

CERTIFICATE OF ANALYSIS

31X MNB5 (batch R)

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	Ni	Al	Cr	Co
Value ¹	1.228	0.157	37.11	0.898	1.32	3.24	0.0116	0.066
Uncertainty ²	0.011	0.003	0.13	0.016	0.02	0.05	0.0005	0.002

Element	Mn	Si	As	Sb	P	Ag	Cu
Value ¹	0.175	0.528	0.0021	(0.006)	0.0399	0.0195	55.14
Uncertainty ²	0.005	0.009	0.0003	-	0.0016	0.0010	0.11

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:

MBH ANALYTICAL LIMITED _____

on 5th August 2008

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. Approximately 2mm has been 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	Ni	Al	Cr	Co
1	1.21	0.150	36.91	0.880	1.260	3.122	0.0105	0.0595
2	1.210	0.152	37.03	0.880	1.28	3.152	0.0105	0.0602
3	1.215	0.153	37.04	0.881	1.288	3.16	0.0109	0.0622
4	1.216	0.157	37.13	0.884	1.295	3.18	0.011	0.0654
5	1.22	0.157	37.18	0.888	1.300	3.180	0.0112	0.0654
6	1.230	0.159	37.20	0.892	1.31	3.222	0.0115	0.0656
7	1.232	0.160	37.28	0.902	1.323	3.233	0.0118	0.0672
8	1.239	0.160		0.904	1.331	3.274	0.0119	0.0672
9	1.240	0.161		0.910	1.332	3.300	0.0121	0.0687
10	1.241	0.161		0.923	1.346	3.301	0.0122	0.0697
11	1.260			0.930	1.353	3.316	0.0122	0.0700
12					1.360	3.331	0.0123	0.0706
13					1.367	3.346	0.0123	0.0709
Mean	1.228	0.157	37.11	0.898	1.319	3.240	0.0116	0.0664
Std Dev	0.016	0.004	0.12	0.018	0.033	0.076	0.0007	0.0038
C_(95%)	0.011	0.003	0.12	0.012	0.020	0.046	0.0004	0.0023

Sample	Mn	Si	As	Sb	P	Ag	Cu
1	0.166	0.516	0.0013	0.0030	0.0368	0.0179	55.01
2	0.169	0.521	0.0014	0.0030	0.0375	0.0180	55.07
3	0.169	0.525	0.0015	0.0035	0.0375	0.0185	55.10
4	0.170	0.533	0.0020	0.0040	0.0377	0.0188	55.11
5	0.173	0.536	0.0022	0.0041	0.0378	0.0188	55.16
6	0.173	0.538	0.0022	0.0044	0.0386	0.0192	55.20
7	0.173		0.0023	0.0070	0.0403	0.0196	55.33
8	0.178		0.0023	0.0076	0.0415	0.0203	
9	0.187		0.0023	0.0092	0.0421	0.0211	
10	0.188		0.0024	0.0098	0.0422	0.0223	
11			0.0030	0.0099	0.0430		
12					0.0435		
Mean	0.175	0.528	0.0021	0.0060	0.0399	0.0195	55.14
Std Dev	0.008	0.009	0.0005	0.0028	0.0025	0.0014	0.10
C_(95%)	0.005	0.009	0.0003	0.0019	0.0016	0.0010	0.10

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
Sheffield Assay Office
Genitest, Inc
Universal Scientific Laboratory Pty Ltd
Institute of Iron & Steel Technology
Luo Yang Copper
Laboratory TUV-Nord Czech
Sargam Metals Pvt Ltd
TCR Engineering Services Ltd
Raghavendra Spectromet Laboratory
Colonial Metals Co
De Bruyn Spectroscopic Solutions Ltd
Rotech Laboratories Ltd

Middlesbrough, England
Sheffield, England
Montreal, Canada
Milperra, NSW, Australia
Shanghai, China
Luo Yang, He Nan, China
Brno, Czech Republic
Chennai, India
Mumbai, India
Bangalore, India
Columbia, PA, USA
Johannesburg, South Africa
Wednesbury, England

UKAS accreditation 0239
UKAS accreditation 0012
PRI accreditation 123077
NATA accreditation 492
CNAL accreditation 0783
CNAL accreditation 0173
CAI accreditation 1060
NABL accreditation 0025
NABL accreditation 0367
NABL accreditation 0371

Note: to achieve the above accreditations (eg UKAS, PRI, NATA, CNAL, 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
Tin	1, 3, 4, 6, 7, 11	2, 5, 9	8, 10	volumetric (iodide)
Lead	2, 4, 5, 7-10	1, 3, 6		
Zinc	1, 2, 6	-	4, 5, 7	volumetric (EDTA)
Iron	1-4, 6-8, 10	5, 11	3	XRF
Nickel	1, 2, 4, 7-10, 13	5, 6	9	photometric (orthophenanthroline)
			3	XRF
			11	volumetric (EDTA, dimethyl glyoxime)
			12	photometric (dimethyl glyoxime)
Aluminium	4-10, 13	1, 2	3	volumetric (EDTA-fluoride, zinc acetate)
			11, 12	photometric (chrome azurol-S)
Chromium	1-6, 9, 11, 13	7, 8, 10, 12		
Cobalt	2-5, 8, 10-13	1, 6, 7, 9		
Manganese	1, 3, 5-7, 9	2, 8, 10	4	XRF
Silicon	5	-	1, 4, 6	photometric (molybdenum blue)
			2, 3	gravimetric (perchloric acid)
Arsenic	1, 3, 5-11	2	4	ICP-MS
Antimony	1, 2, 5, 7, 8, 10, 11	3, 4, 6	9	ICP-MS
Phosphorus	3, 4, 6-8, 10, 12	-	1, 2, 5	photometric (molybdenum yellow)
			9, 11	volumetric (alkalimetric)
Silver	1-3, 6, 8, 10	4, 5, 7, 9		
Copper	6	-	1, 3, 5	electrogravimetric
			2, 4, 7	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 August 2028, 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.