Analysis of Jewelry and Precious Metals

Fast – Accurate – Non-Destructive
Using X-ray Fluorescence

Advances in X-ray fluorescence technology and calibration standards have increased measurement accuracy to a level which meets the highest quality requirements in the assaying of gold and other precious metals. Numerous exclusive patents and nearly 30 years of experience in the fields of development and production of EDXRF spectrometers make our instruments especially efficient and simple to use in both industrial and laboratory applications.

Cupellation is the method recognized worldwide for the exact determination of gold content. However, this method is time-consuming and costly. In contrast, gold content measurement using X-ray fluorescence is faster and above all, non destructive. Therefore, X-ray fluorescence can provide an effective and more cost-efficient solution.

Advantages, Measurement Method, Technical Features

Advantages of X-ray fluorescence

Gold analysis using X-ray fluorescence offers a comparable accuracy to cupellation in the majority of cases but with the following advantages:

- Non-destructive alloy determination.
- Short analysis times of only three minutes provide reliable results – not only for the gold content, but also for the other alloy portions such as silver, palladium, copper etc. By extending the measuring time or repeated measurements, the analysis precision can be enhanced.
- The trueness of gold analysis can be enhanced by using calibration standards. Thus, results comparable to cupellation are possible.
- Large sample volumes can be measured economically through a fully automated measurement run.
- Analysis of completely unknown samples.
- Check for local non-homogeneous gold distribution using small measurement spots – even with complicated sample shapes.
- Dependable results even for gold alloy coatings.
- User-friendly handling without the use of chemicals.
- Convenient documentation of the measurement results, also in graphical format in 3-D or pseudo color display with a color image of the sample for documenting the measurement spot.

Areas of application

The following are just some areas where X-ray fluorescence analysis has significant advantages:

- Jewelry and the watch trade
- Laboratories responsible for gold and precious metal determinations
- Assay offices for the determination of the purity
- Separation institutes and recycling companies
- Coin mints
- Manufacturers and processors of dental alloys
- Customs authorities

Front page: SIC / Werner;
p.2: SIC / Oeding-Erdel, Muenster

Measurement method

Energy dispersive X-ray fluorescence analysis (EDXRF) is based on the following physical principle:

The primary radiation of an X-ray tube excites a sample to emit X-ray fluorescence radiation. The detector registers the energy composition (spectrum) of the fluorescence radiation, which is characteristic for each element. The elements contained in the sample can be determined based on the energy peaks of the spectrum. The concentration of an element is determined from the intensity of its radiation.

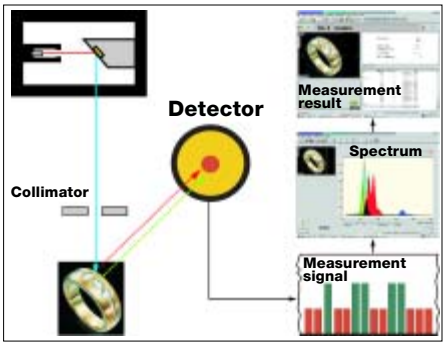


Image 1: Technical functional principle of an X-ray fluorescence measuring instrument

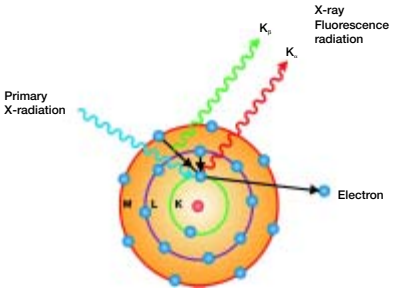
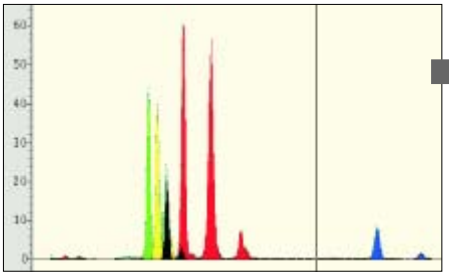


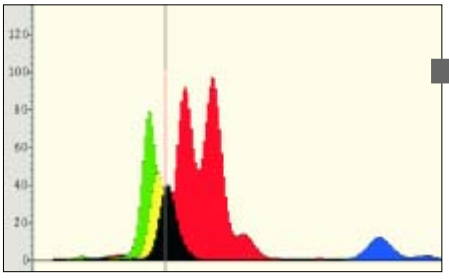
Image 2: Physical principle of X-ray fluorescence



Au	601 ‰
Ag	74 ‰
Ni	142 ‰
Cu	120 ‰
Zn	64 ‰

Analysis

Image 3: Spectrum and analysis result of a gold sample; recorded using the FISCHERSCOPE® X-RAY XAN®-DPP with a semiconductor detector



Au	599 ‰
Ag	77 ‰
Ni	139 ‰
Cu	120 ‰
Zn	65 ‰

Analysis

Image 4: Spectrum and analysis result of a gold sample; recorded using the FISCHERSCOPE® X-RAY XUL® with a proportional counter tube.

Instruments for any type of application

Instruments with a suitable detector are available to match the application and the required energy resolution:

Instruments with a semiconductor detector
Models XDV®-SD, XDAL® and XAN®-DPP offer an excellent energy resolution (Image 3). Even peaks very close to one another, such as gold and platinum, for example, can be evaluated selectively. Thus, these models are ideally suited for the analysis of entirely unknown samples.

Instruments with a proportional counter tube
The more cost-effective models XUL® and XDLM®-C4 also facilitate measurements of very high precision. They are ideally suited for routine measurements of known alloys (Image 4).

FISCHERSCOPE® X-RAY Instrument model
Key applications
Measurement direction
Detector
Collimators (A collimator is an aperture for shaping the primary X-ray beam. It determines the size of the measurement spot on the specimen.)
Measuring stage
Model versions

Applications, Instrument Models

Measurement documentation

Whether performing alloy analysis or coating thickness measurement, generating meaningful documentation of the measurements is simple. With the user-friendly print form generator you can easily design and print documentation that includes a video image and statistical data.

High precision

A standard deviation of better than 0,5 ‰ can be achieved in most cases with a measurement time of less than 3 minutes.

Non-homogeneous alloys

By nature, alloys of precious metals exhibit more or less pronounced irregularities of metal concentrations in their structure. This fact falsifies the analysis if measurements are made at only one spot. Measurements at several spots average this effect – and even provide a measure of the homogeneity.

In addition, X-ray fluorescence analysis enables such non-destructive analyses with relatively little effort. A microanalysis is also possible. Using a fine primary X-ray beam, a defined area of the specimen is scanned to determine the local concentration distribution. Image 6 shows this effect using the example of a 22-carat coin. The statistical evaluation provides a much more secure result (the mean value) than a single point measurement.

Lateral distribution analysis

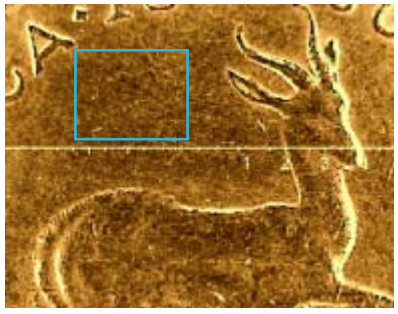


Image 5: 22-carat gold coin. The inhomogenity of the area marked in blue has been analyzed microanalytically. The result is shown in image 6.

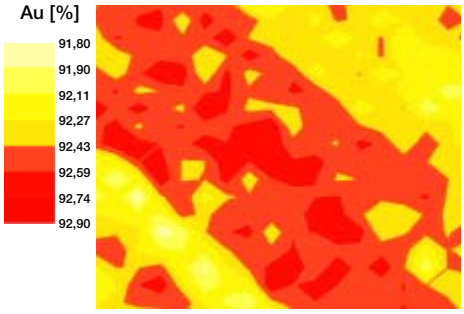


Image 6: Lateral distribution of the gold concentration within an area of 3 mm x 2.5 mm, recorded using the FISCHERSCOPE® X-RAY XDLM®-C4. The specimen is the coin of image 5. The local differences in concentration are more than 0.5 % gold!

Analysis precision for different gold alloys

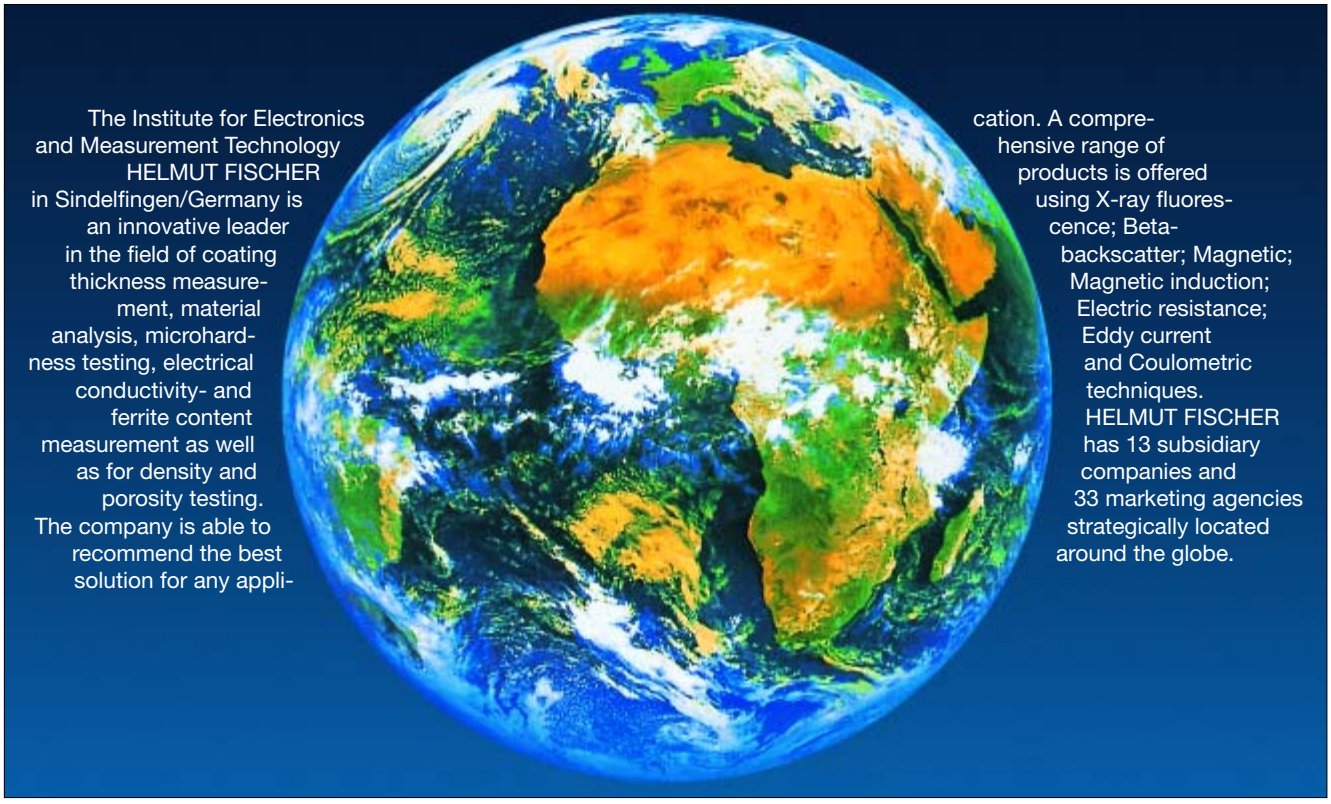
Measuring instrument: FISCHERSCOPE® X-RAY XDV®-SD

Alloy	Au [‰]		Ag [‰]		Pd [‰]	
	Content	s[1]	Content	s[1]	Content	s[1]
Au900Ag50	901.2	0.35	49.0	0.25	-	-
Au750Ag50	750.5	0.23	49.5	0.19	-	-
Au750Ag99	750.8	0.36	98.5	0.26	-	-
Au750Ag154	750.3	0.29	153.5	0.29	-	-
Au585Ag295	585.1	0.35	294.6	0.42	-	-
Au585Ag46	585.8	0.35	45.6	0.13	-	-
Au333Ag767	332.3	0.34	76.8	0.16	-	-
Au750Pd99	749.9	0.36	-	-	98.7	0.29
Au583Ag277Pd140	583.4	0.35	276.8	0.25	139.9	0.32

[1] Standard deviation of 20 single measurements with a measuring time of 180 seconds each.

				
XDV®-SD	**XDAL®**	**XAN®-DPP**	**XUL®**	**XDLM®-C4**
High-end coating analyzer with most features and extensive option variety	Same use as XAN®-DPP; in addition: Automated measurements using an XY(Z) measuring stage. Lateral distribution analysis.	General analytics. Analysis of alloys. Coating analysis.	Process control. Analysis of alloys consisting of a few elements. Coating analysis.	Same use as XUL®; in addition: Automated measurements using an XY(Z) measuring stage. Lateral distribution analysis.
From top to bottom	From top to bottom	From bottom to top	From bottom to top	From top to bottom
PIN semiconductor diode with high energy resolution			Proportional counter tube for high count rates and short measuring times	
4 round collimators: ø 0,1 mm ø 1 mm ø 0,3 mm ø 3 mm	4 collimators: ø 0.1 mm ø 0.6 mm ø 0.3 mm 0.5 mm x 0.15 mm	4 round collimators: ø 0.2 mm/0.6 mm/1.0 mm/ 2.0 mm	1 collimator: ø 0.3 mm or optional 0.05 mm x 0.3 mm	4 collimators: ø 0.1 mm/ 0.2 mm/ 0.3 mm
Ultra high precision, XY(Z) measuring stage, travel 250 mm x 250 mm	Programmable XY(Z) measuring stage, Travel 256 mm x 235 mm	Fixed specimen support	Fixed specimen support; in add.: optional manual XY(Z) meas. stage	Programmable XY(Z) measuring stage, Travel 256 mm x 235 mm
	XDAL®-FD featuring very high count rates resulting in shorter measuring times	XAN®-DPP BC with extra high measuring chamber (H = 248 mm)		

Active Around the World



SIGMASCOPE® SMP10 for the measurement of the electrical conductivity of metals. The measurement results permit statements about the composition, microstructure and mechanical properties of the specimen.

Micro hardness measurement unit FISCHERSCOPE® HM2000 to determine the Martens hardness of thin coatings and foils.

FISCHERSCOPE® MMS® PC. Universal measurement system for magnetic, magnetic inductive, Eddy current and Beta backscatter method coating thickness measurement and general test procedures of materials.

The high quality standard of FISCHER instruments is the result of our efforts to provide the very best instrumentation to our customers.

FISCHER is a reliable and competent partner, offering expert advice, extensive service, and training seminars.

Today, FISCHER instruments are used successfully in all technological fields of industry and research.

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