MBH ANALYTICAL LTD

HOLLAND HOUSE • QUEENS ROAD • BARNET • EN5 4DJ • ENGLAND • TEL: +44 (0)20 8441 2024 • FAX: +44 (0)20 8449 0810
email: info@mbh.co.uk web: www.mbh.co.uk

CERTIFICATE OF ANALYSIS

31X MNB5 (batch Q)

Certified Reference Material Information

Type:	MANGANESE BRASS (CHILL CAST)
Form and Size:	Disc 40mm Diameter x ~17mm Thickness
Manufactured by:	Polycast Ltd
Certified and Supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Mn	Ni	Al	Si
Value [1]	**1.60**	**0.243**	**37.12**	**0.013**	**0.137**	**0.996**	**2.96**	**0.44**
Uncertainty [2]	0.03	0.006	0.12	0.002	0.003	0.011	0.04	0.02

Element	Cr	Co	As	Sb	P	Ag	Cu
Value [1]	**0.19**	**0.0155**	**0.0100**	**0.0118**	**(0.008)**	**0.0063**	**56.18**
Uncertainty [2]	0.01	0.0009	0.0005	0.0014	-	0.0004	0.14

Note: values given in parentheses are not certified - they are provided for information only.

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 13th December 2007

MBH ANALYTICAL LIMITED _____

C Eveleigh

Method of Preparation

This reference material was produced from commercial brass, alloyed by the addition of pure elements 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. Metal was removed from the cast faces of the discs to minimise surface effects.

Homogeneity

The discs were checked for sample and batch uniformity using an optical emission spectrometer.

Using the combined 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.

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, 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.

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 a national authority. It is part of the 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 primary reference materials.

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. A minimum of four 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	Sn	Pb	Zn	Fe	Mn	Ni	Al	Si
1	1.527	0.229	37.00	0.0104	0.129	0.963	2.862	0.416
2	1.56	0.232	37.02	0.0105	0.129	0.970	2.869	0.420
3	1.56	0.238	37.05	0.0120	0.131	0.979	2.925	0.430
4	1.565	0.242	37.10	0.0122	0.131	0.984	2.937	0.433
5	1.582	0.242	37.10	0.0132	0.133	0.986	2.95	0.434
6	1.587	0.243	37.21	0.0132	0.135	0.987	2.952	0.436
7	1.602	0.245	37.22	0.0133	0.135	0.995	2.967	0.448
8	1.623	0.249	37.25	0.0150	0.138	0.999	2.970	0.449
9	1.632	0.249		0.0167	0.139	1.003	2.970	0.460
10	1.637	0.249		0.0173	0.140	1.005	2.981	
11	1.642	0.258			0.142	1.012	2.991	
12	1.656				0.142	1.014	3.050	
13					0.142	1.021	3.060	
14					0.147	1.022		
Mean	**1.598**	**0.243**	**37.12**	**0.0134**	**0.137**	**0.996**	**2.960**	**0.436**
Std Dev	0.040	0.008	0.10	0.0023	0.006	0.018	0.057	0.014
$C_{(95\%)}$	0.026	0.006	0.08	0.0017	0.003	0.011	0.035	0.011

Sample	Cr	Co	As	Sb	P	Ag	Cu
1	0.172	0.0127	0.0092	0.0080	0.0038	0.0051	55.93
2	0.175	0.0131	0.0093	0.0080	0.0046	0.0052	55.98
3	0.188	0.0148	0.0094	0.0096	0.0060	0.0057	56.10
4	0.190	0.0152	0.0094	0.0098	0.0082	0.0059	56.24
5	0.192	0.0153	0.0095	0.0113	0.0083	0.0062	56.25
6	0.199	0.0154	0.0097	0.0115	0.0096	0.0064	56.27
7		0.0154	0.0098	0.0124	0.0129	0.0064	56.27
8		0.0155	0.0101	0.0130		0.0065	56.28
9		0.0158	0.0104	0.0132		0.0067	56.33
10		0.0162	0.0104	0.0136		0.0069	
11		0.0173	0.0105	0.0139		0.0070	
12		0.0176	0.0110	0.0144		0.0071	
13		0.0177	0.0116	0.0150			
Mean	**0.186**	**0.0155**	**0.0100**	**0.0118**	**0.0076**	**0.0063**	**56.18**
Std Dev	0.010	0.0015	0.0007	0.0024	0.0031	0.0007	0.14
$C_{(95\%)}$	0.011	0.0009	0.0004	0.0014	0.0029	0.0004	0.11

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

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 0492
Luo Yang Copper Co Ltd	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 0367
Sargam Metals Pvt Ltd	Chennai, India	NABL accreditation 0025
Laboratory TUV-Nord-Czech	Brno, Czech Republic	CAI accreditation 1060
Institute of Non-Ferrous Metals	Gliwice, Poland	PCA accreditation AB274
De Bruyn Spectroscopic Solutions Ltd	Johannesburg, South Africa	
Coleshill Laboratories Ltd	Coleshill, England	
London & Scandinavian Met Co Ltd	Rotherham, England	
Genitest Inc	Montreal, Canada	
Colonial Metals Co	Columbia, PA, USA	

Note: to achieve National Accreditation (eg UKAS, NATA, CNAL, NABL, CAI, PCA), 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
Tin	1, 3, 4, 6-11	2, 5	12	photometric (phenyl fluorone)
Lead	2, 4-8, 11	1, 3, 9, 10		
Zinc	1, 2, 5, 6	-	3, 4, 8	volumetric (EDTA)
			7	XRF
Iron	1, 2, 5-8	3, 4, 9, 10		
Manganese	2, 4, 5, 7-9, 11-13	1, 3, 6, 10	14	photometric (periodate)
Nickel	1-3, 5, 6, 8, 9, 12-14	4, 7, 10	11	photometric (dimethyl glyoxime)
Aluminium	1-4, 7-11	6, 13	5	volumetric (EDTA-fluoride, zinc acetate)
			12	photometric (chrome azurol-S)
Silicon	1, 2, 4-6, 8, 9	-	3	photometric (molybdenum blue)
			7	gravimetric (perchloric acid)
Chromium	2, 5	1, 3, 4, 6		
Cobalt	3-7, 10-13	1, 2, 8, 9		
Arsenic	1-3, 6, 7, 9, 11-13	5, 8	4	ICP-MS
			10	photometric (turbidity)
Antimony	2-5, 8-11, 13	1, 6, 7, 12		
Phosphorus	2, 4-7	-	1, 3	photometric (molybdenum yellow)
Silver	1-3, 5, 8, 10, 12	4, 6, 7, 9, 11		
Copper	3, 5, 7, 8	-	1, 4, 6	electrogravimetric
			2, 9	volumetric (thiosulfate)

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 unidirectional solidification effects associated with 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 to a depth of ~14mm. Material to the rear of the disc, to a depth of ~3mm, 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. This certification will therefore expire in December 2027, 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.