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Two New Evactron® Plasma Cleaners for Small Chambers and UHV Systems

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Two new models of Evactron® plasma cleaners have been developed to serve different research needs. The Evactron plasma cleaner was introduced in 1999 for cleaning SEMs and has been steadily improved for performance and convenience [1]. Today's most popular model, the E50, can be started directly at high vacuum and cleans over 60 times faster than models produced 20 years ago [2]. The two new models, the U50 and E16, make Evactron cleaning more accessible for special applications.

Evactron flowing afterglow cleaning is done by energizing flowing gas at 10 to 20 SCCM into a RF plasma generated inside the plasma radical source (PRS). The plasma disassociates either oxygen or hydrogen into radicals or metastable species that react with the hydrocarbons to make volatile species that are pumped out of the chamber by dry vacuum pumps. The Evactron process is designed to use air as the most available oxygen source. In specially-equipped models, other oxygen- or hydrogen-containing gas mixtures can also be used so that adverse effects of air plasma are avoided or performance can be enhanced [3]. By using a hollow cathode, a fixed impedance match works with most different gas mixtures and pressures without further adjustment. Pure 100% hydrogen is an exception. It is necessary for Evactron cleaning that useful chemical reactions be planned to remove the hydrocarbons or other contaminants as gasses. There are very few chemical reactions with other radicals or metastables that result in volatile products that can be pumped from a vacuum chamber. The noble gas argon is a sputtering gas with low chemical reactivity and should not be used.

The compact-sized Evactron E16 system is designed to operate at low RF wattage to provide a means to plasma clean compact tabletop SEMs, small vacuum chambers, and load locks with space constraints. It fits in a small space less than 51 mm high and introduces a new type of vacuum flange seal that is easy to install. The Evactron E16 PRS shown in Figure 1 is a compact version of the Evactron E50 PRS with an external hollow cathode electrode around a ceramic plasma chamber of a smaller diameter [4]. By having a small plasma chamber as the source, the RF field is concentrated inside the plasma and does not need high power to disassociate diatomic gases for radical and metastable production. A neutral afterglow flows out of the plasma sheath with the neutral reactive radicals and metastable species that perform the cleaning by chemical etch in high vacuum volumes of 1 liter up to 30 liters.

Electron Beam instruments such as SEMs often have problems keeping surfaces and detectors clean and free of hydrocarbon contamination. Quantitative analytical techniques such as TKD/EBSD and FE-EPMA are compromised if hydrocarbons coat sample surfaces [5,6]. With the Evactron E16 at low power the plasma sheath boundary stays close to the exit port of the plasma chamber. The gas flowing out of the plasma sheath carries the neutral reactive radicals and metastable species in an afterglow that perform the cleaning. Other plasma sources based on ICP (Inductively Coupled Plasma) can create higher voltage ions that sputter. These high wattage plasmas are denser and may clean faster but can generate an ion beam that may cause surface sputtering and particulates that damage and re-contaminate surfaces.

The Evactron U50 (Figure 2) is a UHV version of the E50 plasma source that has a similar plasma chamber and operation but connects to vacuum chambers by means of a CF 2.75 flange. The PRS is bakeable to 150° C and is designed to be vacuum-tight to < 10-11 Torr. Operating up to 50 Watts, the Evactron U50 plasma cleaner can deliver high concentrations of neutral radicals and metastables for chemical etching to clean

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sensitive components without sputter-etching. It is designed for UHV volumes of 10 liters and greater, and we believe it can fill a 300 liter or greater chamber with a cleaning flowing afterglow. It has the ability to use alternate gases to generate oxidative or reductive plasma for modification of sample surface functional groups for optimization of bonding conditions and creating hydrophilic surfaces for in-situ experiments. For chamber cleaning it can provide a faster process for hydrocarbon removal by doing daily clean ups in an hour or deeper cleaning overnight as monitored by an RGA (Residual Gas Analyzer) [7].

In conclusion, the new Evactron E16 plasma cleaner is a remarkably compact system designed for cleaning small vacuum systems and chambers such as tabletop SEMs and load locks. The Evactron U50 provides cleaning, decontamination, and surface modification options to UHV systems. The new additions continue the tradition of product development to serve all facets of the microscopy community.

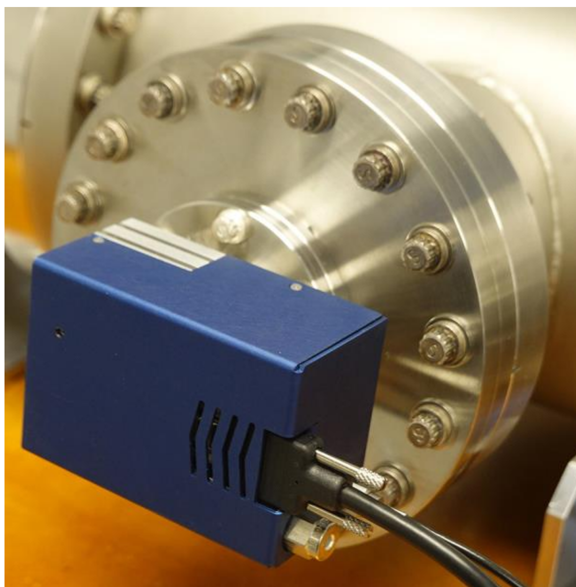

Figure 1. Evactron E16 PRS on test chamber

Figure 2. Evactron U50 System includes PRS, controller and touchpad

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