MBH ANALYTICAL LTD

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CERTIFICATE OF ANALYSIS

31X 7835.10 (batch A)

Certified Reference Material Information

Type:	LEADED BRASS (CHILL CAST)
Form and Size:	Disc ~40mm diameter
Manufactured by:	Polycast Ltd
Certified and Supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Sn	Pb	Fe	Ni	Al	Cu	Mn
Value [1]	**0.234**	**1.419**	**0.408**	**0.159**	**0.648**	**62.55**	**0.0318**
Uncertainty [2]	0.004	0.013	0.004	0.002	0.004	0.13	0.0007

Element	Sb	Co	As	P	Si	Bi	Zn
Value [1]	**0.0216**	**0.0203**	**0.0635**	**0.0417**	**0.010**	**0.0202**	**34.36**
Uncertainty [2]	0.0005	0.0006	0.0016	0.0011	0.001	0.0006	0.12

Definitions

[1] The certified 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, detailed on page 3.

[2] The uncertainty values are generated from the 95% confidence interval derived from the wet analysis results, in combination with a statistical assessment of the homogeneity data, as described on page 2.

Certified by:

on 24th May 2016

MBH ANALYTICAL LIMITED _____

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Method of Preparation

This reference material was produced from commercial-purity metals, and master alloys. The discs are the product of one melt poured into a sequence of multiple chill moulds with feeding systems designed to ensure sound discs. At least 2mm has been removed from the chill-cast faces of the discs to minimise surface effects.

Sampling

Milled samples for chemical analysis were taken from several positions within the batch. In addition, at least 15% of all discs were selected for homogeneity checking.

Homogeneity

Samples representative of the batch were checked for uniformity using an optical emission spectrometer. Multiple measurements were taken from each surface under test.

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 - 2005, using documented methods and validated by appropriate reference materials.

The individual values listed overpage are the average of each analyst's 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 on page 3.

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, described above.

The final certified uncertainty for each element has been derived by combining these two factors, using the square-root of the summed squares.

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.

Usage

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

Recommended method of use: Copper alloys are generally prepared by machining on a mill or a 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.

For optical emission spectroscopy, a minimum of five consistent replicate analyses is recommended to provide the necessary sample size. 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	Sn	Pb	Fe	Ni	Al	Cu	Mn
1	0.224	1.393	0.399	0.1550	0.637	62.41	0.0299
2	0.225	1.396	0.402	0.1562	0.639	62.50	0.0299
3	0.225	1.403	0.402	0.1568	0.644	62.51	0.0302
4	0.226	1.405	0.404	0.1570	0.645	62.53	0.0305
5	0.226	1.407	0.405	0.1580	0.645	62.57	0.0306
6	0.228	1.412	0.405	0.1580	0.646	62.59	0.0320
7	0.233	1.420	0.405	0.1599	0.647	62.64	0.0320
8	0.236	1.426	0.405	0.1600	0.651	62.67	0.0322
9	0.236	1.428	0.411	0.1610	0.653		0.0322
10	0.237	1.435	0.411	0.1621	0.653		0.0324
11	0.238	1.437	0.413	0.1624	0.654		0.0325
12	0.238	1.438	0.415	0.1637	0.654		0.0327
13	0.244	1.443	0.416		0.655		0.0330
14	0.246		0.416				0.0331
15	0.246						0.0337
Mean	**0.234**	**1.419**	**0.408**	**0.1592**	**0.648**	**62.55**	**0.0318**
Std Dev	0.008	0.017	0.006	0.0028	0.006	0.08	0.0012
$C_{(95\%)}$	0.004	0.010	0.003	0.0017	0.004	0.07	0.0007

Sample	Sb	Co	As	P	Si	Bi	Zn
1	0.0210	0.0190	0.0598	0.0398	0.0091	0.0187	34.14
2	0.0210	0.0191	0.0599	0.0401	0.0093	0.0195	34.19
3	0.0215	0.0196	0.0599	0.0405	0.0095	0.0198	34.27
4	0.0215	0.0197	0.0603	0.0405	0.0100	0.0202	34.34
5	0.0215	0.0198	0.0604	0.0413	0.0102	0.0202	34.35
6	0.0217	0.0199	0.0632	0.0421	0.0105	0.0204	34.40
7	0.0217	0.0200	0.0633	0.0425	0.0106	0.0204	34.42
8	0.0217	0.0200	0.0635	0.0426	0.0107	0.0205	34.45
9	0.0219	0.0201	0.0643	0.0427	0.0108	0.0206	34.49
10	0.0220	0.0210	0.0643	0.0433	0.0112	0.0206	34.50
11	0.0223	0.0211	0.0644	0.0434		0.0208	
12		0.0213	0.0661			0.0210	
13		0.0216	0.0662				
14		0.0220	0.0665				
15			0.0669				
16			0.0670				
Mean	**0.0216**	**0.0203**	**0.0635**	**0.0417**	**0.0102**	**0.0202**	**34.36**
Std Dev	0.0004	0.0009	0.0027	0.0013	0.0007	0.0006	0.12
$C_{(95\%)}$	0.0003	0.0005	0.0014	0.0009	0.0005	0.0004	0.09

Note: $C_{(95\%)}$ is the 95% half-width confidence interval derived from the 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.

Participating Laboratories

Exova Ltd	Middlesbrough, UK	UKAS accreditation	0239
Sheffield Analytical Services	Sheffield, UK	UKAS accreditation	0012
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation	0492
Genitest Inc.	Montreal, QC, Canada	PRI accreditation	123077
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation	0173
Shanghai JinYi Test Technology Co. Ltd	Shanghai, China	CNAL accreditation	0783
Shandong Metallurgical & Science Research	Jinan, Shandong, China	CNAS accreditation	1461
Bureau Veritas CPS Ltd	Chennai, India	NABL accreditation	0025
TCR Engineering Services PVT. Ltd.	Mumbai, India	NABL accreditation	0367
Raghavendra Spectro Metallurgical Laboratory	Bangalore, India	NABL accreditation	0371
Institute Of Non-ferrous Metals	Gliwice, Poland	PCA accreditation	AB274
TEC Eurolab SRL	Modena, Italy	ACCREDIA accreditation	52
AMG Superalloys UK Ltd	Rotherham, UK		
Analyticka Laborator Lithea sro	Brno, Czech Republic		
Colonial Metal Co	Columbia, PA, USA		
Coleshill Laboratories Ltd	Coleshill, UK		

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	XRF	FAAS	OTHER	
Tin	1, 4, 7, 8, 10-14	9	2, 3, 5	6	photometric (phenyl fluorone)
Lead	1-6, 9, 10, 12	-	7, 8, 13	11	electro-gravimetric
Iron	1, 3, 4, 6, 7, 9, 12-14	11	5, 8, 10	2	photometric (orthophenanthroline)
Nickel	1, 3-5, 7, 9-12	6	2	8	photometric (dimethyl glyoxime)
Aluminium	1-5, 8-13	-	7	6	photometric (chrome azurol s)
Copper	8	-	-	1, 4, 6	volumetric (thiosulfate)
				2, 3, 5, 7	electro-gravimetric
Manganese	1, 2, 4-6, 8, 9, 12-15	-	3, 7, 10, 11		
Antimony	2, 3, 6-11	-	1, 5	4	photometric (crystal violet)
Cobalt	1, 2, 4-6, 9-12, 14	-	3, 7, 8, 13		
Arsenic	1-9, 11, 12, 15, 16	-	10, 14	13	photometric (turbidity)
Phosphorus	1, 4-6, 8, 10	-	-	2, 7, 9	volumetric (alkalimetric)
				3, 11	photometric (molybdenum yellow)
Silicon	1, 3-5, 7, 8	-	-	2, 6, 10	gravimetric (perchloric acid)
				9	photometric (molybdenum blue)
Bismuth	1-3, 5-8, 11, 12	-	4, 10	9	photometric (iodide)
Zinc	1, 3, 5, 6	4	-	2, 7-10	volumetric (EDTA)

Notes

This Certified Reference Material has been produced and certified in accordance with the requirements of ISO Guide 34-2009, ISO Guide 31-2015 and ISO Guide 35-2006, taking into account the requirements of the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

The unidirectional solidification effects associated with this method of chill casting, have led to the formation of inhomogeneous segregates in the rear portion of the disc. The above certification is therefore only applicable from the front face of the disc. Material to the rear of the disc, to a depth of ~3 mm, is not certified.

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 this certificate. Technical support for this certification will therefore expire in May 2036, 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 L Maxim, Technical Director, MBH Analytical Ltd.

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