IRMM

Institute for Reference Materials and Measurements

CERTIFICATE
SPIKE ISOTOPIC REFERENCE MATERIAL IRMM-632

$9.684(41) \cdot 10^{-8}$ mol (^{65}Cu) · g^{-1} (solution)

The Spike Isotopic Reference Material is supplied with an isotope amount content of ^{65}Cu certified as above.

The amount of the other copper isotope present is related to the ^{65}Cu content through the following certified amount ratio**:**

n(^{63}Cu)/***n***(^{65}Cu) **:**	**0.002 892 1(92)**

This corresponds to an isotopic composition with the following abundances **:**

amount fraction (·100)		mass fraction (·100)	
$n(^{63}Cu)/n(Cu)$	0.288 38(92)	$m(^{63}Cu)/m(Cu)$	0.279 53(89)
$n(^{65}Cu)/n(Cu)$	99.711 62(92)	$m(^{65}Cu)/m(Cu)$	99.720 47(89)

The molar mass of the copper in this sample is 64.922 031(19) g·mol^{-1}

From the certified values, the following amount content and mass fractions are derived:

$9.712(41) \cdot 10^{-8}$	mol (Cu) · g^{-1} (solution)
$6.287(27) \cdot 10^{-6}$	g (^{65}Cu) · g^{-1} (solution)
$6.305(27) \cdot 10^{-6}$	g (Cu) · g^{-1} (solution)

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NOTES

1. The isotope amount content value of this Spike Isotopic Reference Material is traceable to the SI via the values of IRMM-647, the value of the isotope amount ratio is traceable to the SI via NIST SRM 976. Measurements calibrated by this Isotopic Reference Material have therefore the potential of being traceable to SI.

2. All uncertainties indicated are expanded uncertainties $U = k \cdot u_c$ where u_c is the combined standard uncertainty estimated following the ISO/BIPM Guide to the Expression of Uncertainty in Measurement. They are given in parentheses and include a coverage factor $k = 2$. They apply to the last two digits of the value. The values certified are traceable to the SI.

3. The IRMM-632 has been prepared by dissolution of an enriched and purified Cu metal in subboiled nitric acid. The amount content was measured by IDMS against IRMM-647 Isotopic Reference Material.

4. The Spike Isotopic Reference Material IRMM-632 comes in a flame-sealed glass ampoule containing about 0.4 µmol copper in 4 mL of a chemically stable nitric acid solution. The molarity is about 1 M HNO_3 (i.e. 1 mol HNO_3 per Liter of solution).

5. The atomic masses, used in the calculations, are[1]

^{63}Cu : 62.929 600 7(30) g·mol^{-1}
^{65}Cu : 64.927 793 8(38) g·mol^{-1}

6. Using this Spike Isotopic Reference Material, the Cu content in an unknown sample can be determined by Isotope Dilution, through a measurement of the isotope amount ratio $R(B) = n(^{63}Cu)/n(^{65}Cu)$ in a blend. It should be computed with the aid of the following equation which enables an easy quantification of the uncertainty sources in the procedure :

$$c(Cu,X) = \frac{R(Y) - R(B)}{R(B) - R(X)} \cdot \frac{1 + R(X)}{1 + R(Y)} \cdot \frac{m(Y)}{m(X)} \cdot c(Cu,Y)$$

where:

$R(X)$	=	amount ratio $n(^{63}Cu)/n(^{65}Cu)$ in the unknown sample material X
$R(Y)$	=	amount ratio $n(^{63}Cu)/n(^{65}Cu)$ in the spike material Y
$m(X)$	=	mass of the unknown sample used in the measurement
$m(Y)$	=	mass of the sample of spike solution used in the measurement
$c(Cu,X)$	=	amount content of Cu · g^{-1} sample material
$c(Cu,Y)$	=	amount content of Cu · g^{-1} spike solution.

[1] G Audi and A H Wapstra, The 1993 atomic mass evaluation , Nucl Phys A565 (1993) 1-65.

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7. Full details of the certification procedure can be found in IRMM internal Report GE/R/SIM/38/97[2].

The isotopic measurements for determination of the isotopic composition were performed by A Götz by Thermal Ionisation Mass Spectrometry. The amount content was measured against the IRMM 647 (based on BAM A primary Cu) by S Pattberg by Quadrupole Mass Spectrometry.

The solution, used for the isotopic composition measurements, was evaporated to complete dryness. It was reduced, using hydrogen, to pure Cu metal and dissolved in a known amount of solution before the ampoulation. The hydrogen reduction process was performed under the responsibility of S Clifford and the chemical preparation of the material was performed by I Papadakis and C Quétel.

Metrological weighings required in the preparation and certification were performed by F Hendrickx. The ampoulation of this Spike Isotopic Reference Material was accomplished by G Van Baelen, I Papadakis and C Quétel.

S Pattberg co-ordinated the work leading to the establishment, certification and issuance of this Isotopic Reference Material. A Verbruggen was responsible for the preparation and issuance of the certificate.

B-2440 GEEL
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Dr P Taylor
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IRMM Isotope Measurements

[2] I Papadakis, Preparation and certification of copper isotope content in the isotopic reference material IRMM-632