Application Note: 41401

Copper Base

ARL 9900 Series with IntelliPower™ Simultaneous-Sequential XRF Spectrometer

Key Words

- ARL 9900 - 3600W
- Brass
- Bronze
- Copper
- XRF

Copper alloys

Pure copper is mixed with other elements to produce a wide range of alloys:

- Brasses (Cu-Zn)
- Bronzes (Cu-Sn)
- Gun metal (Cu-Sn-Zn) used for casting due to its excellent fluidity, for valves, taps and water fittings
- Manganese bronzes (Cu-Zn-Mn) are not true bronzes as Sn is not the essential constituent. Used for rudders, propellers and ship fittings
- Cupro-nickel (Cu-Ni) used for coins, tubes, wires, electrical resistances and thermocouples
- Nickel silver (Cu-Ni-Zn) used for marine applications, car radiators and fittings

Brasses

One the most important non-ferrous engineering alloys. They cover a large range of physical properties and their applications are multiple.

Copper is capable of holding about 39 % of zinc in solid solution. Alloys containing less than 39 % Zn are known as α-brasses. This brass (70/30) is very widely employed for cartridge, cases, condenser tubes, etc.

From 39 % to 46 % of Zn, a β-solid solution gives αβ-brass. This alloy (60/40) is found in extensive engineering applications with enhanced corrosion resistance used in marine applications. Alloys containing more than 49 % Zn are very hard and only used for brazing brasses.

Bronzes

Bronzes are used for bearing and gears. There are a wide variety of bronze alloys containing various elements such as phosphorus, beryllium, silicon, etc.:

- Leaded bronzes (Cu-Sn-Pb) are mainly used for bearings due to their good wear resistance
- Aluminum bronzes (Cu-Al) have good corrosion resistance but are difficult to cast. Used for pumps rods, diecastings, etc.
- Silicon bronzes (Cu-Sn-Ni) have high electrical conductivity and are used for wires
- Phosphor bronzes (Cu-Sn-P) are used for valves, bearings and gears. Cold worked into rods and sheets

Typical performance

ELEMENT		CONCENTRATION %	PRECISION (1 SIGMA) %	L O D (3 SIGMA) PPM
COUNTING TIME			30 s.	30 s.
Al	Aluminum	0.01 0.1 5 10	0.0006 0.004 0.007 0.01	6
Ag	Silver on gonio + PBF	0.01 0.05	0.001 0.0015	30
As	Arsenic Kβ	0.01 0.06	0.0003 0.0004	9
Bi	Bismuth on gonio	0.01 0.04	0.0004 0.0007	21
Cd	Cadmium on gonio + PBF	0.01 0.025	0.0017 0.002	45
Cr	Chromium	0.01	0.0001	3
Co	Cobalt	0.005	0.00003	1
Cu	Copper	50 65 80	0.01 0.015 0.02	--
Fe	Iron	0.03 0.1 2 5	0.00005 0.0002 0.0005 0.002	2
Mn	Manganese	0.01 1 5	0.0001 0.0005 0.001	2
Ni	Nickel	0.01 0.2 1 5 10 30	0.0001 0.0003 0.001 0.003 0.004 0.006	4
P	Phosphorus *Ge 111*	0.01 1	0.0003 0.0004	17
Pb	Lead Lβ	0.01 1 5 10	0.0002 0.001 0.005 0.01	4
S	Sulphur	0.02 0.1	0.0004 0.001	4
Sb	Antimony	0.01 0.1	0.0002 0.0006	7

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ELEMENT		CONCEN-TRATION %	PRECISION (1 SIGMA) %	L O D (3 SIGMA) PPM
COUNTING TIME			30 s.	30 s.
Se	Selenium on gonio	0.01	0.0004	7
Si	Silicon on gonio	0.01 0.05 0.1	0.0001 0.0004 0.0007	8
Sn	Tin	0.02 0.5 5 10	0.0002 0.0003 0.0014 0.002	5
Te	Tellurium on gonio	0.01 0.03	0.0012 0.0015	30
Zn	Zinc	0.2 1 5 20 40	0.0005 0.0007 0.0015 0.008 0.011	8

This list will be updated as improvements are announced. Please contact your nearest Thermo office for the most recent values.

The values listed in the general table are calculated from the following formulae:

$$\text{Precision (1 sigma)} = \sqrt{\frac{P + B}{Q\,T}}$$

and

$$\text{LOD = limit of detection (3 sigma)} = 3\sqrt{\frac{B}{Q\,T}}$$

where

- Q = counts per second per 1 % element
- B = background equivalent concentration
- T = time of analysis in seconds
- P = the percentage concentration at which the sigma value is calculated.

The limits of detection are determined with low alloy copper samples. In practice, these values should agree with values measured practically using the mathematical derivation of standard deviation (1 sigma).

$$1\ \text{sigma} = \pm\sqrt{\frac{\Sigma(X - \overline{X})^2}{n - 1}}$$

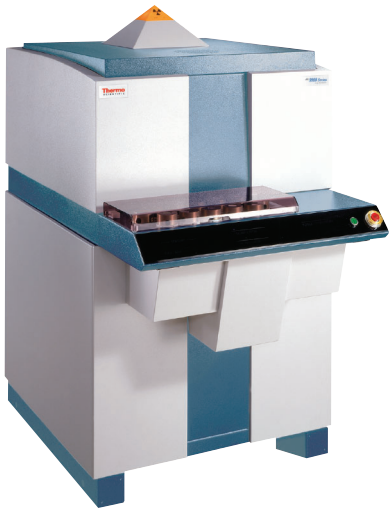
where

- X = the individual readings
- $\overline{X}$ = the arithmetic mean of the individual values
- n = number of determination (normally ≥ 10)

For guaranteed values, the values of precision and LODs should be multiplied by factor 1.5.

Instrument calibration

It should be stressed that an XRF spectrometer is a very accurate comparator, but the accuracy of the final analysis is entirely dependent on the quality of the standards used for calibration. The Thermo Scientific ARL 9900 XRF spectrometer, can be factory calibrated for various copper alloys or a general copper program using commercially available standards. It can also be calibrated on-site using well analyzed samples from the user.



Conclusion

The long experience of our company in metals analysis comes from an installed base of over 1'000 XRF spectrometers world-wide. The ARL 9900 is the answer to your metallurgical analysis needs; whether they be incoming material control, metal QC or production analysis. Working 24 hours a day and 7 days a week, the ARL 9900 delivers dependable performance year after year. The high performance of the ARL 9900 will meet your analytical needs today and in the future.

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