AMPTEK C SERIES WINDOWS FREQUENTLY ASKED QUESTIONS (FAQ)

What are the advantages of the C series windows?

The C series windows offer less attenuation (higher intrinsic efficiency) than the standard Be windows for X-ray energies below 1.5 keV (for elements below Al). The C windows are about a factor of 2 more efficient for Na K_α X-rays (at 1.04 keV) than the thinnest Be window (8 μm). With Be windows it is virtually impossible to measure elements below Na in the periodic table, and even Na and Mg are marginal. The C windows make it practical to measure light elements.

One should measure in vacuum to take full advantage of the C series windows. Attenuation in air can be more important than attenuation in the windows for low energies. For Na K_α X-rays at 1.04 keV the attenuation length in air is only 2.2 mm: an air path of 2.2 mm will attenuate these X-rays as much as a Be window. This not only reduces the sensitivity at Na, but path length variations become very important: an additional 0.2 mm of air changes the Na K_α intensity by 10%, making accurate analysis difficult.

Are there any disadvantages to the C series windows?

Above 1.5 keV the C series windows offer slightly more attenuation (lower efficiency) than the Be windows. This difference is small for most elements. For example the C windows offer 10-15% lower efficiency than Be around 3 keV. For X-rays above 6 keV the efficiency for the two windows is nearly identical.

The C series windows are made from silicon nitride and coated with aluminum. The characteristic X-rays of Al, Si, and N are all observed in the spectrum. All Amptek detectors contain aluminum (e.g. the multilayer collimator is coated with aluminum) so this interference is always present. The Si interference may be a disadvantage in some applications.

The C2 windows are not light-tight. They are intended only for use in a dark system. Operating a C2 detector in light will not damage the detector but the photocurrent through the detector will make it impossible to detect X-rays. The C1 windows can be operated in normal ambient light.

Are the C series windows strong enough to hold vacuum?

Yes, the C series windows will hold vacuum. The detector hybrid has a vacuum inside, so the C series windows usually hold 1 atmosphere of pressure. Used in a vacuum chamber, the pressure across the window is actually reduced.

One must be careful when using these detectors in vacuum systems. It is common for debris from samples or from handling to exist inside the chamber of an XRF system. When one begins to pump or breaks vacuum, the pieces of debris can fly around inside the chamber and penetrate C1 and C2 windows. Cleanliness is vital, but one must not touch the C series windows when cleaning the system.

Can the C Series windows be used in Helium (He) purged environments?

Please contact us to discuss your application in more detail.

The standard C1 window is not He tight. There is a special order option for the C1 window to be He tight. The C2 window is NOT He tight. Putting the C2 window in He will destroy the vacuum in the detector and void warranty.

Can the C series windows be used for high energies as well as low energies?

Yes, the C series windows are fine for high energies. Above roughly 6 keV, they offer essentially the same sensitivity as Be windows.

For what applications do you recommend the C series windows?

The C1 windows are very well suited to the EDXRF of samples containing Na, Mg, and heavier elements, particularly when a dark environment is not possible (e.g. handheld instruments).

The ideal application for the C2 windows is SEM-EDS, i.e. the excitation of characteristic X-rays by electrons in an SEM. Because these electrons have a short range in the sample, they excite the X-rays very close to the surface, yielding many X-rays from all the elements down to carbon. The high efficiency of these windows at the low energies makes these detectors very useful.

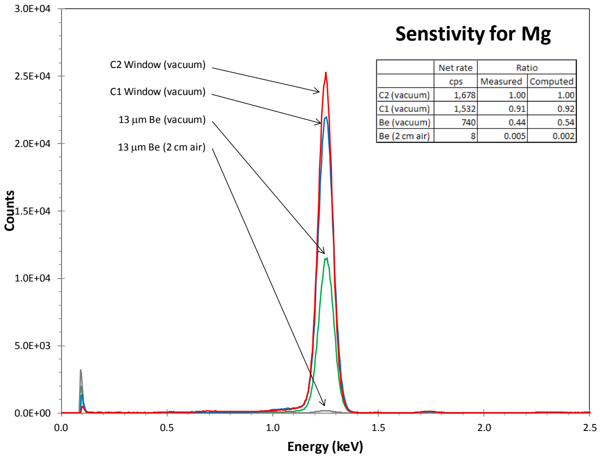
The C2 windows can certainly be used for EDXRF from light elements, i.e. measuring characteristic X-rays produced by X-ray excitation. But the X-ray yield for light elements is low and their attenuation length in most samples is low. A powerful low energy X-ray source is required for EDXRF of light elements.

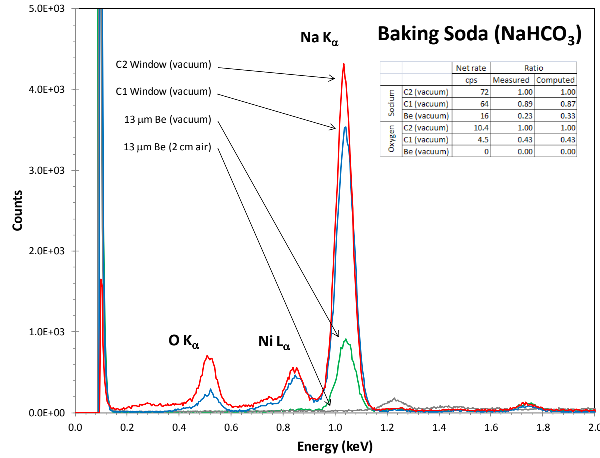
How accurate are the published attenuation curves?

These curves represent nominal material parameters and normal incidence. Manufacturing variations will occur, so some variation is expected. In many applications the beam of incident X-rays may not be at normal incidence. Even more commonly a range of angles are incident on the window. This will cause the path length to be longer, hence greater attenuation will occur. It is good practice to calibrate each system with known standards.

Do you have spectra from real samples illustrating the differences?

The plots below show spectra measured by an Amptek 25 mm^2 SUPER SDD with a C1 window, a C2 window, and a 13 μm (1/2 mil) Be window in vacuum. The samples were 99% pure Mg (left) and baking soda, $NaHCO_3$ (right). The tables compare the measured ratio of photopeak count rates with that calculated from the nominal attenuation curves. The increase in efficiency is clear and is in good agreement with the published values. Also shown is a spectrum measured with the same Be window in air, with a 2 cm path length. Note that the air attenuation is far more important than the attenuation in Be.

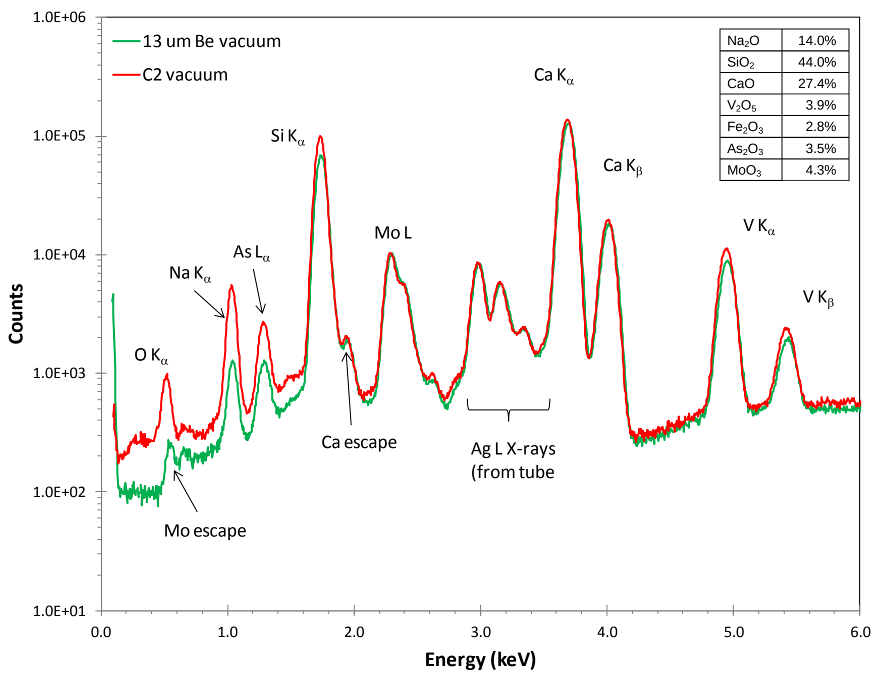


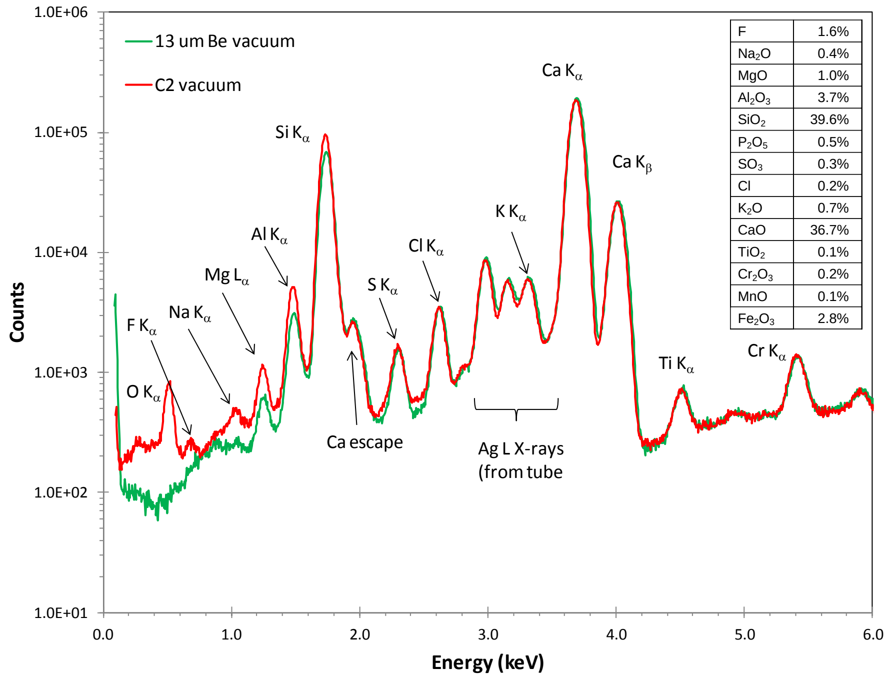


The two figures below show spectra measured with an Amptek 25 mm^2 SUPER SDD with a C2 windows and a 13 μm Be window, in vacuum. These samples were excited by an Amptek Mini-X X-ray tube with an Ag anode at 8 kVp. These are glass XRF drift monitors, FLX-SP1 (top) and FLX-C2 (bottom), both sold by Fluxana, Inc. The SiO_2 and CaO peaks are very clear in the glass. The increased efficiency of the C2 window below 2 keV is clear in both plots, as is the clear separation and identification of the low energy peaks.

The SP1 sample contains 14% Na_2O. The Na peak is clear in both spectra but is much more intense in the C2 spectrum. The C2 sample contains 1.6% F and only 0.4% Na_2O. These are very weak peaks but they are visible with the C2 window (these spectra were measured for 1800 sec so the rate is very low).

Note the O Kα peak visible in both C2 spectra. The glass samples are approximately 50% oxygen by atomic concentration, yet the intensity of the O Kα line is only 10 cps. This is a clear indication of the challenges involved in doing EDXRF on the lightest elements. One needs a lower energy, more intense X-ray source or an electron source to efficiently excite the characteristic X-rays of the lightest elements.




13 um Be vacuum
C2 vacuum
Counts
Energy (keV)
1.0E+06
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
0.0
1.0
2.0
3.0
4.0
5.0
6.0
O Kα
F Kα
Na Kα
Mg Lα
Al Kα
Si Kα
Ca escape
S Kα
Cl Kα
K Kα
Ag L X-rays (from tube
Ca Kα
Ca Kβ
Ti Kα
Cr Kα
F 1.6%
Na2O 0.4%
MgO 1.0%
Al2O3 3.7%
SiO2 39.6%
P2O5 0.5%
SO3 0.3%
Cl 0.2%
K2O 0.7%
CaO 36.7%
TiO2 0.1%
Cr2O3 0.2%
MnO 0.1%
Fe2O3 2.8%