficiency and chemical inertness with the surface material.

CHEMICAL ETCHING

- Chemical etching involves the chemical reaction of surface organic contaminants with highly reactive free radicals in the plasma to form volatile byproducts that are released from the sample surface.
- By proper selection of the gas chemistry and mixture, various types of materials can be chemically etched. In addition, the material can be selectively etched with minimal etching of other materials on the sample surface.
- Chemical etching involves minimal physical damage or roughening of the sample surface.
- O_2 is often used for chemical etching of organic contaminants from sample surfaces.

TYPES OF PLASMA-SURFACE INTERACTIONS

ACTIVATION

- Plasma surface activation involves the creation of surface chemical functional groups through the use of plasma gases - such as oxygen, hydrogen, nitrogen and ammonia - which dissociate and react with the surface.
- In the case of polymers, surface activation involves the replacement of surface polymer groups with chemical groups from the plasma gas.
- The plasma breaks down weak surface bonds in the polymer and replaces them with highly reactive carbonyl, carboxyl, and hydroxyl groups.
- Such activation alters the chemical activity and characteristics of the surface, such as wetting and adhesion, yielding greatly enhanced adhesive strength and permanency.

DEPOSITION

- Plasma deposition involves the formation of a thin polymer coating at the substrate surface through polymerization of the process gas.
- The deposited thin coatings can possess various properties or physical characteristics, depending on the specific gas and process parameters selected.
- Such coatings exhibit a higher degree of cross-linking and much stronger adherence to the substrate in comparison to films derived from conventional polymerization.

CROSS-LINKING

- Cross-linking is the covalent bonding of polymer chains to form dense molecular networks.
- Plasma processing with inert gases can be used to cross-link polymers and produce a stronger and harder substrate surface.
- Under certain circumstances, cross-linking through plasma treatment can also lend additional wear or chemical resistance to a material.

PLASMA PROCESSING

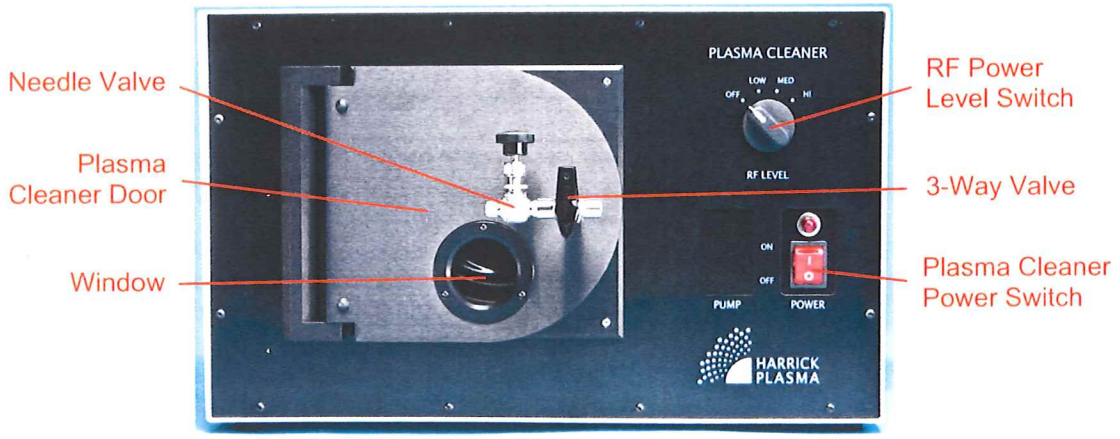
In general, plasma processing proceeds as follows:

- The sample is placed in the reaction chamber and the chamber is evacuated.
- Process gas(es) are flowed into the chamber at flowrates of typically 1-2 SCFH and at low to medium pressure (0.2-1 Torr).
- The process gas is subjected to a MHz-range RF electromagnetic field, creating plasma at near ambient temperature.
- The type of interaction between the plasma and the sample surface depends on parameters such as the intensity and frequency of the RF power used to excite the plasma, the type of gas(es) that are ionized, the pressure and flow rate of the gas(es), the sample surface material, and the duration of the plasma process.
- Detailed guidance on plasma processing may be found in the subsequent *PLASMA PROCESSING* sections of this manual.

GETTING STARTED

Before starting, take a few moments to familiarize yourself with the Plasma Cleaner by looking at the images of the front and back of the unit (Figure 1).

(A) • Front view



(B) • Back view

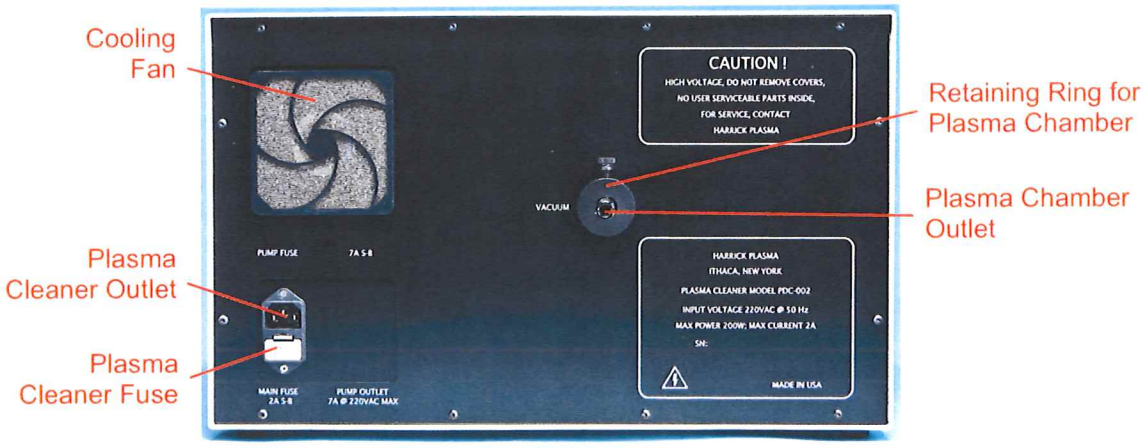


Figure 1 • Expanded Plasma Cleaner (230V)

NOTE: *The expanded Plasma Cleaner PDC-002 is rated for 230V at 50Hz can accept line voltages of 220-240V at 50-60Hz.*

Use a vacuum pump with a minimum pumping speed of 1.4 m^3h^{-1} and an ultimate total pressure of 200 mTorr or less.

SETTING UP A VACUUM PUMP FROM HARRICK PLASMA

If you have purchased a vacuum pump from Harrick Plasma, your pump should be accompanied by pump oil/fluid (if applicable), as well as a length of 1/2" inner diameter (ID) vacuum hose, hose clamps, inlet port adaptor, swing clamp, and centering ring to connect the pump to the Plasma Cleaner (Figure 2).

To set up the vacuum pump for use with the Plasma Cleaner (a BOC Edwards XDS-5 dry pump is used as an example pump below):

- If applicable, fill the vacuum pump with the appropriate pump oil or fluid. Refer to the pump manual for instructions and oil/fluid capacity. Note that Fomblin-prepared pumps for oxygen service require Fomblin fluid, not pump oil.
- Place the centering ring on top of the inlet port of the vacuum pump (Figure 3A).
- Place the inlet port adaptor on top of the centering ring (Figure 3B).
- Wrap the swing clamp around the inlet port adaptor and centering ring. Tighten the swing clamp using the wing nut (Figure 3C).
- Connect the vacuum hose to the inlet port adaptor on the pump. Tighten a hose clamp over the end of the hose (Figure 3D).
- We recommend that the pump exhaust from the outlet port be properly vented, either by conducting the pump outlet exhaust to an exhaust hood through a vacuum hose or attaching an oil mist filter to the outlet port.

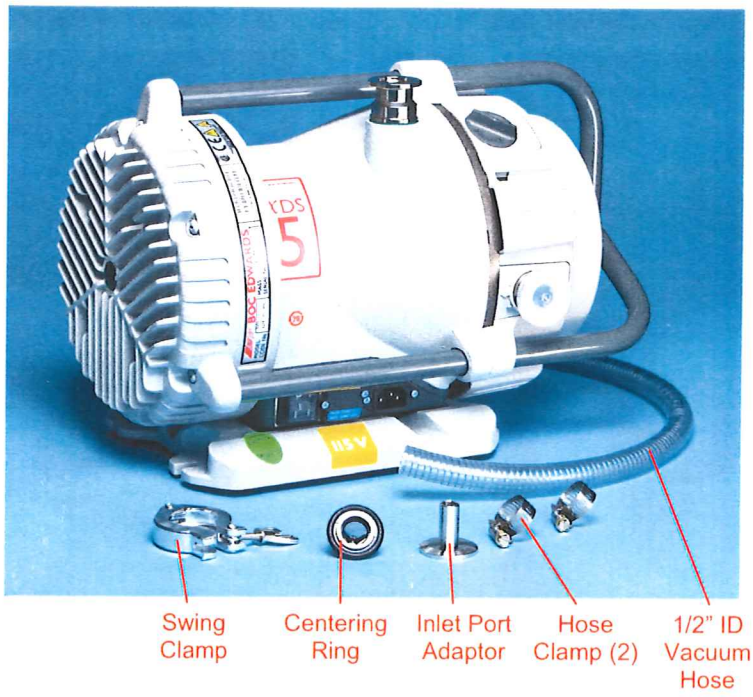


Figure 2 • Example of Vacuum Pump and Accessories

(A) • Centering ring on the inlet port

(B) • Adaptor on the inlet port

(C) • Swing clamp around inlet port adaptor

(D) • Attach vacuum hose

Figure 3 • Setting Up the Vacuum Pump

SETTING UP YOUR OWN VACUUM PUMP

If you are using your own vacuum pump, refer to your pump manufacturer for appropriate parts and accessories required for connecting the pump to the Plasma Cleaner. Below are guidelines to set up the vacuum pump for use with the Plasma Cleaner (see also the previous section *SETTING UP A VACUUM PUMP FROM HARRICK PLASMA* as an example):

- If applicable, make sure the vacuum pump is filled with the appropriate pump oil or fluid. Refer to the pump manual for instructions and oil/fluid capacity.
- To connect the vacuum pump to the plasma chamber outlet at the rear of the Plasma Cleaner, use 1/2" inner diameter (ID) flexible vacuum hose with hose clamps tightened at both ends.
- To connect the vacuum hose to the inlet port of your vacuum pump, use a 1/2" outer diameter (OD) inlet port adaptor with the appropriate centering ring and swing clamp to tighten and seal to the inlet port.
- We recommend that the pump exhaust from the outlet port be properly vented, by either conducting the pump outlet exhaust to an exhaust hood through a vacuum hose or attaching an oil mist filter to the outlet port.

SETUP

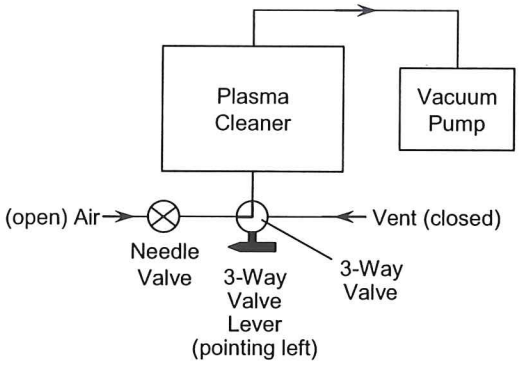
See *ABOUT THE VACUUM PUMP* for instructions to set up the vacuum pump for use with the Plasma Cleaner.

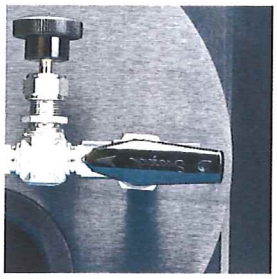
NOTE: *When connecting NPT tapered threads, always wrap the thread with PTFE (Teflon) tape to ensure a good seal and lubrication. Remove any debris or residual tape on the internal and external threads before wrapping with new tape and reconnecting. Wrap the tape in the direction counter to the screw direction. Tighten all threaded connections with a wrench.*

To set up the Plasma Cleaner for processing with room air (Figure 4):

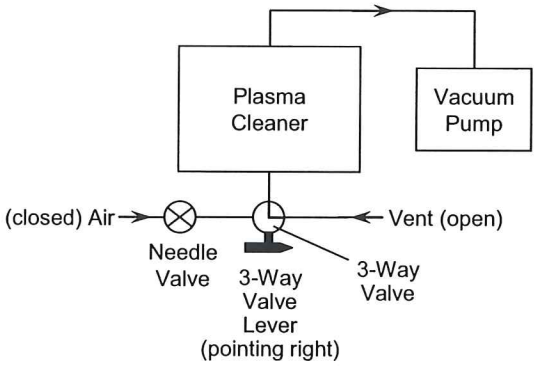
- Connect the needle valve/3-way valve to the Plasma Cleaner door (Figure 5). The appropriate connection, located opposite the 3-way valve lever, should already be wrapped with Teflon tape.
- Connect the plasma chamber outlet at the back of the Plasma Cleaner (Figure 1B) to the vacuum pump using 1/2" ID vacuum hose. Tighten hose clamps over the hose at each end.
- Plug the vacuum pump into a wall outlet.
- Plug the Plasma Cleaner into a wall outlet.

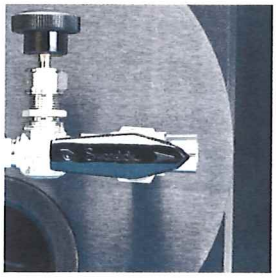
(A) • To process gas (air)





(B) • To vent





(C) • 3-way valve closed

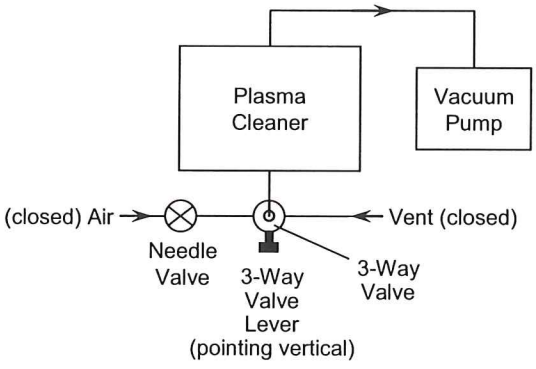


Figure 4 • Setup for Processing with Room Air

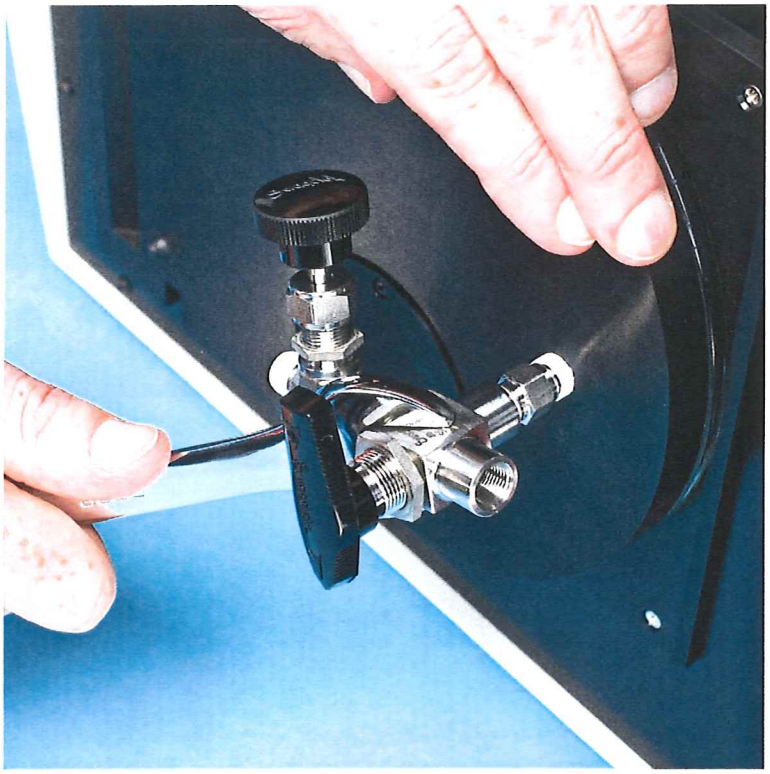


Figure 5 • Connecting the Needle Valve/3-Way Valve to the Plasma Cleaner Door

OPERATION

> ⚠ ***CAUTION:***
> *Following completion of processing, the Plasma Cleaner power switch should be turned off in order to prevent overheating and possible damage to the Plasma Cleaner.*

NOTE: *If the Plasma Cleaner is intended to be repeatedly used with no change to the process settings (as in the case of a single user), it is recommended for process repeatability to leave the needle valve open and fixed to the desired setting. Instead, use only the 3-way valve to switch between bleeding in air, isolating the plasma chamber, and venting (Figure 4).*

If the process settings of the Plasma Cleaner may vary with each use (as in the case of multiple users), it is recommended to close the needle valve at the end of each use as the default setting.

EVACUATING THE CHAMBER

- Put the sample in the Plasma Cleaner chamber.
- Check that the 3-way valve is closed (lever is in the vertical position, Figure 4C).
- Close the Plasma Cleaner door and hold the door against the vacuum chamber.
- Turn on the vacuum pump. It will take a few minutes to evacuate the air in the chamber.

BLEEDING IN AIR

- Open the 3-way valve to room air (lever points to the needle valve, Figure 4A).
- Slightly open the needle valve and allow the air to enter the Plasma Cleaner chamber.

GENERATING PLASMA

- Turn on the Plasma Cleaner power switch on the front of the Plasma Cleaner.
- Select the appropriate RF power level (refer to the following *NOTE* below) using the RF power level switch.
- Look through the window on the Plasma Cleaner door and wait until a glow is observed. For air, the plasma glow discharge should be purple-pink in color. This indicates that the plasma has been generated.
- Adjust the needle valve slightly until the plasma intensity is visibly maximized. This broadly corresponds to optimal plasma generation conditions.

NOTE: *By selecting the process pressure, plasma energy (RF power), and processing duration, the nature and extent of the surface interactions can be tailored for your application.*

For optimal plasma uniformity, the RF power level should be set to Medium or High. Process pressures of ~600 mTorr and process times of 1-3 minutes are good process parameter initial values. Optimal process parameter values will depend on the sample material and intended application. Some experimentation may be required to determine these optimal values.

PLASMA PROCESSING

- Process the sample for the desired duration.
- At the end of the process, set the RF power level to OFF.
- Turn off the Plasma Cleaner.

VENTING THE CHAMBER

- Turn off the vacuum pump.
- Slowly open the 3-way valve to vent (lever points to the vent flow, Figure 4B).
- Once atmospheric pressure is reached, open the Plasma Cleaner door.
- Close the needle valve.
- Close the 3-way valve (lever is in the vertical position, Figure 4C).
- Take out the sample.

CAUTION:
If the Plasma Cleaner is not vented immediately, oil may backstream from the vacuum pump and contaminate the system. We recommend the use of a vacuum pump with an anti suck back feature, such as that optionally provided by Harrick Plasma. Do not open the door when the chamber is under vacuum since this will damage the glass chamber.

SETUP

See *ABOUT THE VACUUM PUMP* for instructions to set up the vacuum pump for use with the Plasma Cleaner.

NOTE: *When connecting NPT tapered threads, always wrap the thread with PTFE (Teflon) tape to ensure a good seal and lubrication. Remove any debris or residual tape on the internal and external threads before wrapping with new tape and reconnecting. Wrap the tape in the direction counter to the screw direction. Tighten all threaded connections with a wrench.*

To set up the Plasma Cleaner for processing with process gas (Figure 6):

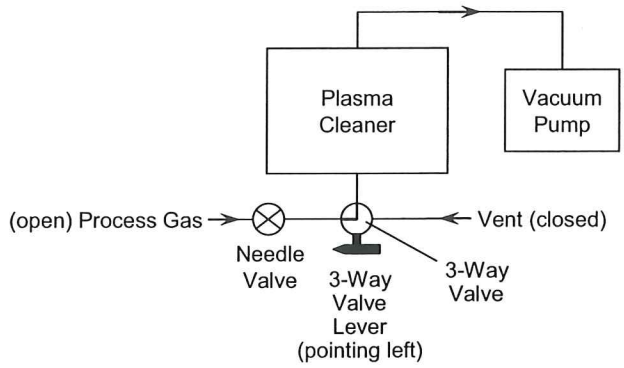
- Connect the needle valve/3-way valve to the Plasma Cleaner door (Figure 5). The appropriate connection, located opposite the 3-way valve lever, should already be wrapped with Teflon tape.
- Attach an appropriate pressure regulator to the process gas cylinder. We recommend using regulated pressures of 5-10 psi.
- Wrap the threads on the open end of the needle valve with Teflon tape. Connect the needle valve to the pressure regulator on the process gas cylinder through appropriate adaptors and tubing. The needle valve has 1/8" NPT fittings.
- Connect the plasma chamber outlet at the back of the Plasma Cleaner (Figure 1B) to the vacuum pump using 1/2" ID vacuum hose. Tighten hose clamps over the hose at each end.
- Plug the vacuum pump into a wall outlet.
- Plug the Plasma Cleaner into a wall outlet.

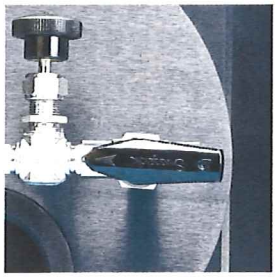
NOTE: *To monitor and control the pressure and rate of process gas flow, we recommend using the optional PlasmaFlo (Figure 7).*

***CAUTION*:**
For processing with pure oxygen, make sure that you use an oxygen compatible vacuum pump. The optional Harrick Plasma oil-based vacuum pumps are NOT oxygen compatible. The hydrocarbon pump oil mist can react with the concentrated oxygen to produce a potentially explosive combination. We do offer oxygen service pumps for use with oxygen process gas; please inquire with Harrick Plasma.

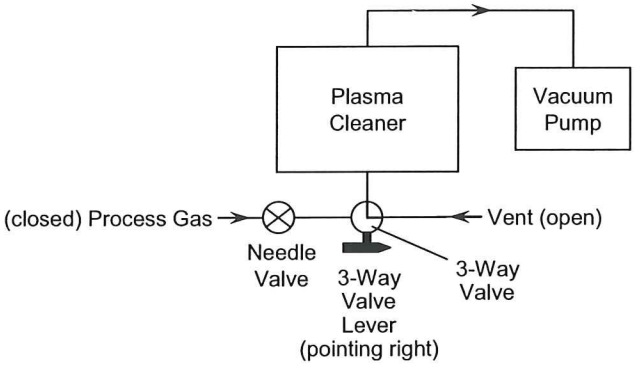
CAUTION:
If you are working with highly reactive or corrosive gases, be sure that the seals and gas connection materials of the Plasma Cleaner and vacuum pump are compatible with the gas(es). Use a suitable vacuum pump to service corrosive gases. It may be necessary to use different materials to avoid reaction with the process gas. Please contact Harrick Plasma to determine materials compatibility with your process gas(es).

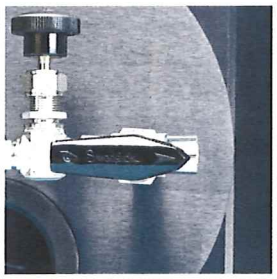
(A) • To process gas



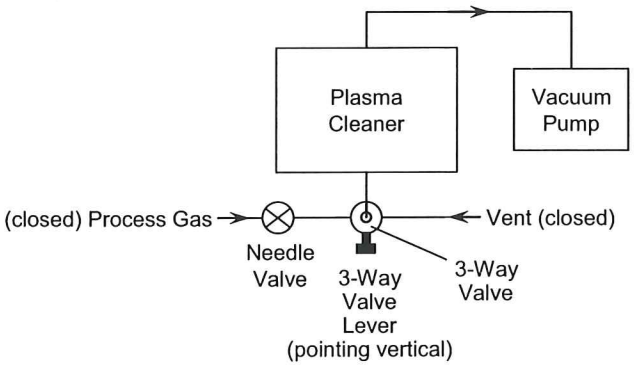


(B) • To vent





(C) • 3-way valve closed



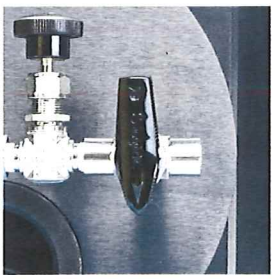


Figure 6 • Setup for Processing with Process Gas

OPERATION

> ***CAUTION:***
> *Following completion of processing, the Plasma Cleaner power switch should be turned off in order to prevent overheating and possible damage to the Plasma Cleaner.*

PURGING THE GAS LINE(S)

Purging the gas line with the process gas is recommended if it is necessary to flush out unwanted substances in the gas line. Purging should be performed in a controlled environment, within the Plasma Cleaner chamber and vacuum pump system.

> ***CAUTION:***
> *If you are working with toxic or highly reactive gases, the gases must be handled with extreme caution. To avoid releasing toxic or highly reactive gases into the ambient environment, it is recommended to run several pump/purge cycles (purge the chamber with an inert gas (e.g. N_2 or Ar) and allow it to pump out) to ensure the toxic and highly reactive gases are properly evacuated from the chamber prior to venting. The pump exhaust must also be properly vented.*
>
> *See CONFIGURATION OPTIONS: PUMP/PURGING AND VENTING WITH INERT GAS for guidelines to set up the Plasma Cleaner to pump/purge and vent with inert gas. For safe gas handling procedures specific to your process gas, contact the process gas manufacturer.*

To purge the non-toxic or non-reactive gas line(s):

- Check that the needle valve and 3-way valve are closed (lever is in the vertical position, Figure 6C).
- Close the Plasma Cleaner door and hold the door against the vacuum chamber.
- Turn on the vacuum pump. It will take a few minutes to evacuate the air in the chamber.
- Open the process gas cylinder valve and adjust the regulator pressure to 5-10 psi.
- Open the 3-way valve to process gas (lever points to the needle valve, Figure 6A).

PURGING THE GAS LINE(S) (continued)

- Slightly open the needle valve and allow the gas to flow for 30-60 seconds.
- Close the process gas cylinder valve.
- Allow 1-3 minutes for the vacuum pump to pump out any residual process gas from the chamber.
- Close the needle valve.
- Turn off the vacuum pump.
- Slowly open the 3-way valve to vent (lever points to the vent flow, Figure 6B).
- Once atmospheric pressure is reached, open the Plasma Cleaner door.
- Close the 3-way valve (lever is in the vertical position, Figure 6C).

NOTE: *If the Plasma Cleaner is intended to be repeatedly used with no change to the process settings (as in the case of a single user), it is recommended for process repeatability to leave the needle valve open and fixed to the desired setting. Instead, use only the 3-way valve to switch between bleeding in gas, isolating the plasma chamber, and venting (Figure 6).*

If the process settings of the Plasma Cleaner may vary with each use (as in the case of multiple users), it is recommended to close the needle valve at the end of each use as the default setting.

EVACUATING THE CHAMBER

- Put the sample in the Plasma Cleaner chamber.
- Check that the 3-way valve is closed (lever is in the vertical position, Figure 6C).
- Close the Plasma Cleaner door and hold the door against the vacuum chamber.
- Turn on the vacuum pump. It will take a few minutes to evacuate the air in the chamber.

BLEEDING IN PROCESS GAS

- Open the process gas cylinder valve and adjust the regulator pressure to 5-10 psi.
- Open the 3-way valve to process gas (lever points to the needle valve, Figure 6A).
- Slightly open the needle valve and allow the gas to flow for 30-60 seconds. Proceed to *GENERATING PLASMA*.

GENERATING PLASMA

- Turn on the Plasma Cleaner power switch on the front of the Plasma Cleaner.
- Select the appropriate RF power level (refer to the following *NOTE* below) using the RF power level switch.
- Look through the window on the Plasma Cleaner door and wait until a glow discharge is observed. This indicates that plasma has been generated.
- Adjust the needle valve until the plasma is visibly maximized. This broadly corresponds to optimal plasma generation conditions.

NOTE: *By selecting the process gas (or gas mixture), process pressure, plasma energy (RF power), and processing duration, the nature and extent of the surface interactions can be tailored for your application.*

For optimal plasma uniformity, the RF power level should be set to Medium or High. Process pressures of ~600 mTorr and process times of 1-3 minutes are good process parameter initial values. Optimal process parameter values will depend on the sample material and intended application. Some experimentation may be required to determine these optimal values.

PLASMA PROCESSING

- Process the sample for the desired duration.
- At the end of the process, set the RF power level to OFF.
- Turn off the Plasma Cleaner.
- Close the process gas cylinder valve.
- Allow 1-3 minutes for the vacuum pump to pump out any residual process gas from the chamber.
- Close the needle valve.

CAUTION:
If you are working with toxic or highly reactive gases, the gases must be handled with extreme caution. To avoid releasing toxic or highly reactive gases into the ambient environment, it is recommended to run several pump/purge cycles (purge the chamber with an inert gas (e.g. N_2 or Ar) and allow it to pump out) to ensure the toxic or highly reactive gases are properly evacuated from the chamber prior to venting. The pump exhaust must also be properly vented.

See CONFIGURATION OPTIONS: PUMP/PURGING AND VENTING WITH INERT GAS for guidelines to set up the Plasma Cleaner to pump/purge and vent with inert gas. For safe gas handling procedures specific to your process gas, contact the process gas manufacturer.

VENTING THE CHAMBER

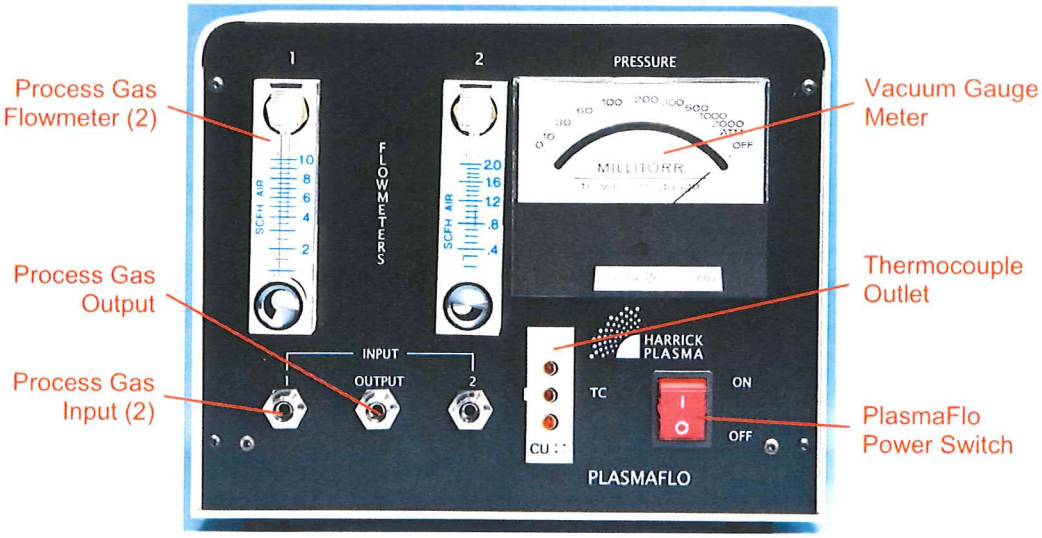
- Turn off the vacuum pump.
- Slowly open the 3-way valve to vent (lever points to the vent flow, Figure 6B).
- Once atmospheric pressure is reached, open the Plasma Cleaner door.
- Close the 3-way valve (lever is in the vertical position, Figure 6C).
- Take out the sample.

> ⚠ ***CAUTION:***
> *If the Plasma Cleaner is not vented immediately, oil may backstream from the vacuum pump and contaminate the system. We recommend the use of a vacuum pump with an anti suck back feature, such as that optionally provided by Harrick Plasma. Do not open the door when the chamber is under vacuum since this will damage the glass chamber.*

GETTING READY

Before starting, take a few moments to familiarize yourself with the PlasmaFlo by looking at the images of the front and back of the unit (Figure 7) and the PlasmaFlo accessories (Figure 8).

(A) • Front view



(B) • Back view

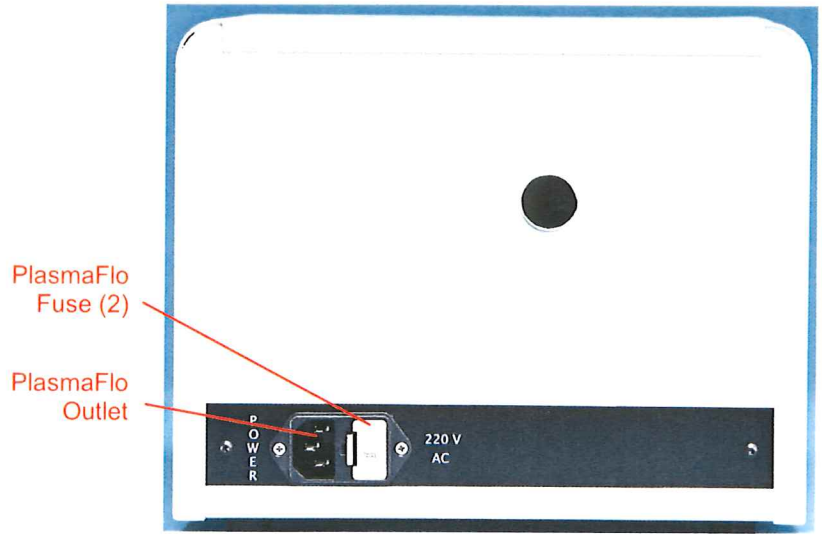


Figure 7 • PlasmaFlo (230V)

NOTE: *The PlasmaFlo PDC-FMG-2 is rated for 230V at 50Hz but can accept line voltages of 220-240V at 50-60Hz.*

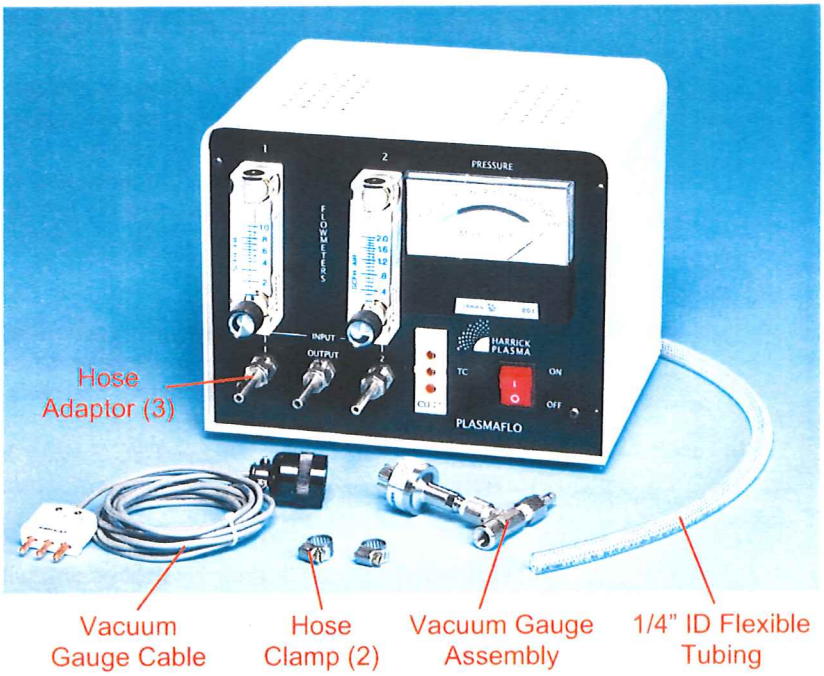


Figure 8 • PlasmaFlo and Accessories

SETUP

See *ABOUT THE VACUUM PUMP* for instructions to set up the vacuum pump for use with the Plasma Cleaner.

NOTE: *When connecting NPT tapered threads, always wrap the thread with PTFE (Teflon) tape to ensure a good seal and lubrication. Remove any debris or residual tape on the internal and external threads before wrapping with new tape and reconnecting. Wrap the tape in the direction counter to the screw direction. Tighten all threaded connections with a wrench.*

NOTE: *As an option, the vacuum gauge may be connected in between the 3-way valve and needle valve to isolate the plasma chamber and monitor only the chamber pressure with no gas input. See CONFIGURATION OPTIONS: VACUUM GAUGE IN BETWEEN THE 3-WAY VALVE AND NEEDLE VALVE for instructions to assemble this configuration.*

To set up the Plasma Cleaner for processing with process gas(es) and the PlasmaFlo (Figure 9):

- Connect the three (3) hose adaptors to the two (2) inputs and output on the PlasmaFlo (Figure 8). Tighten with a wrench.
- Connect the vacuum gauge assembly to the needle valve (Figure 10A).
- Connect the vacuum gauge assembly/needle valve/3-way valve to the Plasma Cleaner door (Figure 10B). The appropriate connection, located opposite the 3-way valve lever, should already be wrapped with Teflon tape.
- Connect the PlasmaFlo output to the vacuum gauge assembly on the Plasma Cleaner door using the supplied 1/4" ID flexible tubing. Tighten hose clamps over the tubing at each end.
- Attach appropriate pressure regulator(s) to the process gas cylinder(s). We recommend using regulated pressures of 5-10 psi.
- Connect the PlasmaFlo input(s) to the pressure regulator on the process gas cylinder(s) using 1/4" ID flexible tubing and through appropriate adaptors. Tighten hose clamps over the tubing at each end.
- Connect the vacuum gauge to the thermocouple outlet on the PlasmaFlo using the supplied vacuum gauge cable (keep in mind the polarity of the thermocouple outlet).

SETUP (continued)

- Connect the plasma chamber outlet at the back of the Plasma Cleaner (Figure 1B) to the vacuum pump using 1/2" ID vacuum hose. Tighten hose clamps over the hose at each end.
- Plug the vacuum pump into a wall outlet.
- Plug the Plasma Cleaner and PlasmaFlo into a wall outlet.

CAUTION:
For processing with pure oxygen, make sure that you use an oxygen compatible vacuum pump. The optional Harrick Plasma oil-based vacuum pumps are NOT oxygen compatible. The hydrocarbon pump oil mist can react with the concentrated oxygen to produce a potentially explosive combination. We do offer oxygen service pumps for use with oxygen process gas; please inquire with Harrick Plasma.

CAUTION:
If you are working with highly reactive or corrosive gases, be sure that the seals and gas connection materials of the Plasma Cleaner and vacuum pump are compatible with the gas(es). Use a suitable vacuum pump to service corrosive gases. It may be necessary to use different materials to avoid reaction with the process gas. Please contact Harrick Plasma to determine materials compatibility with your process gas(es).

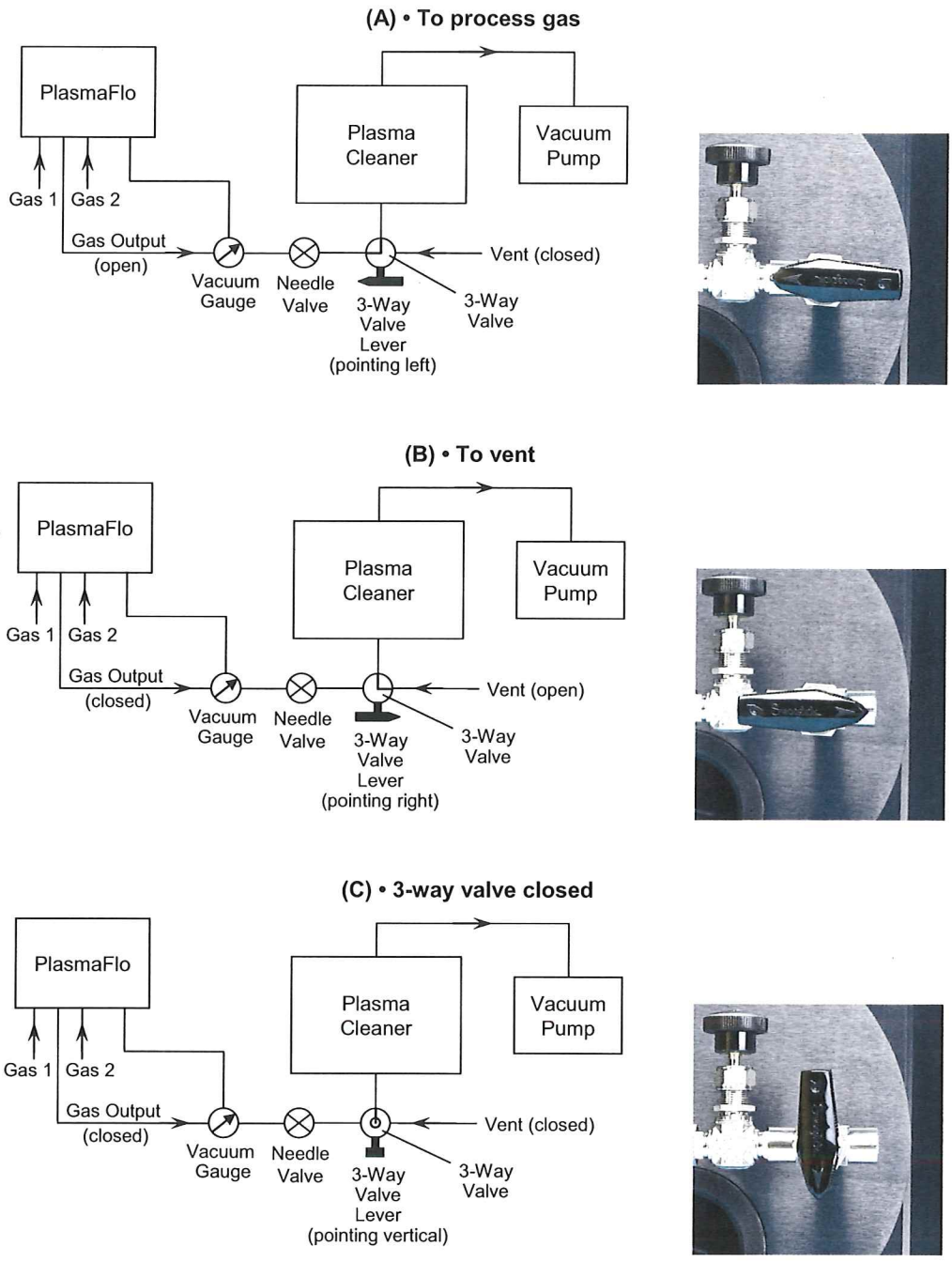
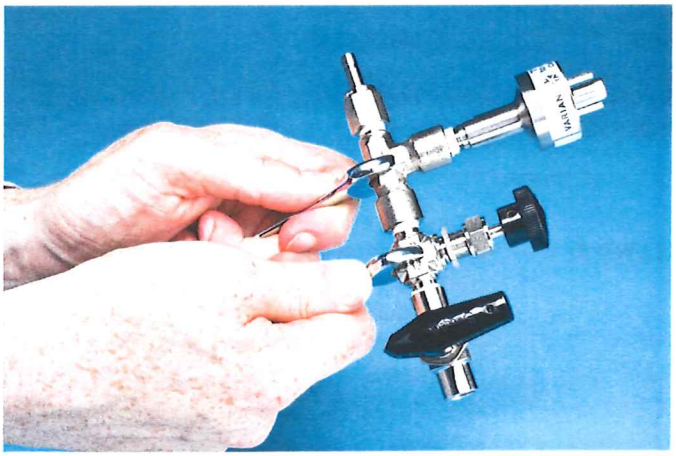


Figure 9 • Setup for Processing with Process Gas and the PlasmaFlo

(A) • Connecting the vacuum gauge assembly to the needle valve



(B) • Connecting the vacuum gauge assembly/needle valve/3-way valve to the Plasma Cleaner door

Figure 10 • Connecting the Vacuum Gauge Assembly and Needle Valve/3-Way Valve Assembly to the Plasma Cleaner Door

OPERATION

> ***CAUTION:***
> *Following completion of processing, the Plasma Cleaner power switch should be turned off in order to prevent overheating and possible damage to the Plasma Cleaner.*

PURGING THE GAS LINE(S)

Purging of the gas line with the process gas is recommended if there is a possibility that the gas line contains unwanted substances. Purging should be performed in a controlled environment, within the Plasma Cleaner chamber and vacuum pump system.

> ***CAUTION:***
> *If you are working with toxic or highly reactive gases, the gases must be handled with extreme caution. To avoid releasing toxic or highly reactive gases into the ambient environment, it is recommended to run several pump/purge cycles (purge the chamber with an inert gas (e.g. N_2 or Ar) and allow it to pump out) to ensure the toxic or highly reactive gases are properly evacuated from the chamber prior to venting. The pump exhaust must also be properly vented.*
>
> *See CONFIGURATION OPTIONS: PUMP/PURGING AND VENTING WITH INERT GAS for guidelines to set up the Plasma Cleaner to pump/purge and vent with inert gas. For safe gas handling procedures specific to your process gas, contact the process gas manufacturer.*

To purge the non-toxic or non-reactive gas line(s):

- Check that the needle valve and 3-way valve are closed (lever is in the vertical position, Figure 9C).
- Close the Plasma Cleaner door and hold the door against the vacuum chamber.
- Turn on the vacuum pump. It will take a few minutes to evacuate the air in the chamber.
- Open the 3-way valve to process gas (lever points to the needle valve, Figure 9A).
- Open the needle valve.
- Open the first process gas cylinder valve and adjust the regulator pressure to 5-10 psi.

PURGING THE GAS LINE(S) (continued)

- On the PlasmaFlo, open the flowmeter connected to the first process gas cylinder to ~1 SCFH. Allow the gas to flow for 30-60 seconds.
- Close the first process gas cylinder valve.
- Allow 1-3 minutes for the vacuum pump to pump out any residual process gas from the chamber.
- Close the flowmeter connected to the first process gas cylinder.
- Close the needle valve.
- Turn off the vacuum pump.
- Slowly open the 3-way valve to vent (lever points to the vent flow, Figure 9B).
- Once atmospheric pressure is reached, open the Plasma Cleaner door.
- Close the 3-way valve (lever is in the vertical position, Figure 9C).

- If necessary, repeat the above steps with the second process gas.

NOTE: *If the Plasma Cleaner is intended to be repeatedly used with no change to the process settings (as in the case of a single user), it is recommended for process repeatability to leave the needle valve and flowmeter(s) open and fixed to the desired setting. Instead, use only the 3-way valve to switch between bleeding in gas, isolating the plasma chamber, and venting (Figure 9).*

If the process settings of the Plasma Cleaner may vary with each use (as in the case of multiple users), it is recommended to close the needle valve and flowmeters at the end of each use as the default setting.

EVACUATING THE CHAMBER

- Put the sample in the Plasma Cleaner chamber.
- Turn on the PlasmaFlo power switch.
- Check that the 3-way valve is closed (lever is in the vertical position, Figure 9C).
- Close the Plasma Cleaner door and hold the door against the vacuum chamber.
- Turn on the vacuum pump. The pressure, as indicated by the vacuum gauge meter, should begin to decrease.
- Pump down the chamber to ~200 mTorr or to the desired base pressure prior to flowing in process gas(es).

BLEEDING IN PROCESS GAS(ES)

- Open the process gas cylinder valve(s) and adjust the regulator pressure to 5-10 psi.
- Open the 3-way valve to process gas (lever points to the needle valve, Figure 9A).
- Slowly open the needle valve until it is fully opened.
- Open the gas flowmeter(s) on the PlasmaFlo (Figure 7A).
- Adjust the flowmeter(s) and the needle valve, if necessary, to obtain the desired flow rate(s) and process pressure.
- Allow the gas to flow for 30-60 seconds or until the flow rate(s) has stabilized. Proceed to *GENERATING PLASMA*.

GENERATING PLASMA

- Turn on the Plasma Cleaner power switch on the front of the Plasma Cleaner.
- Select the appropriate RF power level (refer to the following *NOTE* below) using the RF power level switch.
- Look through the window on the Plasma Cleaner door and wait until a glow discharge is observed. This indicates that plasma has been generated.
- If necessary, readjust the flowmeter(s) and needle valve until the plasma is visibly maximized. This broadly corresponds to optimal plasma generation conditions.

NOTE: *By selecting the process gas (or gas mixture), process pressure, plasma energy (RF power), and processing duration, the nature and extent of the surface interactions can be tailored for your application.*

For optimal plasma uniformity, the RF power level should be set to Medium or High. Process pressures of ~600 mTorr and process times of 1-3 minutes are good process parameter initial values. Optimal process parameter values will depend on the sample material and intended application. Some experimentation may be required to determine these optimal values.

PLASMA PROCESSING

- Process the sample for the desired duration.
- At the end of the process, set the RF power level to OFF.
- Turn off the Plasma Cleaner.
- Close the process gas cylinder valve(s).
- Allow 1-3 minutes for the system to pump out any residual process gas(es) from the chamber.
- Close the gas flowmeter(s).
- Close the needle valve.

> ⚠ ***CAUTION:***
> *If you are working with toxic or highly reactive gases, the gases must be handled with extreme caution. To avoid releasing toxic or highly reactive gases into the ambient environment, it is recommended to run several pump/purge cycles (purge the chamber with an inert gas (e.g. N_2 or Ar) and allow it to pump out) to ensure the toxic or highly reactive gases are properly evacuated from the chamber prior to venting. The pump exhaust must also be properly vented.*
>
> *See CONFIGURATION OPTIONS: PUMP/PURGING AND VENTING WITH INERT GAS for guidelines to set up the Plasma Cleaner to pump/purge and vent with inert gas. For safe gas handling procedures specific to your process gas, contact the process gas manufacturer.*

VENTING THE CHAMBER

- Turn off the vacuum pump.
- Slowly open the 3-way valve to vent (lever points to the vent flow, Figure 9B).
- Once atmospheric pressure is reached, open the Plasma Cleaner door.
- Close the 3-way valve (lever is in the vertical position, Figure 9C).
- Turn off the PlasmaFlo.
- Remove the sample.

> ⚠ ***CAUTION:***
> *If the Plasma Cleaner is not vented immediately, oil may backstream from the vacuum pump and contaminate the system. We recommend the use of a vacuum pump with an anti suck back feature, such as that optionally provided by Harrick Plasma. Do not open the door when the chamber is under vacuum since this will damage the glass chamber.*

PUMP/PURGING AND VENTING WITH INERT GAS

If you are working with toxic or highly reactive gases, the gases must be handled with extreme caution. To avoid releasing toxic or highly reactive gases into the ambient environment, it is recommended to run several pump/purge cycles (purge the chamber with an inert gas (e.g. N_2 or Ar) and allow it to pump out) prior to venting to ensure the toxic or highly reactive gases are properly evacuated from the chamber. The chamber can then be vented with the inert gas. The pump exhaust must also be properly vented.

Note that the procedures outlined below are general guidelines for pump/purging and venting the plasma chamber with inert gas. For safe gas handling procedures specific to your process gas, please consult with your process gas manufacturer.

NOTE: *When connecting NPT tapered threads, always wrap the thread with PTFE (Teflon) tape to ensure a good seal and lubrication. Remove any debris or residual tape on the internal and external threads before wrapping with new tape and reconnecting. Wrap the tape in the direction counter to the screw direction. Tighten all threaded connections with a wrench.*

SETUP

- Attach an appropriate pressure regulator to the inert gas cylinder. We recommend using regulated pressures of 1-2 psi.
- Connect the vent flow side of the 3-way valve to the pressure regulator on the inert gas cylinder using appropriate tubing and adaptors. The 3-way valve has 1/8" NPT fittings.

PUMP/PURGING WITH INERT GAS AFTER PLASMA PROCESSING

To pump/purge with inert gas after following the procedures in *EVACUATING THE CHAMBER*, *BLEEDING IN PROCESS GAS*, *GENERATING PLASMA*, and *PLASMA PROCESSING*:

- Check that the needle valve and 3-way valve are closed (lever is in the vertical position, Figure 11A).
- Open the inert gas cylinder valve.
- Adjust the inert gas regulator to 1-2 psi.
- Partially open the 3-way valve halfway to vent flow (lever is intermediate to inert gas flow and vertical position, Figure 11B). If using the optional PlasmaFlo, the chamber pressure should quickly increase.

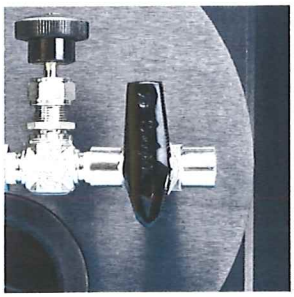
PUMP/PURGING WITH INERT GAS AFTER PLASMA PROCESSING (continued)

- Quickly close the 3-way valve (lever is in the vertical position, Figure 11A). These steps should be performed quickly to avoid disturbing the sample or overloading the vacuum pump. If using the optional PlasmaFlo, the chamber pressure should decrease back to a lower pressure.
- Repeat the previous 2 steps of quickly opening and closing the 3-way valve to inert gas flow. Repeat a third time. At the end of this procedure, the 3-way valve should be closed (lever is in the vertical position, Figure 11A).

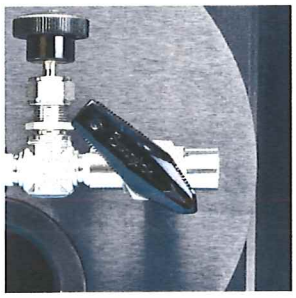
VENTING THE CHAMBER WITH INERT GAS

- Turn off the vacuum pump.
- Slowly open the 3-way valve to vent (lever points to the vent flow, Figure 11C).
- Once atmospheric pressure is reached, open the Plasma Cleaner door.
- Close the inert gas cylinder valve.
- Close the 3-way valve (lever is in the vertical position, Figure 11A).
- Turn off the optional PlasmaFlo.
- Remove the sample.

(A) • 3-way valve closed



(B) • 3-way valve partially open to inert gas



(C) • 3-way valve fully open to inert gas

Figure 11 • Pump/Purging and Venting with Inert Gas (vent flow side of 3-way valve would be connected to an inert gas source)

VACUUM GAUGE IN BETWEEN THE 3-WAY VALVE AND NEEDLE VALVE

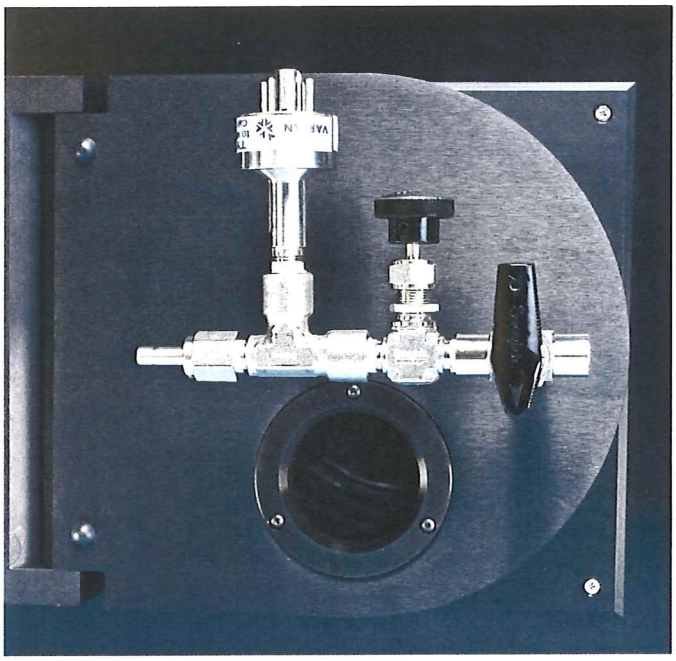
With the optional PlasmaFlo, the vacuum gauge may be connected in between the 3-way valve and needle valve to isolate the plasma chamber and monitor only the chamber pressure with no gas input. This configuration is useful for troubleshooting possible vacuum leakage in the plasma chamber.

NOTE: *When connecting NPT tapered threads, always wrap the thread with PTFE (Teflon) tape to ensure a good seal and lubrication. Remove any debris or residual tape on the internal and external threads before wrapping with new tape and reconnecting. Wrap the tape in the direction counter to the screw direction. Tighten all threaded connections with a wrench.*

To set up this configuration (Figure 12B):

- If necessary, disconnect the vacuum gauge assembly/needle valve/3-way valve from the Plasma Cleaner door.
- Disconnect the vacuum gauge assembly and 3-way valve from the needle valve. Remove any residual Teflon tape on the external and internal threads of the needle valve, 3-way valve, and vacuum gauge assembly. Rewrap the threads on both ends of the needle valve with Teflon tape.
- Disconnect the hose adaptor on the vacuum gauge assembly. Remove any residual Teflon tape on the external and internal threads. Rewrap the thread on the vacuum gauge assembly with Teflon tape.
- Connect the hose adaptor to the inlet side of the needle valve (the arrow on the needle valve points away from the inlet).
- Connect the outlet side of the needle valve (the arrow on the needle valve points to the outlet) to the vacuum gauge assembly.
- Connect the needle valve/vacuum gauge assembly to the left opening of the 3-way valve (from the perspective of having the 3-way valve lever facing you, with the 3-way valve closed and the lever pointing down).
- Wrap the thread on the 3-way valve (opposite the 3-way valve lever) with Teflon tape.
- Connect the needle valve/vacuum gauge assembly/3-way valve to the Plasma Cleaner door.

(A) • Standard configuration: vacuum gauge/needle valve/3-way valve



(B) • Optional configuration: needle valve/vacuum gauge/3-way valve

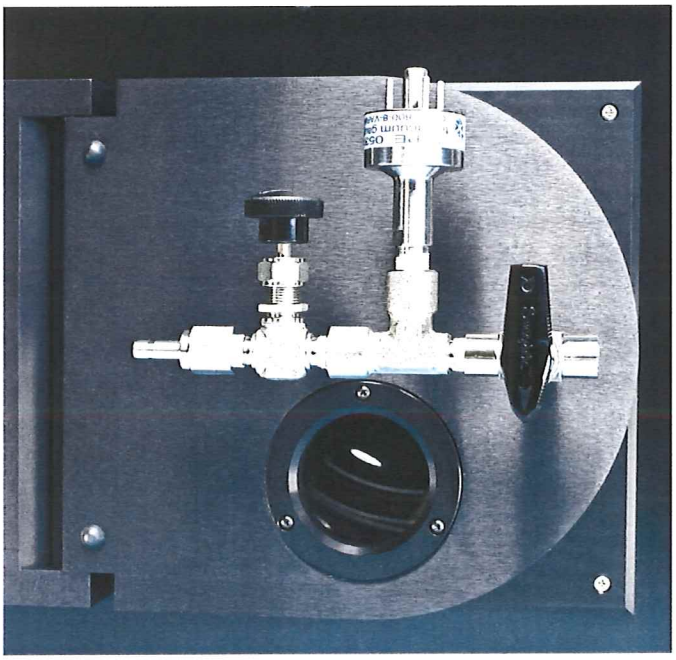


Figure 12 • Vacuum Gauge Configuration Options

MAINTENANCE REQUIREMENTS

For most plasma cleaning and plasma processing applications, the Plasma Cleaner requires little or no maintenance. The vacuum pump does require routine servicing. Please review the pump manual to determine the maintenance requirements for the vacuum pump.

CLEANING THE CHAMBER

Some combinations of process gas(es) and sample materials may generate particulates and contaminants that can accumulate on the chamber wall. Over time, these contaminants may affect the plasma power and effectiveness of the plasma process. If a change to the plasma process or plasma intensity is detected, the chamber may require cleaning to remove these contaminants.

> ⚠ ***CAUTION:***
> *Please take all safety precautions and use the appropriate personal protection equipment (e.g. gloves, goggles, etc.) when cleaning the plasma chamber with solvents or hazardous chemicals.*

The plasma chamber is made of borosilicate glass (Pyrex) and may be cleaned using similar cleaning methods for standard laboratory glassware. These may include:

- Soaking or wiping the plasma chamber surface with acetone or isopropyl alcohol.
- Lightly scrubbing the plasma chamber using a standard laboratory glassware cleaner (e.g. Alconox).

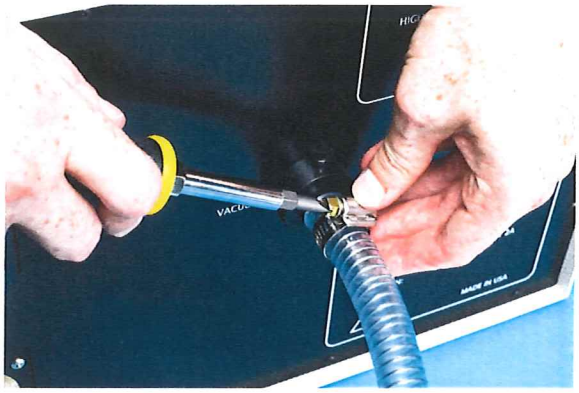
REPLACING THE CHAMBER

If standard laboratory glassware cleaning methods do not remove the contaminants and the contaminants are affecting the plasma process, the plasma chamber may require replacement. See *OPTIONAL AND REPLACEMENT PARTS* to find the appropriate part number.

To replace the Plasma Cleaner chamber (Figure 13):

- Disconnect the vacuum hose on the plasma chamber outlet at the back of the Plasma Cleaner (Figure 13A).
- Loosen the thumbscrew of the retaining ring on the plasma chamber outlet (Figure 13B). Remove the retaining ring.
- Slide the old chamber out (Figure 13C).
- Slide the new chamber in.
- Slide the retaining ring onto the plasma chamber outlet and hand-tighten the thumbscrew.
- Reconnect the vacuum hose to the plasma chamber outlet. Tighten the hose clamp around the end of the tubing.

(A) • Disconnect the vacuum hose from the plasma chamber outlet



(B) • Loosen the thumbscrew of the retaining ring

(C) • Slide the old chamber out

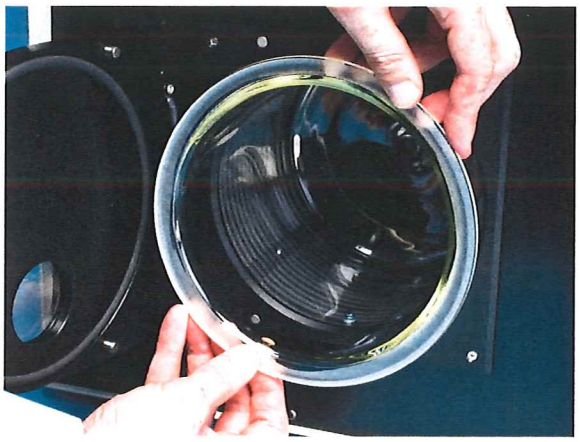


Figure 13 • Replacing the Plasma Chamber

CLEANING THE PLASMA CLEANER DOOR AND O-RING

To clean the Plasma Cleaner door and o-ring:

- Remove the o-ring from the Plasma Cleaner door (Figure 14).
- Wipe the interior of the Plasma Cleaner door with isopropyl alcohol.
- Visually inspect the o-ring. If the o-ring shows signs of degradation (e.g. surface is cracked or worn), replace the o-ring (see *OPTIONAL AND REPLACEMENT PARTS* to find the appropriate part number). If the o-ring appears in good condition, wipe the o-ring with isopropyl alcohol to remove any debris or contaminants on the surface.
- Reinsert the o-ring into the circular groove on the Plasma Cleaner door. Make sure the o-ring is properly seated in the groove.

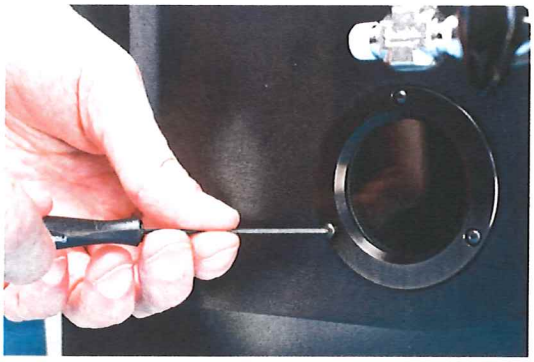
Figure 14 • Removing the O-Ring on the Plasma Cleaner Door

REPLACING THE WINDOW AND WINDOW O-RING

To replace the Plasma Cleaner window (Figure 15):

- Remove the three (3) screws securing the Plasma Cleaner window (Figure 15A).
- Remove the retaining ring in front of the window (Figure 15B).
- Remove the window (Figure 15C).
- Remove the o-ring (Figure 15D) and visually inspect it. If the o-ring shows signs of degradation (e.g. surface is cracked or worn), replace the o-ring (see *OPTIONAL AND REPLACEMENT PARTS* to find the appropriate part number). If the o-ring appears in good condition, wipe the o-ring with isopropyl alcohol to remove any debris or contaminants on the surface.
- Reinsert the o-ring into the circular groove. Make sure the o-ring is properly seated in the groove.
- Insert the new window.
- Reinsert the retaining ring.
- Secure the retaining ring with the three (3) screws. Tighten with a wrench.

(A) • Remove the three (3) screws



(B) • Remove the retaining ring

(C) • Remove the window

(D) • Remove the o-ring

Figure 15 • Replacing the Window on the Plasma Cleaner Door

CHECKING AND REPLACING THE FUSES

- Remove the fuse holder(s) on the back of the Plasma Cleaner (Figure 1B).
- Check the fuse either visually or using a digital multimeter:
  If the fuse is in working condition, the metal wire inside the fuse should be intact and the digital multimeter should indicate an electrical short across the fuse (resistance of 1 ohm or less).
  If the fuse is blown, the metal wire inside the fuse may be broken and the digital multimeter should indicate an electrical open across the fuse (resistance overload (OL)).
- Replace the blown fuse(s). Refer to the back of the Plasma Cleaner (Figure 1B) or *OPTIONAL AND REPLACEMENT PARTS* for specifications on the replacement fuse(s).
- Reinsert the fuse holder(s) into the back of the Plasma Cleaner.

MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTIONS
Plasma fails to form in the chamber.	The electronics fails to deliver power to RF coil.	Check the fuses in the back of the unit. Replace any blown fuses (refer to *MAINTENANCE: CHECKING AND REPLACING THE FUSES*). If plasma still does not form, test the electronics with the fluorescent bulb. Place the miniature fluorescent bulb supplied with the Plasma Cleaner into the chamber. Leave the door open and turn the RF power level to its three (3) settings, successively. If the bulb glows on all three RF power settings, the electronic system is functioning properly; proceed to the test of the vacuum system below. If the electronics test fails, contact Harrick Plasma.
	The vacuum system fails to sufficiently evacuate the chamber.	If you are using a vacuum pump not supplied by Harrick Plasma, make sure that your vacuum pump is capable of reaching an ultimate total pressure of 200 mTorr or less. Then check that the vacuum hose is properly attached, all hose clamps and gas line connections are properly tightened, the Plasma Cleaner door is properly seated, the door o-ring is in place, and the window on the Plasma Cleaner door is tightly secured and sealed. The o-rings on the Plasma Cleaner door and window should be clean and free of defects. See *MAINTENANCE: CLEANING THE PLASMA CLEANER DOOR AND O-RING* and *MAINTENANCE: REPLACING THE WINDOW AND WINDOW O-RING* for instructions on inspecting and cleaning the o-rings. If you are still unable to form plasma following these test and corrective procedures, contact Harrick Plasma.
Plasma degrades in effectiveness of surface treatment.	Contaminants from previous use have deposited on the plasma chamber walls and door interior.	Plasma chamber and/or door requires cleaning. See *MAINTENANCE: CLEANING THE CHAMBER* and *MAINTENANCE: CLEANING THE PLASMA CLEANER DOOR AND O-RING*.

DISCLAIMER

The Plasma Cleaner is designed for safe and efficient operation when used properly and in accordance with the instructions. Failure to observe the following precautions could result in serious personal injury: The Plasma Cleaner is an electrical instrument; to avoid electric shock, please observe all standard precautions, such as not operating the device near water and operating the device at appropriate line voltage and frequency. Do not remove cover plates or housing, except by certified electronics technician. Do not open the Plasma Cleaner door when the chamber is under vacuum. Do not use the Plasma Cleaner near flammable materials. With respect to vacuum pumps, please refer to the pump user's manual for specific precautions. In general, for oxygen process gas, an oxygen compatible pump should be used; in case of using toxic gases or gases that ionize to toxic products, an efficient pump exhaust filter should be used. Harrick Plasma shall not be held liable for any damages: indirect or consequential related to this product including loss of revenue. Furthermore, Harrick Plasma's liability shall not exceed the cost of the product. Operational instructions should be followed at all times.

WARRANTY

All products manufactured by Harrick Plasma come with a 1 year limited warranty. Any product failure that results from use in accordance with manufacturers guidelines is covered under the warranty. Any failure resulting from misuse of the product or resulting from actions such a dropping the unit or damage in poor storage conditions, for example, will not be repaired or replaced under warranty. Furthermore, products that have been intentionally damaged cannot be replaced or repaired under warranty. Products out of warranty or not subject to these conditions may be repaired by the manufacturer as a billed service at the manufacturer's discretion. With the exception of this exclusive warranty, Harrick Plasma makes no warranties, explicit or implied. We also disclaim any implied warranties of merchantability or fitness for a particular purpose.

REPAIR RETURNS

Owners of products manufactured by Harrick Plasma in need of service or repair should contact Harrick Plasma prior to return of equipment, regardless of warranty coverage status. Products out of warranty may be repaired by the manufacturer as a billed service at the manufacturer's discretion. Any potentially hazardous substances must be removed from the plasma chamber and front cover interior if these items are to be returned with the product. Products to be repaired out of warranty will be initially evaluated and a formal repair estimate will be prepared for approval prior to any repairs being carried out. Any product returned for repair must be accompanied by a repair return document providing contact information, return shipping address and a description of product problems at issue and any measures taken.

NEW EQUIPMENT RETURNS

Recently purchased products manufactured by Harrick Plasma may be returned within 30 days of receipt. Products must be returned in unused, resalable condition, in original packing materials, and are subject to a 15% restocking fee. Vacuum pumps and accessories must be returned within 15 days of receipt in unused, resalable condition, in original packing materials, and are also subject to a 15% restocking fee. Purchasers wishing to return products should contact Harrick Plasma prior to returning.

OPTIONAL AND REPLACEMENT PARTS

OPTIONAL PARTS

Premium Vacuum Pump, 230V	PDC-VP-2
Premium Vacuum Pump Oil	PDC-VP-OIL
Basic Vacuum Pump, 230V	PDC-VPE-2
Basic Vacuum Pump Oil	PDC-VPE-OIL
Fomblin-Based Vacuum Pump, 230V (for Oxygen Service)	PDC-OPF-2
Fomblin Fluid for Fomblin-Based Vacuum Pump	PDC-FMB
Dry Scroll Vacuum Pump, 230V (for Oxygen Service)	PDC-OPD-2
PlasmaFlo, 230V	PDC-FMG-2
Quartz Plasma Chamber	PDC-00Q
Quartz Sample Tray (5.5" x 6.5")	PDC-00T

REPLACEMENT PARTS

Pyrex Vacuum Chamber	PDC-191-420
Front Door O-ring, Viton	ORV-438
Inset Window O-ring, Viton	ORV-032
Window, Glass	001-505
Fluorescent Bulb	PDC-FLB

REPLACEMENT FUSES	**230V (PDC-002)**
Plasma Cleaner	2 Amp, slow-blow (2)
PlasmaFlo	0.5 Amp, fast acting (2)

SPECIFICATIONS

PLASMA CLEANER (PDC-002)

Chamber Dimensions	6" diameter x 6 1/2" deep
System Dimensions	11" H x 18" W x 9" D
System Weight	45 lbs
Chamber Material	Pyrex
Input Power	200 W
RF Frequency	MHz range
Inlet	1/8" NPT needle valve
Outlet	1/2" OD Pyrex tubing

POWER APPLIED TO RF COIL

Low Setting	7.2 W
Medium Setting	10.2 W
High Setting	29.6 W

OPTIONAL PLASMAFLO (PDC-FMG-2)

System Dimensions	8 1/2" H x 10" W x 8" D
System Weight	7 lbs
Number of Gas Inputs	2
Gas Input 1 Flowmeter	1 standard cubic feet per hour (SCFH) full scale
Gas Input 2 Flowmeter	2 standard cubic feet per hour (SCFH) full scale
Gas Inputs	1/4" Swagelok to 1/4" Stainless Steel tubing
Gas Output	1/4" Swagelok to 1/4" Stainless Steel tubing
Pressure Gauge	Thermocouple Vacuum Gauge
Pressure Range	1 x 10^{-3} to 2 Torr

SPECIFICATIONS

UTILITIES REQUIRED

Vacuum Pump	minimum pumping speed of 1.4 m^3h^{-1} and an ultimate total pressure of 200 mTorr or less

OPTIONAL VACUUM PUMPS

Premium Vacuum Pump (PDC-VP-2)

Pumping speed 50 Hz	3.2 m^3h^{-1}
Ultimate total pressure (gas ballast closed)	1.5 mTorr
Ultimate total pressure (gas ballast open)	23 mTorr
Motor power 50 Hz	250 W
Weight	34 lbs
Dimensions	9" H x 15" W x 5" D

Basic Vacuum Pump (PDC-VPE-2)

Pumping speed 50 Hz	5.1 m^3h^{-1}
Ultimate total pressure (gas ballast closed)	7.5 mTorr
Ultimate total pressure (gas ballast open)	150 mTorr
Motor power 50 Hz	373 W
Weight	27 lbs
Dimensions	9 3/4" H x 14" W x 5 1/2" D

Fomblin-Based Vacuum Pump for Oxygen Service (PDC-OPF-2)

Pumping speed 50 Hz	3.3 m^3h^{-1}
Ultimate total pressure (gas ballast closed)	1.5 mTorr
Ultimate total pressure (gas ballast open)	90 mTorr
Motor power 50 Hz	250 W
Weight	48 lbs
Dimensions	9" H x 17" W x 6 1/2" D

Dry Scroll Vacuum Pump for Oxygen Service (PDC-OPD-2)

Pumping speed 50 Hz	4.8 m^3h^{-1}
Ultimate total pressure (gas ballast closed)	53 mTorr
Ultimate total pressure (gas ballast open)	263 mTorr
Motor power 50 Hz	250 W
Weight	51 lbs
Dimensions	11 1/2" H x 17" W x 10" D

Manual Part No. PDC002-M-03