MBH ANALYTICAL LTD

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CERTIFICATE OF ANALYSIS

39X 17872 (batch A)

Certified Reference Material Information

Type:	RESIDUALS IN COPPER (CONTINUOUS CAST)
Form and Size:	Disc 42mm Diameter x 15mm Thickness
Produced by:	Copper Alloys Ltd
Certified and supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Pb	Zn	Fe	Ni	As	Sb	Mn
Value [1]	**0.293**	**0.107**	**(0.045)**	**0.0537**	**0.0203**	**0.0217**	**0.0055**
Uncertainty [2]	0.005	0.002	-	0.0016	0.0008	0.0005	0.0007

Element	Cd	Bi	S	Se	Ag	Sn	Co
Value [1]	**0.0013**	**0.0240**	**0.0242**	**0.0103**	**0.0214**	**0.180**	**0.0102**
Uncertainty [2]	0.0001	0.0012	0.0014	0.0008	0.0014	0.004	0.0008

Element	P	Al	In	Au	Te	Zr
Value [1]	**0.0045**	**0.0118**	**0.0241**	**(0.0015)**	**0.0208**	**(0.0024)**
Uncertainty [2]	0.0004	0.0010	0.0011	-	0.0019	-

Notes: i) values given in parentheses are not certified - they are provided for information only.

ii) [1, 2] : for definitions, see page 2.

Certified by:

on 2nd June 2009

MBH ANALYTICAL LIMITED _____

C Eveleigh

Method of Preparation

This reference material was produced from commercial-purity copper, and a combination of pure elements and binaries. The discs are the product of one melt, continuous cast; the metal is presented in the as-cast condition.

Sampling

Milled samples for chemical analysis, and discs for homogeneity checks, were taken randomly from several positions throughout the casting process. At least 15% of all discs were selected for homogeneity checking.

Homogeneity

The discs were checked for sample and batch uniformity using an optical emission spectrometer. Using the meaned data from each surface, standard deviation values were derived for each element as an indicator of any non-homogeneity (as determined for the specific sample size taken by the spectrometer).

Chemical Analysis

Analysis was carried out on millings taken from samples representative of the product. It was performed by a panel of laboratories mostly operating within the terms of EN ISO/IEC 17025 - 2000, using documented standard reference methods and validated by appropriate reference materials. The individual values listed overpage are the average of each analyst's results.

Traceability

Much of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to ISO 17025. It is an implicit requirement for this accreditation that analytical work should be performed with due traceability, via an unbroken chain of comparisons, each with stated uncertainty, to primary standards such as the mole, or to nationally- or internationally-recognised reference materials. In addition, some of the results derived as part of this testing programme have traceability to NIST standards, as part of the analytical calibration or process control.

Definitions

1 The assigned values are the present best estimates of the true content for each element. Each value is a panel consensus, based on the averaged results of an interlaboratory testing programme, listed on page 3.

2 The analytical uncertainty values are generated from the 95% half-width confidence interval $C_{(95\%)}$, which is derived from the wet analysis results, in accordance with the following equation:

$$C_{(95\%)} = (t \times SD)/\sqrt{n}$$

where n is the number of available values, t is the Student's t value for n-1 degrees of freedom, and SD is the standard deviation of the test results.

Estimation of Uncertainties

Each element certified has been analysed by several laboratories, and 95% half-width confidence intervals ($C_{(95\%)}$) for the resultant mean values have been derived by the method shown above. As a separate exercise, the degree of non-homogeneity of the batch for each element has been quantified by a programme of non-destructive application testing, also discussed above. The final certified uncertainty for each element has been derived by combining these two factors, using the square-root of the summed squares.

Usage

Intended use: With optical emission and X-ray fluorescence spectrometers.

Recommended method of use: Copper and its alloys are generally prepared by machining on a mill or lathe. However, users are recommended to follow the calibration and sample preparation procedures specified by the relevant instrument manufacturer. Preparation should be the same for reference materials and the samples for test.

A minimum of five consistent replicate analyses is recommended to optimise precision and accuracy. Users are advised to check against possible bias between reference materials and production samples due to differences in metallurgical history, and be aware of possible inter-element effects.

Analytical Data

Percentage element by weight

Sample	Pb	Zn	Fe	Ni	As	Sb	Mn
1	0.281	0.102	0.0345	0.0509	0.0172	0.0205	0.0040
2	0.284	0.103	0.0358	0.0510	0.0185	0.0210	0.0043
3	0.289	0.104	0.0364	0.0519	0.0189	0.0210	0.0048
4	0.292	0.106	0.0366	0.0523	0.0200	0.0210	0.0050
5	0.293	0.107	0.0386	0.0528	0.0200	0.0211	0.0050
6	0.295	0.107	0.0450	0.0540	0.0203	0.0212	0.0052
7	0.297	0.107	0.0451	0.0550	0.0205	0.0214	0.0058
8	0.301	0.107	0.0505	0.0552	0.0207	0.0218	0.0058
9	0.302	0.109	0.0531	0.0560	0.0210	0.0218	0.0059
10		0.110	0.0548	0.0576	0.0212	0.0220	0.0070
11		0.111	0.0557		0.0212	0.0228	0.0073
12		0.111	0.0572		0.0218	0.0229	
13		0.112			0.0223	0.0230	
Mean	**0.293**	**0.107**	**0.045**	**0.0537**	**0.0203**	**0.0217**	**0.0055**
Std Dev	0.007	0.003	0.009	0.0022	0.0014	0.0008	0.0010
$C_{(95\%)}$	0.005	0.002	0.006	0.0016	0.0008	0.0005	0.0007

Sample	Cd	Bi	S	Se	Ag	Sn	Co
1	0.0010	0.0221	0.0213	0.0082	0.0185	0.168	0.0087
2	0.0010	0.0232	0.0217	0.0082	0.0195	0.172	0.0091
3	0.0011	0.0232	0.0221	0.0092	0.0202	0.173	0.0092
4	0.0011	0.0234	0.0232	0.0098	0.0214	0.177	0.0093
5	0.0013	0.0239	0.0236	0.0102	0.0215	0.177	0.0093
6	0.0013	0.0241	0.0243	0.0105	0.0218	0.179	0.0097
7	0.0013	0.0242	0.0244	0.0107	0.0222	0.182	0.0099
8	0.0014	0.0242	0.0252	0.0110	0.0234	0.183	0.0101
9	0.0014	0.0242	0.0263	0.0114	0.0240	0.186	0.0102
10	0.0014	0.0243	0.0269	0.0114		0.187	0.0106
11	0.0014	0.0244	0.0272	0.0116		0.188	0.0118
12	0.0015	0.0247		0.0119		0.189	0.0119
13		0.0260					0.0128
Mean	**0.0013**	**0.0240**	**0.0242**	**0.0103**	**0.0214**	**0.180**	**0.0102**
Std Dev	0.0002	0.0009	0.0021	0.0013	0.0018	0.007	0.0013
$C_{(95\%)}$	0.0001	0.0006	0.0014	0.0008	0.0014	0.004	0.0008

Sample	P	Al	In	Au	Te	Zr
1	0.0037	0.0099	0.0220	0.0005	0.0179	0.0010
2	0.0039	0.0110	0.0223	0.0008	0.0181	0.0014
3	0.0041	0.0115	0.0225	0.0011	0.0182	0.0017
4	0.0042	0.0120	0.0231	0.0012	0.0185	0.0023
5	0.0042	0.0122	0.0232	0.0014	0.0192	0.0025
6	0.0045	0.0130	0.0238	0.0015	0.0194	0.0033
7	0.0045	0.0130	0.0240	0.0019	0.0218	0.0045
8	0.0046		0.0256	0.0020	0.0220	
9	0.0048		0.0258	0.0021	0.0225	
10	0.0054		0.0262	0.0022	0.0254	
11	0.0059		0.0268		0.0254	
Mean	**0.0045**	**0.0118**	**0.0241**	**0.0015**	**0.0208**	**(0.0024)**
Std Dev	0.0006	0.0011	0.0017	0.0006	0.0028	-
$C_{(95\%)}$	0.0004	0.0010	0.0011	0.0004	0.0019	-

For the definition of $C_{(95\%)}$ see page 2.

Participating Laboratories

Bodycote Materials Testing	Middlesbrough, England	UKAS accreditation 0239
Sheffield Assay Office	Sheffield, England	UKAS accreditation 0012
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 492
Laboratory Testing, Inc	Hatfield, PA, USA	A2LA accreditation 0117
Genitest, Inc	Montreal, Canada	PRI accreditation 123077
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation 0173
Institute of Iron & Steel Technology	Shanghai, China	CNAL accreditation 0783
TCR Engineering Services Ltd	Mumbai, India	NABL accreditation T0367
Shriram Institute for Industrial Research	Delhi, India	NABL accreditation T0045
Raghavendra Spectrometallurgical Lab.	Bangalore, India	NABL accreditation T0371
Sargam Metals Pvt Ltd	Chennai, India	NABL accreditation T0025
De Bruyn Spectroscopic Solutions Ltd	Johannesburg, South Africa	
Colonial Metals Co	Columbia, PA, USA	
Coleshill Laboratories Ltd	Birmingham, England	

Note: to achieve the above accreditation (UKAS, NATA, etc), test houses must demonstrate conformity to the general requirements of EN ISO/IEC 17025

Analytical Methods Used

ELEMENT	RESULT No. & METHOD			
	ICP-AES	FAAS	OTHER	
Lead	1, 3-5, 7, 8	2, 6, 9		
Zinc	2-4, 6-10	1, 5, 11-13		
Iron	2, 4-7, 10, 11	1, 3, 8, 9, 12		
Nickel	2-4, 6, 8, 10	1, 5, 7, 9		
Arsenic	1-6, 8, 12, 13	7, 10, 11	9	photometric (turbidity)
Antimony	1-3, 5-9, 12	4, 10, 11, 13		
Manganese	2, 5, 7-11	1, 3, 4, 6		
Cadmium	2-5, 10-12	1, 6-9		
Bismuth	1-3, 5-8, 10, 13	4, 9, 11	12	photometric (iodide)
Sulfur	4	5	1, 8, 10	combustion (volumetric detection)
			others	combustion (infra-red detection)
Selenium	1, 2, 4, 6, 7, 9-12	3, 5, 8		
Silver	1-4, 6, 8	5, 7, 9		
Tin	1, 2, 5-8, 11, 12	3, 4, 10	9	photometric (phenyl fluorone)
Cobalt	1, 3, 5-7, 10-13	2, 4, 8, 9		
Phosphorus	1, 2, 5, 7, 8, 10	-	3	volumetric (alkalimetric)
			4	ICP-MS
			6, 9, 11	photometric (molybdenum yellow)
Aluminium	2, 6, 7	3, 5	1, 4	photometric (chrome azurol S)
Indium	1, 3-5, 7, 8, 11	2, 6, 9, 10		
Gold	1, 3, 5, 7, 8, 10	2, 6, 9	4	ICP-MS
Tellurium	1-3, 6-8, 10, 11	4, 5	9	ICP-MS
Zirconium	1-4, 6, 7	-	5	ICP-MS

Notes

This Certified Reference Material has been produced and certified in accordance with the requirements of ISO Guide 34-2000, ISO Guide 31-2000 and ISO Guide 35-1989, taking into account the requirements of the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

The above certification is applicable to the whole of the disc. However, in accordance with normal practice for OES, it is appropriate to avoid sampling from the middle of the disc, within a diameter of about 8mm.

This material will remain stable provided adequate precautions are taken to protect it from cross-contamination, extremes of temperature and atmospheric moisture. All production records will be retained for a period of 20 years from the date of original analysis. This certification will therefore expire in June 2029, although we reserve the right to make changes as issue revisions, in the intervening period.

This material is also available in the form of chippings.

The manufacture, analysis and certification of this product were supervised by C Eveleigh, PhD, Technical Director, MBH Analytical Ltd.

The material to which this certificate of analysis refers is supplied subject to our general conditions of sale.