Innov-X systems
Innovative X-ray Technologies

Portable XRF Technology for Archaeometry and Authentication and Conservation of Art Objects

The Innov-X analyzer may be remotely controlled from a tripod to examine paintings and other art without the analyzer touching the work of art.

Overview

Art objects have been studied with x-ray technology virtually from the start. When Wilhelm Roentgen discovered X-rays in 1895, one of his first experiments was a film of his wife Bertha's left hand, clearly revealing the ring on her finger.

Of course, X-ray technology has evolved tremendously since those early experiments to allow extensive qualitative and quantitative analysis of historically significant objects. However, much of these analyses have been limited to laboratory work, where the object must be transported to a lab, and frequently altered or even destroyed, to analyze. Today, portable XRF systems allow field scientists to analyze objects immediately without transporting, altering, or damaging them.

Field Portable XRF systems have been providing rapid, on-site measurements of metals in soil for environmental studies and of alloys for industrial applications for decades. Only recently have they been used as *in-situ*, non-destructive analytical tools for conservation and archaeometry. Conservation involves the restoration and preservation of museum objects and historical monuments utilizing structural and compositional information obtained from modern analytical techniques. Archaeometry investigates a material's composition, provenance, technology, authenticity and dating using those techniques. Innov-X Systems Portable Handheld XRF Analyzer is *the breakthrough system that utilizes an x-ray tube* instead of burdensome radioactive isotopes for x-ray analysis in the field. Versatile software provides factory calibrations and allows the user to generate their own calibration curves.

Archaeometallurgy: *The H.L. Hunley*

Archaeometallurgy is concerned with the analysis of archaeological and historical metals such as those of the *H.L. Hunley*, the first attack submarine ever constructed. Built in 1863 by the Confederacy, the *Hunley* attacked and sank the *USS Housatonic* outside of Charleston Harbor (SC). The sub never returned from her maiden combat voyage, and is sometimes referred to as the "iron tomb." The sub was located and raised off the coast of Charleston in August of 2000. Preservation and conservation efforts continue today.

A critical requirement of this preservation effort is to identify accurately the metallurgy of the various components of the sub. The Innov-X Portable XRF was chosen to do this for its state-of-the-art software, versatile x-ray analysis with multiple filter options, and the ability to add new elements, new alloy grades and fine-tune calibrations specific to the task. The Innov-X System offers the performance, portability and versatility required for these unique archaeometallurgical challenges.

Bronze Age: Copper Based Alloy Analysis

XRF analysis not only offers clues about metals in the relatively late Iron Age, such as for the *Hunley*. It also answers questions about metals in a much earlier time, the Bronze Age. Some bronze objects are simply two-component copper based alloys. More often there are several components, the identity and/or concentration of which help determine the composition, provenance, technology and authenticity of an object. Commonly produced copper based alloys found from the Bronze Age, including gunmetal and leaded gunmetal, consist of 1–15% Sn/Pb, up to 28% Zn, and Cu making up the balance. Trace levels of other elements, such as Sb, can indicate impurities in the ores which can give information about the object's origin. The presence of Zn at levels higher than 28% or the absence of other trace elements can indicate that the piece is from a time period after the Bronze Age. Copper based alloys are very simple to analyze with XRF. Detection limits in alloys range from 0.1 to 0.5% depending on the element and the sample matrix. An XRF spectral overlay of two different bronze alloys can be seen in Figure 1.

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fig. 1 Spectral overlay of two bronze alloys having different levels of Cu, Zn, Pb and Sn. Shown is the 10–30 keV spectral region that spans the Pb and Sn channels.

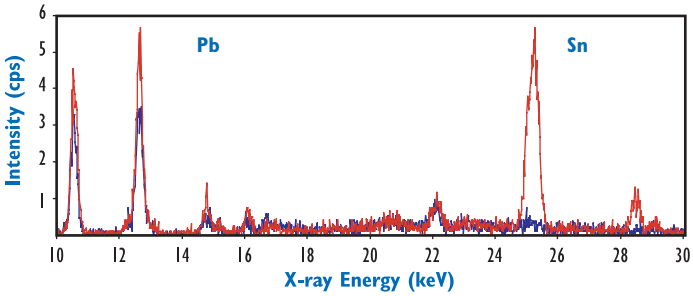
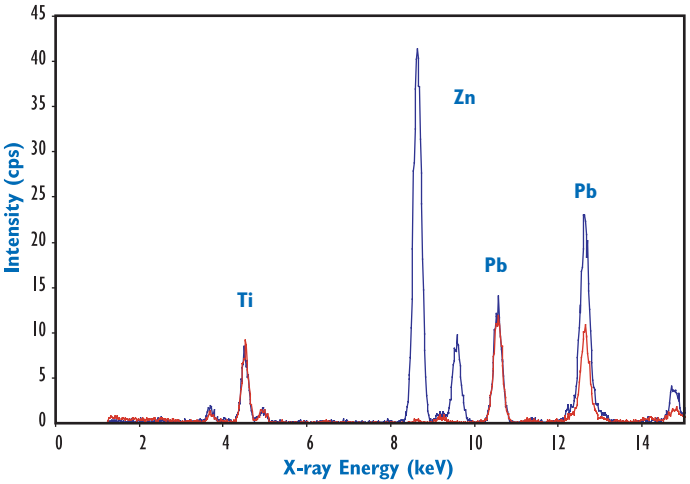


fig. 2 Spectral overlay of two pigments containing different amounts of Ti, Zn, and Pb. The ratio of the two Pb peaks at 10.5 and 12.6 show the lead is not in the surface paint layer.



Paintings and Art Objects: XRF Analysis for Authentication and Conservation

As we all know, everything isn't always what it seems or what someone says it is. When there is any doubt about the authenticity of a painting or other art object, an investigation is required. XRF can give information necessary to determine the authenticity of the painting by analyzing its pigment or, in the case of ceramics and statues, the base materials also. Essentially, different pigments have been used at different times in history, and at different locations and by different artists. In other words, the materials used to make pigments can vary considerably by artist, region and date. XRF analysis of the pigments can answer the questions of when, where and by whom the pigments were made. If this information does not concur with what is known about the attributed artist's pigment materials, then forgeries can be revealed. The same is true about the base materials of ceramics and statues. Information gained from authentication studies is also used to help repair and restore an object by allowing the conservator to produce materials similar to that of the original art object for restoration.

An example shown here is a painting that is believed to be a 16th Century Venetian portrait of Mary Magdalene. XRF analysis of the pigments used can help to determine its authenticity. The content of the red wax seals on the four corners of the back of the painting can also be analyzed by XRF to learn about its provenance, or ownership trail.

Pigments are very simple to analyze with XRF. Detection limits in pigments range from 0.01 to 0.1 mg/cm^2 depending on the element and the sample matrix. An XRF spectral overlay of two different paint pigments can be seen in Figure 2.

Summary

The latest x-ray tube technology from Innov-X Systems offers fast, high-precision measurements of in-situ objects of art, archaeological and historical significance. Information gleaned from these studies allows for the restoration and preservation of objects as well as for information on their composition, provenance, technology, authenticity and dating. Although materials investigated vary considerably – metals, bronze and other alloys, coins, jewelry, weapons, ceramics, glass, statues, religious objects, pigments in paintings and other artifacts – the high accuracy and low detection limits achievable with the Innov-X Portable XRF Analyzer make it ideal for these unique challenges. Innov-X developed a hand-held, point-and-shoot XRF system that eliminates burdensome radioactive sources and provides on-the-spot quality data of elements significant to art conservation and archaeometry. The x-ray tube system eliminates most regulatory issues, particularly for interstate travel. The single "tube" design of the Innov-X system offers true simultaneous analysis of 20–25 metals, replacing the need for multiple isotopes as used in competing systems.

For more information on this application and others, or for information on the specifications or purchase of the Innov-X Portable XRF Analyzer for your materials, please contact Innov-X Systems.

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