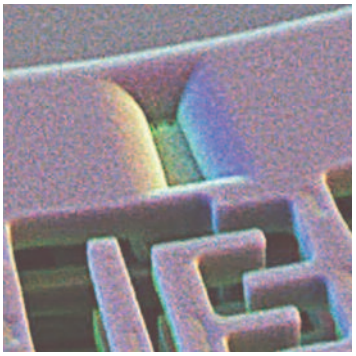
reduce hydrocarbon contamination in vacuum chambers, improving electron microscope imaging and analytical performance

Evactron® Series

Decontaminators and Cleaning Systems



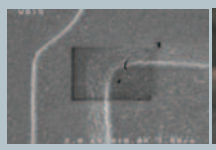
Electron Microscopy Sciences

Evactron® Series Decontaminators and Cleaning Systems

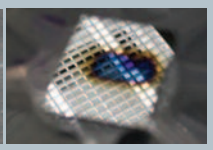
Overview

Volatile hydrocarbon molecules are an unavoidable constituent of all vacuum chambers. They are introduced into the chamber through atmospheric (adventitious) contamination, lubrication, or inadvertent contamination by users. This contamination does not pose an issue in and of itself.

However, if energetic radiation such as the electron beam of a scanning electron microscope, an ion beam from a FIB, or EUV radiation of the next generation of lithography tools is used, then the hydrocarbon contamination will cause problems. As the hydrocarbons adsorb onto a surface impinged by the energetic radiation, e.g. a sample examined in an SEM or a mirror in an EUV lithography tool, they will be chemically altered by the radiation and then recombine into less volatile polymers. More adsorbed hydrocarbons will diffuse into the impingement area, and a buildup of polymeric carbon will occur.

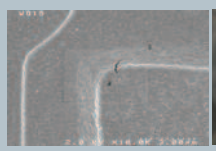


Black square caused by hydrocarbon contamination seen in SEM image.

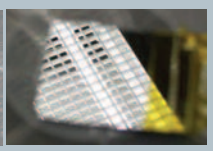


Carbon buildup leading to loss in reflectivity seen on an EUV mirror.

In microscopes this buildup will reduce the image quality. When the user reduces the magnification, a black square due to the carbon buildup will be seen on the SEM image. In EUV lithography, the mirror will also suffer a carbon buildup which will cause a reduction in the reflectivity of the mirror. Less reflectivity will cause a much reduced throughput of the lithography tool.



Removed contamination by Evactron cleaning results in no black square.



Carbon buildup removed from same EUV mirror shown above.

Electron Microscopy Sciences

Evactron® Model EP Plasma Decontaminators

The Evactron® E-Series™ of remote RF plasma cleaners reduces hydrocarbon contamination from high vacuum chambers by breaking down the carbon and turning it into gas phase that are then removed by the pumping system.

Features

- **High cleaning efficiency**
- **Small footprint/compact plasma radical source (PRS)**
- **Operates at TMP and turbomolecular pressures**
- **"Pop" ignition (patent pending)**
- **Windows and Android GUI software**
- **Desktop controller**
- **Fits chambers and load locks**
- **Vacuum safety interlock**

The Evactron® EP Decontaminator is the latest model in the E-Series cleaning systems. It was designed for:

- Cleaning high vacuum chambers, SEM/FIB
- Pre-cleaning of the samples

The Evactron® EP model with instant ignition from any vacuum level brings the user highest cleaning rates at low pressures. It uses flowing afterglow to remove surface hydrocarbons from vacuum chambers operating with turbo molecular pumps.

Technology

Energy efficient hollow cathode plasma

Flow through gas supply

Plasma Radical Source (PRS) design maximizes delivery of radicals to chamber

"Pop" ignition of the plasma works at pressures below 100 Pa/750 mTorr

Low pressure operation 1-3 Pa/7.5-22.5 mTorr

Starts and operates at turbo molecular pump compatible pressures

Fixed match provides maximum plasma power transfer

Other Features

High reliability at 20 Watts and 13.56 MHz power supply

No vacuum gauge needed

NW 40 flange standard, CF 2.75 optional

Vacuum only operation interlock

>100 Å/min cleaning rates

Rack mount for system integration

Elegant and compact design

Windows GUI interface/Android tablet programming compatibility

Ordering Information *Attachment Flange required, sold separately. See below.*

Cat. No.	Description	Qty.
For Hitachi 8200 /4800 Series SEM		
91000-11	Evactron® EP De-Contaminator System, + Android Consisting of: Evactron EP Plasma Radical Source, Horizontal Configuration, Windows 7.0 GUI Programming Software, Evactron EP Table Top Controller, Evactron EP Cable Set (12.5ft), System user manual	each
For JEOL TMP Systems		
91000-12	Evactron® EP De-Contaminator System, + Android, Consisting of: Evactron EP Plasma Radical Source, Horizontal Configuration, 1 cc ignition ballast, Windows 7.0 GUI Programming Software, Evactron EP Table Top Controller, Evactron EP Cable Set (12.5ft), System user manual	each
For Zeiss		
91000-13	Evactron® EP De-Contaminator System, + Android Consisting of: Evactron EP Vertical Plasma Radical Source, Evactron EP Table Top Controller, Evactron EP Cable Set (12.5ft), Evactron EP GUI Programming Software, System user manual	each

Evactron® Adapter Flanges – SEM Port to KF40

All dimensions are in millimeters
OD = Outside Flange diameter
ORID = O-Ring Inside Diameter

#H = number of mounting holes + symmetry
O-ring not included with Adapter Flange
The most common Adapter Flanges are shown

Cat No.	Description	Qty.
230090-01	FEI, 64 X 80, 50 ORID, 4H, OCTG, ASYM	each
230141-01	FEI, 100 OD, 75 ORID, 6H	each
230142-01	FEI, 100 OD, 72 ORID, 88 BC, 3H	each
230143-01	FEI, 90 OD, 60 ORID, 78BC, 3H	each
230153-01	FEI, 85 OD, 60 ORID, 76 BC, 3H	each
230154-01	FEI, 100 OD, 70 ORID 84.5 BC, 3H	each
230155-01	FEI, 64 OD, 38 ORID, 57 BC, 4H	each
230235-01	FEI, 70 OD, 33 ORID, 61 BC, 4H, PLUG, 1 PIECE	each
230335-01	FEI, 87 OD, 60 ORID, 74 BC, 3H	each
230350-01	FEI, 120 OD, 93 ORID, 109 BC, 6H	each
230351-00	FEI, 59 OD, 38 ORID, 52 BC, 4H, 1 PIECE	each

Cat No.	Description	Qty.
230359-01	FEI, 90 OD, 70 ORID, 80 BC, 3H	each
230006-01	HITACHI, 57 OD, 34.5 ORID, 50 BC, 4H	each
230320-01	HITACHI, 58 X 58, 24 ORID, 41.5 BC, 4H, PLUG, 1 PIECE	each
230568-01	HITACHI, 69 OD, 47.5 ORID, 4H	each
230001-01	JEOL, 64 OD, 40 ORID, 55 BC, 4H	each
230002-01	JEOL, 99 OD , 75 ORID, 89 BC, 4H, 38 (1.5") LONG NIPPLE	each
230002-02	JEOL, 99 OD, 75 ORID, 89 BC, 4H, 64 (2.5") LONG NIPPLE	each

Evactron® Zephyr™ Plasma Decontaminators

The Evactron® Zephyr Decontaminator line was created to accommodate SEMs, FIBs, and other vacuum chambers that use turbo molecular pumps. They are designed for SEM/FIB systems and offer fast and efficient hydrocarbon removal with no damage to samples or sensitive components. They offer users:

- **Cleaning of SEM/FIB chambers at turbo pressure**
- **Shorter cleaning time (increased production, less downtime)**
- **One button operation**

Evactron® Model 25 Zephyr Plasma Decontaminator

- **Desktop controller**
- **SEM/FIB chambers or load locks**
- **2 operating regimes**
  Classic mode (roughing pressures)
  T-pump mode (turbomolecular pressures)

This easy to use tabletop model easily removes atmospheric hydrocarbons and carbon contamination from SEMs, FIBs, and other vacuum chambers.

The Evactron® Model 25 Zephyr Decontaminator uses a remote RF plasma to produce gas-phase radicals that flow downstream through the chamber eliminating contamination.

This model was created for chambers that use turbo molecular pumps (TMPs). It is designed to clean/de-contaminate in the turbo pressure regime at 1-50 mTorr and has no adverse effects on the TMP temperatures.

Features

- **Clean chambers at turbo pump pressures**
- **5-20 Watts RF power**
- **≥10x improved cleaning rate**
- **One button operation**
- **1-50 mTorr operating pressure**

Benefits

- **No stress to the turbo molecular pump**
- **Safely de-contaminates the chamber without damage to sensitive components**
- **Shorter cleaning time, giving increased production with less system down time**
- **Cleans chamber while in "pump down"**
- **Increased mean free path, yet ion damage free**

Ordering Information

Cat. No.	Description	Qty.
91000-10	Evactron® 25 Zephyr Plasma Decontaminator with PRS-V, Vertical Plasma Radical, Source with shroud, Desktop controller and cable set	each

Evactron® SoftClean™ System

Features

- **Windows and Android GUI software**
- **Optional Safar side loaders (US 8,716,676 B2)**
- **Accommodates up to three TEM stage rods**

The Evactron® SoftClean Chamber extends the ability to pre-clean specimens, specimen mounts, and holders with the proven downstream plasma ashing process before examination in the chamber, thus insuring high image quality. The Evactron® SoftClean Chamber can also be used as a specimen storage system, keeping samples in a clean environment.

The downstream plasma process used in the Evactron® SoftClean Chamber is gentle, yet very effective at removing H/C contamination. Sputter etching by other plasma cleaners can damage specimens through exposure to energetic ions and heat.

The Evactron® SoftClean Chamber uses reactive gas radicals to remove H/C from specimen surfaces by chemical etch, preserving critical sample fine structure. This downstream etching process breaks down problematic H/C residues into smaller molecules such as CO_2, H_2O and CO, which are easily pumped out of the chamber.

Specifications

Cleans SEM/TEM samples
Cleans TEM grids/sample rods
Inert sample storage
Just use air for oxygen radicals, or use other gases for alternative plasma processes
Easy setup and operation. Preset pressure, power and time settings
Can be operated from either front panel or computer interface
Optional shroud can cover transducer and valve assembly on the Plasma Radical Source
Start cleaning by using chamber vent and evacuation controls
Advanced plasma detection logic
Cleaning and error logs record history and aid troubleshooting
Electronic Chassis: 3.5"H x 19"W x 7"D (9 x 23 x 48 cm)
RF Power: 5-20 Watts at 13.56 MHz
KF 40 vacuum mounting flange, adapter flanges available
90-250 VAC 50/60 Hz input
Shipping: 20 lb. (10 kg.)

Ordering Information

Cat. No.	Description	Qty.
91000-15	Evactron® SoftClean EP	each

Cat No.	Description	Qty.
230003-01	JEOL, 86 X 206, NO O-RING, 4H ASYM	each
230010-01	JEOL, 73 OD, 50 ORID, 64 BC, 4H	each
230011-01	JEOL, 74 X 90, OVAL O-RING, 4H, ASYM	each
230013-01	JEOL, 88 OD, 45 ORID,79 BC, 4H, ASYM, 90 LONG NIPPLE	each
230022-01	JEOL, 100 X 355, NO O-RING, 5H, ASYM	each
230023-01	JEOL, 72 X 86, OVAL O-RING, 4H, ASYM	each
230311-01	JEOL, 88 OD, 45 ORID, 79 BC, 4H, ASYM	each
230322-01	JEOL, 75 X 98 (ARCHED ON ONE SIDE), OVAL O-RING, 4H, ASYM	each
230325-01	JEOL, 154 X 204, RECT O-RING, 4H, ASYM	each
230664-01	JEOL, 95 OD, 71.5 ORID, 85.5 BC, 3H	each
230008-01	ZEISS, 55 OD, 30 ORID, 45 BC, 4H	each
230012-01	ZEISS, 64 X 64, 54 ORID, 57 BC, 4H	each
230014-01	ZEISS, 79 OD, 53 ORID, 70.5 BC 4H	each
230015-01	ZEISS, 84 OD, 54 ORID, 72 BC, 4H	each

Cat No.	Description	Qty.
230016-01	ZEISS, 70 OD, 45 ORID, 57 BC, 4H	each
230017-01	ZEISS, 113.5 OD, 46.5 ORID, 92 BC, 4H	each
230018-01	ZEISS, 64 OD, 38 ORID, 57 BC, 4H	each
230020-01	ZEISS, 82 OD, 41 ORID, 68 BC, 4H, PLUG	each
230034-01	ZEISS, 96 OD, 72 ORID, 86 BC, 4H, ASYM	each
230036-01	ZEISS, 62 X 62, 53 ORID, 71 BC, 4H	each
230037-01	ZEISS, 162 OD, 127 ORID, 149 BC, 6H	each
230038-01	ZEISS, 68 X 88, OVAL O-RING, 4H, SYMM	each
230039-01	ZEISS, 89 X 89, 72 ORID, 92 BC, 4H	each
230356-01	ZEISS, 100 OD, 60 ORID, 90 BC, 6H	each
230357-01	ZEISS, 90 OD, 66 ORID, 81 BC, 4H, ASYM	each
230358-01	ZEISS, 81 X 85, 4H, ASYM	each
230364-01	ZEISS, 85 x 85, 70 ORID, 92 BC, 4H	each
230366-01	ZEISS, 150 X 190, RECTANGULAR O-RING, 10H, ASYM	each

Evactron® Series

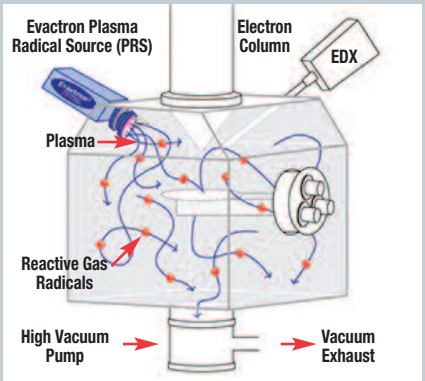
Decontaminators and Cleaning Systems

Removing Hydrocarbons and Decontaminating Vacuum Chambers with the Evactron De-Contaminator

Plasma ashing and glow discharge cleaning of samples have long been cleaning methods available for sample preparation for SEMs and TEMs, but they require expensive auxiliary equipment. Argon and oxygen plasmas are normally used. Argon cleans via a sputter etching mechanism. However, sputter etch should be avoided because of possible damage to components within the chamber.

The Evactron Decontaminator, on the other hand, is a small device which is attached to any vacuum chamber allowing for direct in situ cleaning of the vacuum chamber. The Evactron Decontaminator has a valve manifold which introduces a small stream of gas such as room air, oxygen or hydrogen into the vacuum chamber. An attached pressure sensor is used to control the amount of gas flow. The gas flows past an electrode energized by a low power (5-20 W) radio frequency (RF) generator. This will create RF plasma localized in the region around the electrode.

The Evactron RF plasma creates radicals that chemically etch and remove hydrocarbons, organics, and surface carbon from SEMs and other vacuum systems. Contaminants are ashed into volatile products which are removed through the roughing pump. As seen in the figure below left, the radicals are carried out of the plasma into the main chamber by convection. In the chamber they react with all exposed surfaces including the specimen if present. The plasma itself is confined to the Plasma Radical Source (PRS), which prevents ion bombardment damage to the instrument or specimen.



Cross-section of SEM chamber illustrates how the Evactron De-Contaminator removes hydrocarbons from the system.

SEM chamber with Evactron De-Contaminator Plasma Radical Source (PRS) attached. An adaptor flange is used to mount the Evactron De-Contaminator to the SEM.

Evactron® CombiClean™ System

- **Cleans SEM/TEM samples and SEM chambers from one desktop controller**
- **Stores samples and parts after cleaning**
- **Uses patented Safar TEM side loaders**

Decontaminate specimens and columns of SEMs and FIBs. The Evactron® CombiClean™ System combines onboard vacuum cleaning chamber and external PRS (Plasma Radical Source) control in one unified system.

- **Cleans SEM/TEM samples and SEM chambers from one desktop controller**
- **Stores samples and parts after cleaning**
- **Uses patented Safar TEM side loaders**

Innovative Design

Designed as a complete cleaning solution, the Evactron® CombiClean System features an integrated vacuum chamber for desktop cleaning samples and vacuum parts, as well as an external Plasma Radical Source (PRS) for Evactron® in-situ cleaning of E-beam instruments such as SEMs, FIBs, and other analytic instruments, by removing carbon contamination.

The system monitors operation of either PRS unit, has internal memory, and is designed for routine operation with minimal operator training. Onboard control allows for changing the cleaning modes between external and internal PRS with just the flip of a switch.

This system is compatible with rotary vane pumps without the worry of oil backstreaming. A dry nitrogen purge feature keeps specimens clean after a plasma cleaning, and a storage mode allows you to continue dry nitrogen purging a sample while the external PRS is in use.

Specifications

The system features a microprocessor with embedded software to regulate a leak valve and control the chamber pressure by a MicroPirani gauge.

The microprocessor also regulates the RF power, has a clock to time the downstream plasma cleaning and nitrogen purging cycles, and records the operational and fault log.

Cleaning with the Evactron® CombiClean System may be setup from either the front panel or a remote computer.

VentDetect™ Technology
Compatible with rotary vane pumps without the worry of oil backstreaming
Dry Nitrogen purge feature keeps specimens clean after plasma cleaning
Storage mode allows continued dry nitrogen purging of samples while external PRS is in use
System monitors operation of either PRS unit
Onboard control allows for cleaning modes between internal and external PRS with just the flip of a switch
Wide Pressure Range

Ordering Information

Cat. No.	Description	Qty.
91000-17	Evactron® CombiClean™ System	each

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