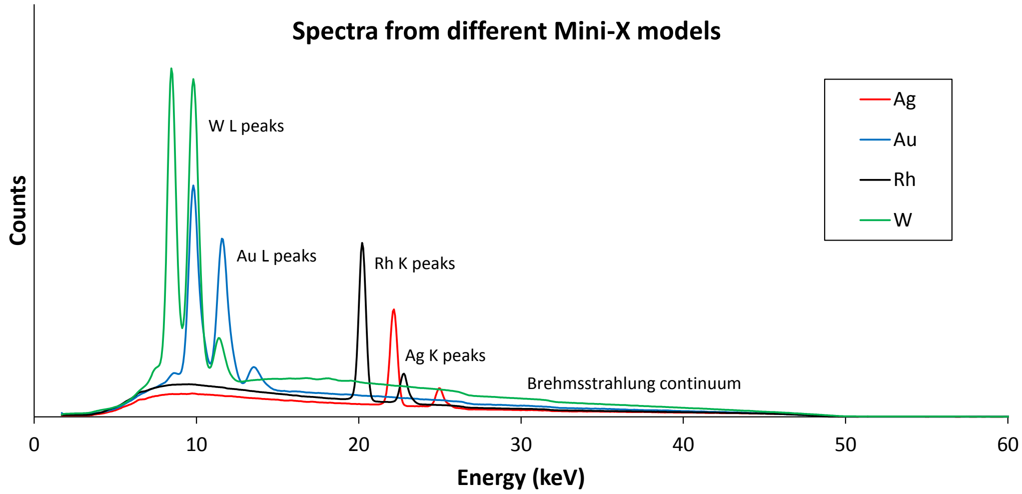
CHOOSING THE AMPTEK MINI-X ANODE MATERIAL

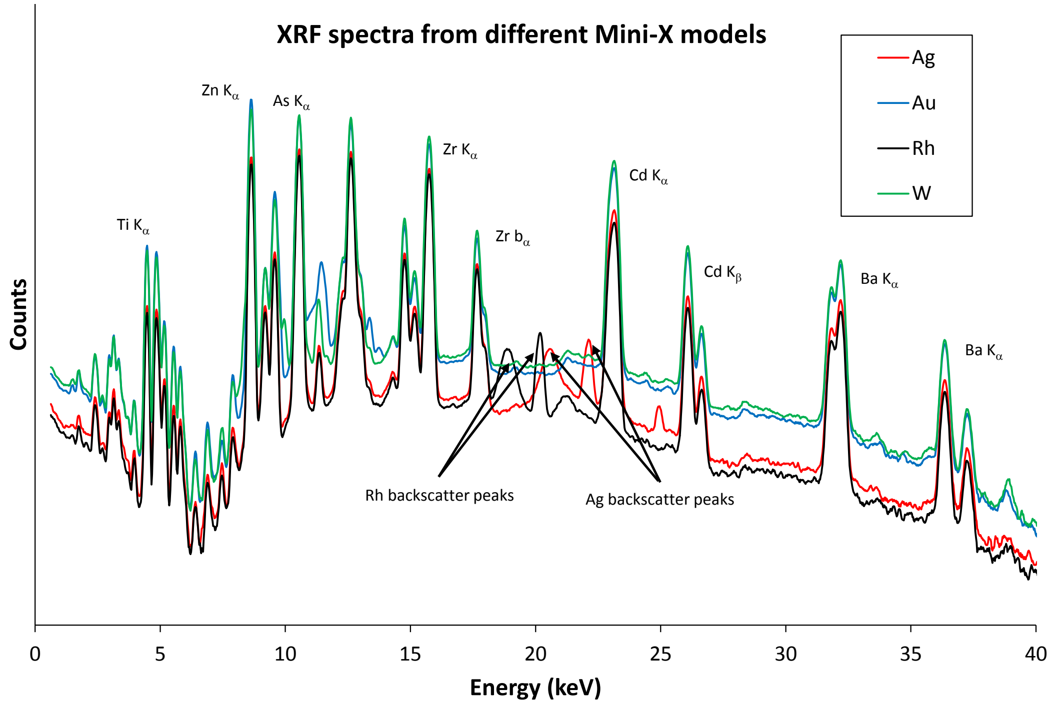
Amptek's Mini-X is available with silver (Ag), gold (Au), rhodium (Rh) or tungsten (W) as the anode material. A common question is: Why would I pick one material versus another one? In general, the excitation spectrum depends on the tube material. The plots below show the spectra from the tubes, at 50 kV and 80 μA.

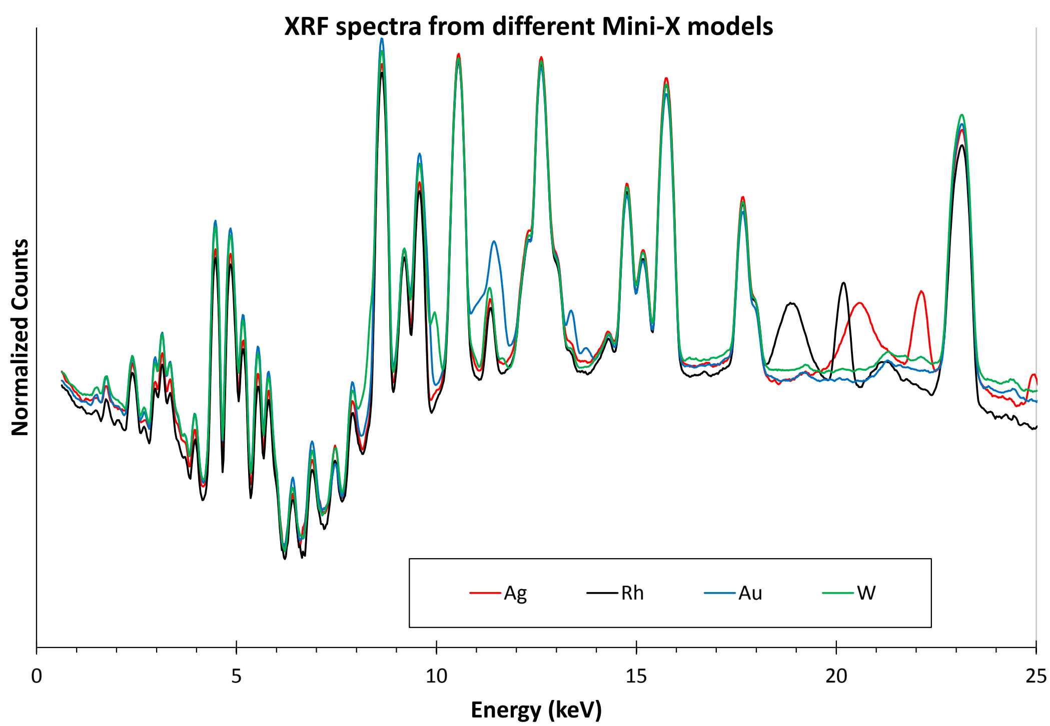


How does this impact XRF analysis?

- To best measure the characteristic X-rays of any single element, the analyte, one should excite with X-rays with an energy about 1.5 to 2 times the element's K edge, and with the background continuum low at energies near the characteristic lines.
- The spectrum of X-rays emitted by a tube has two components: a continuum (from bremsstrahlung) and lines (from the characteristic X-rays of the anode materials).
- At high energies, the spectrum arises entirely from the continuum; to measure analytes at these high energies, one wants a source with an intense continuum. The intensity of bremsstrahlung increases with atomic number, so the intensity of the continuum and total intensity are higher for the Au and W anodes than Ag and Rh.
- The characteristic X-ray lines are clearly seen in the spectrum above; Ag and Rh have higher energy characteristic X-rays.
    - Using excitation from these lines can improve signal to background relative to using the continuum as the primary excitation. These energies will be well suited to excite some elements but not for others. The Ag K lines, for example, are well suited to excite a range of metals from Cr through Mo.
    - These energies may interfere with elements in the sample. The Au and W L lines interfere with several metals of common interest. The Ag lines make it difficult to measure Ag in a sample.
    - The strong K_α line from Ag and Rh produces clear backscatter peaks from Rayleigh and Compton scattering. Some algorithms use this ratio to estimate sample atomic number; this is much harder with the Au and W, due to the many L lines.

The plots below show spectra taken from a calibration standard (multiple elements in a glass matrix) using the four different anode materials, with a light filter (10 mil Al) and 50 kVp. The bottom plot is normalized. Each tube produces different ratios for the intensity of the analytes and produces different scattered characteristic X-rays from the anode.





General advice for anode selection

- Silver (Ag) is probably the most commonly used material. This is in part legacy (much software was built around ^{109}Cd as an excitation source). The clear 22.1 keV peak provides good excitation for many elements of most common interest and provides a clear backscatter ratio, for those using the scattered intensity method to characterize the matrix.
- Rhodium (Rh) is very similar to Ag but it permits one to measure Ag in samples. Rh is relatively rare so is less likely to be an interference concern.
- Gold (Au) produces about twice the continuum intensity. One can use filters to shape the spectrum and retain and higher total count rate. It is particularly useful for analytes with a K edge above the silver lines, where the continuum alone produces the excitation. Moreover, the L lines of gold are low enough energy to easily filtered out, producing an almost pure-continuum spectrum.
- Tungsten (W) is similar to Au but it permits one to measure Au in samples. W is relatively rate so is less likely to be an interference concern.