Analysis of gold alloys with Thermo Scientific ARL PERFORM'X Series Advanced X-Ray Fluorescence Spectrometers

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Key Words
ARL PERFORM'X 4200 W, Gold alloys, X-ray fluorescence, XRF

Goal

A quick and simple analysis of gold alloys using WDXRF as a direct measurement for routine process and quality control.

Introduction

Gold is one of the most sought-after and therefore valuable precious metals in the world. It has been used in the manufacturing of coins, jewelry, ornaments and decorations for thousands of years. In recent years, the market value of gold has increased dramatically as it is seen as a stable investment. Many new companies and industries for recycling and refinement have sprung up all over the world.

The production of gold alloyed products is based on the amount of gold used in the alloy process. This is because Au is the most valuable element in these products. The term karat or carat (K or kt) is used as a unit of purity for gold alloys. Karat purity is measured as 24 times the purity by mass:

$$X = 24\,\frac{M_g}{M_m}$$

Where:
X is the karat rating of the material,
M_g is the mass of pure gold or platinum in the material, and
M_m is the total mass of the material.

Thus, 24-Karat gold is fine (99.9% Au w/w), 18-Karat gold is 18 parts of gold (75.0% Au w/w) and 6 parts of other metals (forming an alloy), 12-Karat gold is 12 parts of gold (50.0% Au w/w) and 12 parts of other metals, and so forth.

The precision and accuracy in the analysis of gold is highly demanding due to its high price. A small error in concentration determination can equate to a large amount of money. It is for this reason that high power wavelength dispersive X-ray fluorescence (WDXRF) is one of the primary methods for quality control in gold analysis.

Instrument

Thermo Scientific ARL PERFORM'X series spectrometer used in this analysis was a 4200 watt system. This system is configured with 6 primary beam filters, 4 collimators, up to nine crystals, two detectors, helium purge and our 5GN+ Rh X-ray tube for best performance from ultra-light to heaviest elements thanks to its 50 micron Be window. This new X-ray tube fitted with a low current filament ensures an unequalled analytical stability month after month.

The ARL PERFORM'X™ offers the ultimate in performance and sample analysis safety. Its unique LoadSafe design includes a series of features that prevent any trouble during sample pumping and loading. Liquid cassette recognition prevents any liquid sample to be exposed to vacuum by mistake. Over exposure safety automatically ejects a liquid sample if X-ray exposure time is too long.

The Secutainer system protects the primary chamber by vacuum collecting any loose powders in a specially designed container, easily removed and cleaned by any operator. For spectral chamber protection, the ARL PERFORM'X uses a helium shutter designed for absolute protection of your goniometer during liquid analysis under helium operation. In the "LoadSafe Ultra" optional configuration, a special X-ray tube shield provides total protection against sample breakage or liquid cell rupture.

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Calibration

A set of certified reference standards were used in the creation of elemental regression plots. These graphs are linear regressions of the known concentrations plotted against the measured intensities. One set of regression calibrations were made using a 20 mm aperture.

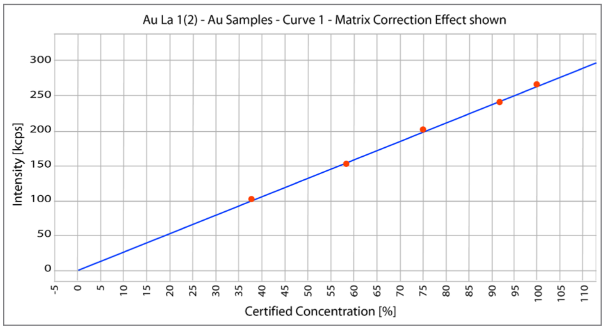

Figure 1: Au calibration at 20 mm aperture

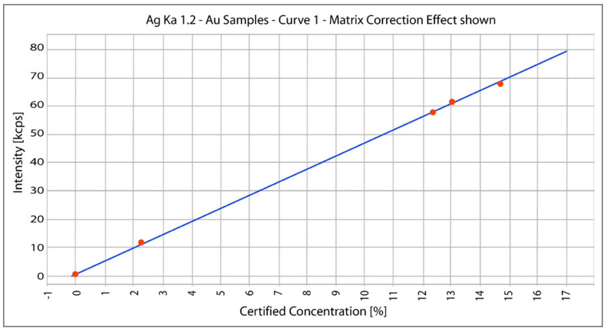

Figure 2: Ag calibration at 20 mm aperture

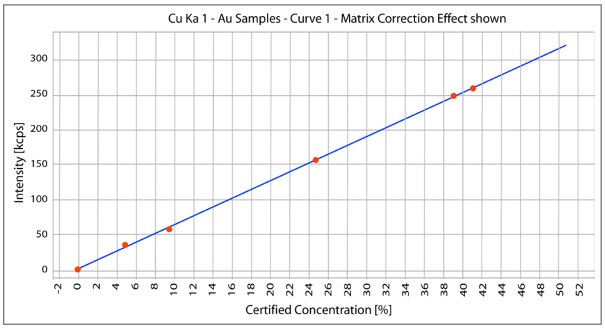

Figure 3: Cu calibration at 20 mm aperture

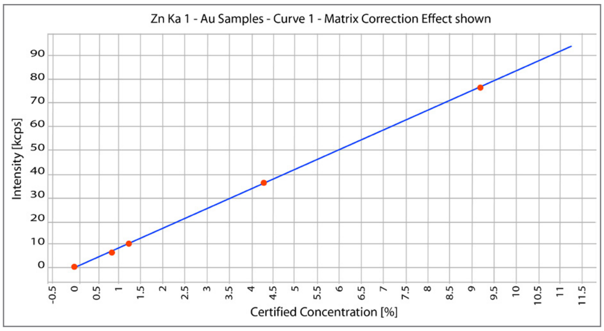

Figure 4: Zn calibration at 20 mm aperture

Results

Precision tests on gold alloys were carried out by running the sample for ten repeat analyses at 100 seconds counting time. The results are summarized in Table 1. The standard estimates of error (SEE), the standard deviations (SD) and the relative standard deviations (RSD) are the typical deviations achieved from the above regressions.

Table 1 represents the results using the 20 mm cassette aperture for this sample. It should be noted that the result can be improved by the use of a larger cassette aperture. The 20 mm aperture was chosen due to the limited size of the samples.

Elements	Conc. (‰)	SEE (‰)	SD (‰)	RSD (‰)
Au	755	0.012	0.47	0.62
Ag	141	0.046	0.05	0.35
Cu	88	0.014	0.16	1.83
Zn	8	0.067	0.016	1.96

Table 1: Typical gold alloy calibration at 20 mm aperture

Conclusion

The results show that gold alloy analysis can easily be performed with the ARL PERFORM'X sequential XRF spectrometer. The precision and accuracy are shown to be incredibly high in this matrix type for routine and non-standard analysis.

Furthermore, operation is made easy through the newest and most advanced state-of-the-art Thermo Scientific OXSAS WDXRF software which is able to operate with the latest Microsoft Windows® 7 packages.

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