

Precise Analysis of Gold Alloys by X-Ray Fluorescence

Introduction

The traditional methods determining Gold in precious metal alloys, preferably jewellery alloys, are carried out by the Touchstone test or by the Cupellation. But these methods are destructive and time consuming. Therefore since many years the X-ray Fluorescence Spectrometry has been introduced to solve this problem. It is the power means for precise determination of alloy composition and concentrations of Au or Ag.

Alloy system Au-Ag-Cu

The analytical instrument

The instrument *Xray ComPact 5/PIN* offered by Röntgenanalytik Messtechnik GmbH has been especially developed for the analysis of jewellery alloys made of gold, silver or platinum.

A low power tube is used in either instrument in excitation mode. A special collimator reduces the exciting beam down to 0.6 mm in diameter. In this way a local analysis of several parts of the jewellery object and its filigree zones with irregular geometry, as usual for jewellery manufacturing, can be achieved.

Energy dispersive measurement is made with a PIN-diode. The high resolution of this type of detector allows to analyse trace elements in samples with complex composition. Good statistical measurement guarantees high reproducibility.

Sample preparation

The surface of the samples should be thoroughly cleaned free of contaminants. This will enable the irradiated area to be representative of the whole.[^]

Further preparation is not necessary as the very small excited area and the use of normalized intensities reduce the geometric influence of the signal.

The following figure 1 shows a typical spectrum of AuAgCu alloy.

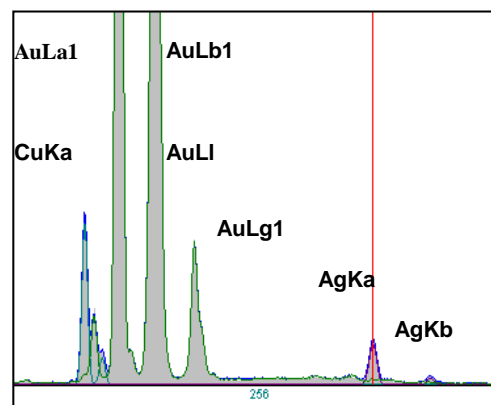


Figure 1: spectrum of AuAgCu alloy

Excitation conditions

Tube	W-Microfocus-glass-window
Voltage	40 kV
Power	approx. 30 W
Collimator	0.4 mm in diameter
Measuring time for analysis	60-120 s

Program Parameters

Program	XMaster Vers. 2.0.2.3
Application:	AuAgCu

Analytical Features

Limits of detection

Traces in alloys of about 0.1% can be analysed. In most cases this sensitivity is more than sufficient for jewellery analysis.

Application Note

X-Ray Application

Calibration ranges

The spectrometer is calibrated for gold, silver and platinum alloys. For calibration

certified reference samples are used. Calibration is valid for the concentration ranges shown in table 1.

Alloy system	Au	Ag	Cu	Zn	Pd	Ni
Gold	30 - 100	0 - 70	0 - 40	0 - 10	0 - 30	0 - 20

Table 1: Calibrated concentration ranges

Accuracy of analysis

An accuracy of $\pm 0.1\%$ can be achieved within an analysis time of 2 min; this corresponds to 0.05 Carat. For all other admixtures the accuracy is in the same range. The accuracy of the X-ray spectrometric

determination of Gold shall be validated by certified standards of jewellery alloy samples. The following table 2 enables to compare X-ray measured values with these of Gold standards.

Alloy system	Au		Ag		Cu	
	given	is	given	is	given	is
Au1	33,32	32,40	66,59	67,59		
Au2	33,35	33,38	44,65	45,19	21,98	21,42
Au13	91,67	91,67	2,76	2,98	5,28	5,35
Au15	98,60	98,78			1,40	1,21
Au16	99,99	100,0				

Table 2: Analysis results

Reproducibility

For determination of reproducibility repeated measurements with a measuring time of 60 s have been realised within 10 min on a sample with the following composition [%]: Au-Ag-Cu: 916.7 - 27.6 - 52.8

No of meas.	Au	Ag	Cu
1	916,6	29,8	53,6
2	917,4	29,1	53,4
3	917,0	30,0	53,0
4	916,8	30,0	53,1
5	917,1	29,3	53,6
6	917,0	29,9	53,0
7	915,7	30,2	54,1
8	916,3	29,5	54,1
9	916,0	30,3	53,6
10	917,1	29,7	53,1
Mean	916,7	29,8	53,5
Error rel [%]	0,05	1,34	0,75
SD [%]	0,5	0,4	0,4

Table 2: Reproducibility of measurement
Concentration in [%]

Conclusion

The analytical results demonstrate that the standardless X-Ray fluorescence analysis is a most important alternative method for the analysis of jewellery alloys. The X-ray spectrometer **Compact 5/PIN** allows the determination of Gold in jewellery alloys with high accuracy and high precision. In comparison with the conventional touch method, the analytical accuracy is improved by a factor of 10. Not only is the X-Ray fluorescence analysis nondestructive, it does not need high operator skill and highly accurate results are quickly obtained. Extremely narrow collimated X-Ray beams enable even the finest filigree jewellery to be analysed.

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