

CERTIFICATE OF ANALYSIS

31X MNB11 (batch A)

Certified Reference Material Information

Type: MANGANESE BRASS (CHILL CAST)
Form and Size: Disc 42mm Diameter x 18mm Thickness
Manufactured by: Polycast Limited
Certified and Supplied by: MBH Analytical Limited

Certified Analysis

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Mn	Ni	Al	Si	Cr
Value ¹	0.161	1.610	22.85	0.337	11.99	4.46	1.19	0.071	0.0046
Uncertainty ²	0.006	0.015	0.15	0.006	0.07	0.04	0.02	0.003	0.0004

Element	Co	As	Bi	Sb	Cd	P	S	C	Cu
Value ¹	0.0046	0.0010	0.0021	0.0051	0.0009	0.0186	(0.0007)	(0.009)	57.36
Uncertainty ²	0.0002	0.0002	0.0004	0.0005	0.0001	0.0015	-	-	0.13

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 _____

C Eveleigh

on 27th November 2006



Method of Preparation

This reference material was produced from commercial alloy, UNS C99700-type. 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. For each of the surfaces checked, the differences between the averaged result and the overall mean value were evaluated to ensure that the homogeneity of the material comprising the batch satisfied the definition given in ISO guide 30 - 1992.

Using the combined data for 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

Most 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	Cr
1	0.149	1.586	22.67	0.324	11.81	4.351	1.139	0.0650	0.0035
2	0.150	1.587	22.76	0.326	11.92	4.432	1.142	0.0668	0.0036
3	0.150	1.590	22.79	0.333	11.95	4.446	1.168	0.0693	0.0040
4	0.155	1.590	22.80	0.334	11.95	4.449	1.175	0.0703	0.0045
5	0.163	1.595	22.82	0.336	11.96	4.45	1.180	0.0716	0.0046
6	0.165	1.605	22.85	0.339	11.98	4.452	1.182	0.0719	0.0047
7	0.165	1.608	23.01	0.340	12.00	4.463	1.192	0.0721	0.0050
8	0.168	1.620	23.06	0.343	12.03	4.500	1.200	0.074	0.0050
9	0.168	1.622		0.345	12.09	4.510	1.201	0.0762	0.0051
10	0.169	1.630		0.349	12.10	4.52	1.202		0.0052
11	0.171	1.636			12.12	4.530	1.220		0.0054
12		1.647					1.224		
Mean	0.161	1.610	22.85	0.337	11.99	4.464	1.185	0.0708	0.0046
Std Dev	0.008	0.021	0.13	0.008	0.09	0.051	0.027	0.0034	0.0006
C_(95%)	0.006	0.013	0.11	0.006	0.06	0.034	0.017	0.0027	0.0004

Sample	Co	As	Bi	Sb	Cd	P	S	C	Cu
1	0.0044	0.0006	0.0014	0.0042	0.0007	0.0151	0.0003	0.0072	57.19
2	0.0044	0.0008	0.0016	0.0044	0.0008	0.0163	0.0005	0.0078	57.23
3	0.0044	0.0009	0.0017	0.0045	0.0008	0.0168	0.0005	0.0080	57.28
4	0.0045	0.0009	0.0020	0.0045	0.0008	0.0175	0.0008	0.0098	57.34
5	0.0046	0.0010	0.0020	0.0048	0.0009	0.0188	0.0009	0.0101	57.34
6	0.0048	0.0010	0.0020	0.0054	0.0010	0.0197	0.0012		57.38
7	0.0048	0.0012	0.0025	0.0054	0.0010	0.0199			57.41
8		0.0014	0.0028	0.0056	0.0010	0.0201			57.49
9		0.0014	0.0028	0.0058	0.0011	0.0201			57.54
10				0.0059	0.0011	0.0215			
11					0.0011				
Mean	0.0046	0.0010	0.0021	0.0051	0.0009	0.0186	(0.0007)	(0.009)	57.36
Std Dev	0.0002	0.0003	0.0005	0.0006	0.0001	0.0021	-	-	0.11
C_(95%)	0.0002	0.0002	0.0004	0.0005	0.0001	0.0015	-	-	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

Bodycote Materials Testing	Middlesbrough, England	UKAS accreditation 0239
Laboratory Testing Inc	Hatfield, PA, USA	A2LA accreditation 0117
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 492
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 0367
Sargam Metals Pvt Ltd	Chennai, India	NABL accreditation 0025
TUV-Nord Laboratory	Brno, Czech Republic	CAI accreditation 1060
De Bruyn Spectroscopic Solutions Ltd	Johannesburg, South Africa	
Coleshill Laboratories Ltd	Coleshill, England	
Genitest Inc	Montreal, Canada	
Colonial Metals Co	Columbia, PA, USA	

Note: to achieve National Accreditation (eg UKAS, A2LA, NATA, CNAL, NABL, CAI), test houses must demonstrate conformity to the general requirements of EN ISO/IEC 17025.

Analytical Methods Used

ELEMENT	RESULT No. & METHOD			
	ICP-AES	ICP-MS	FAAS	OTHER
Tin	1, 3, 5, 7, 9-11	-	6, 8	2 photometric (phenyl fluorone) 4 volumetric (iodide)
Lead	1, 5-9, 12	-	2, 3, 4	10, 11 volumetric (dichromate)
Zinc	1, 5, 8	-	-	2-4, 6, 7 volumetric (EDTA)
Iron	1, 2, 4-9	-	3	10 photometric (orthophenanthroline)
Manganese	1, 4, 8, 10, 11	-	-	2, 5-7 volumetric (FAS, arsenite) 3, 9 photometric (periodate)
Nickel	2-4, 6, 8-11	-	1	5, 7 gravimetric (dimethyl glyoxime)
Aluminium	1, 2, 4, 7, 11, 12	-	3, 5, 8, 9	6, 10 volumetric (EDTA-fluoride, zinc acetate)
Silicon	1, 2, 6	-	-	3-5, 8 photometric (molybdenum blue) 7, 9 gravimetric (perchloric acid)
Chromium	2-4, 7-11	1	5, 6	
Cobalt	2, 3, 5-7	-	1, 4	
Arsenic	1, 3-7, 9	2	8	
Bismuth	1, 2, 6, 8, 9	3	4, 7	5 volumetric (iodide)
Antimony	2, 3, 6-10	1	4, 5	
Cadmium	1-3, 6-8, 10, 11	5	4, 9	
Phosphorus	2-5	-	-	1, 9 volumetric (alkalimetric) 6-8, 10 photometric (molybdenum yellow)
Sulfur	5	-	-	1, 2 combustion (volumetric detection) 3, 4, 6 combustion (infra-red detection)
Carbon	-	-	-	all combustion (infra-red detection)
Copper	1, 9	-	-	3, 4, 7, 8 electrogravimetric 2, 5, 6 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 ASTM E1724 and 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 12mm. Material to the rear of the disc, to a depth of ~6mm, 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 November 2026, 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.