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Advancements of Evactron® Plasma Cleaning of Moxtek® X-ray Windows

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XEI Scientific Inc. is a recognized manufacturer of plasma cleaners that have been proven to be very effective in removing adventitious hydrocarbon contamination from electron microscope chambers [1]. Over 15 years there are no reports of X-ray window failure or damage to EDS detectors on SEM chambers due to oxygen radicals generated by the Evactron plasma cleaners.

The oxygen radicals created in the plasma oxidize carbon compounds, producing CO, CO_2 and H_2O, which are then evacuated from the instrument. Quantum chemistry rules regarding energy loss state that these oxygen atoms do not react with diatomic molecules in two body collisions but require a third body to kinetically carry away excess energy. Oxygen radicals also react on solid surfaces such as metals where they can react or recombine with hydrocarbons. Numerous studies performed at XEI Scientific using previously contaminated quartz crystal microbalances to measure cleaning rates have shown that Evactron plasma cleaning is very effective at removing hydrocarbons [2].

In an update to an earlier study [3], Moxtek and XEI Scientific performed window exposure tests to show that Evactron plasma cleaning will not damage the newly developed BX-1 EDS windows. The tests consisted of exposing several BX-1 windows to the oxygen radical flow from an Evactron Model E50 in an experimental vacuum chamber for 200 hours of continuous exposure to air plasma.

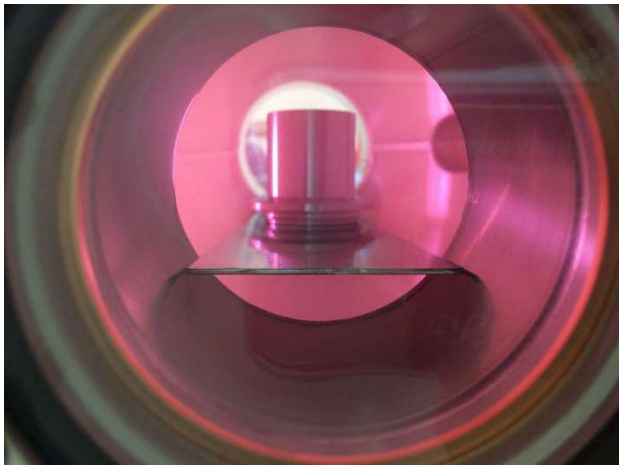
Moxtek BX-1microanalysis x-ray windows were placed on a platform in a 20 L vacuum chamber in the path of the oxygen radical flow. Testing was done in high vacuum with the turbo molecular pump on. Interaction of the back side of the Moxtek window with the oxygen radicals was minimized by a fine mesh on the platform on which the windows were placed. Only the front side of the window is exposed to Evactron plasma cleaning. The Evactron E50 Plasma Cleaner was operated at turbo molecular pressures (~3 mTorr operating pressure) at 50 Watts of RF power at 13.56 MHz with room air as the process gas. BX-1 Moxtek windows were exposed to a continuous flow of oxygen plasma at 50 Watts for 200 hours. They were then returned to Moxtek for evaluation (helium leak test and visual inspection of any surface damage).

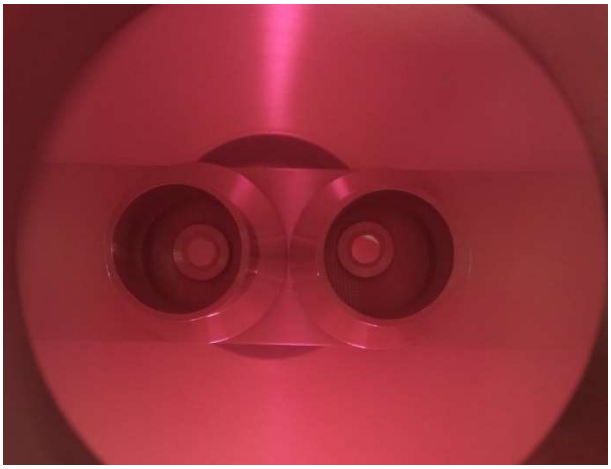
Evactron plasma cleaning does not damage Moxtek BX-1 windows. Evactron E50 cleaning cycles are 5 to 10 minutes long under usual operation conditions and each microscopy lab follows a tested protocol. Using cleaning periods of 5 minutes, 160 hours exposure is equivalent to 1,920 cleaning cycles, or 8.7 years of daily SEM cleaning. Inspection of the BX-1 microanalysis x-ray windows from Moxtek after 200 hours of plasma exposure did not reveal damage to the windows.

References:

[1] E Kosmowska et al., Microsc. Microanal. **23 (S1)** (2017), p. 74.
[2] R Vane and CA Moore, Microsc. Microanal. **20 (S3)** (2014), p. 2014.
[3] E Kosmowska et al., Microsc. Microanal. **24 (S1)** (2018), p. 682.
[4] R Vane et al., Microsc. Microanal. **10 (S2)** (2004), p. 966.

Figures 1. and 2. Moxtek BX-1 window and experimental apparatus at XEI Scientific Inc.





Figures 3. and 4. View of the Moxtek BX-1 windows in the vacuum chamber during plasma operation.

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