

CERTIFICATE OF ANALYSIS

32X CA23 (batch A)

Certified Reference Material Information

Type: ALUMINIUM BRONZE (WROUGHT)
Form and Size: Disc 50mm Diameter x 18mm Thickness
Manufactured by: Cerro Manganese Bronze Limited
Certified and Supplied by: MBH Analytical Limited

Certified Analysis

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Ni	Al	Si	Mn
Value ¹	0.0164	(0.0026)	0.031	3.63	4.71	9.19	0.026	1.298
Uncertainty ²	0.0005	-	0.002	0.03	0.04	0.07	0.003	0.014

Element	Mg	P	Cr	Co	Ag	C	Cu
Value ¹	0.0003	0.0011	0.0018	(0.0036)	0.0008	(0.0050)	81.05
Uncertainty ²	0.0001	0.0003	0.0002	-	0.0002	-	0.12

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 29th April 2006

C Eveleigh



Method of Preparation

This reference material was produced from commercial bar, continuous cast, hot extruded, cold drawn and stress-relieved. The discs are derived from a single piece of bar, from one batch.

Sampling

Samples for chemical analysis, and discs for homogeneity checks, were taken at regular intervals from the bar. Approximately 20% of all discs were incorporated into the schedule for homogeneity checking.

Homogeneity

The discs were checked for lateral and batch 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 certified portion 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 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	Zn	Fe	Ni	Al	Si	Mn
1	0.0150	0.0015	0.0285	3.584	4.622	9.073	0.0212	1.273
2	0.0158	0.0016	0.0286	3.59	4.630	9.10	0.0225	1.284
3	0.0158	0.0022	0.0303	3.605	4.682	9.105	0.0228	1.284
4	0.0161	0.0022	0.0314	3.606	4.688	9.116	0.0231	1.287
5	0.0162	0.0032	0.0315	3.617	4.705	9.171	0.0260	1.297
6	0.0165	0.0036	0.0321	3.625	4.729	9.18	0.0271	1.298
7	0.0168	0.0040	0.0332	3.635	4.730	9.219	0.0286	1.305
8	0.0168		0.0350	3.642	4.74	9.231	0.0288	1.306
9	0.0173			3.650	4.76	9.312	0.0290	1.32
10	0.0175			3.676	4.763	9.350	0.0324	1.324
11				3.693	4.770			
Mean	0.0164	0.0026	0.0313	3.629	4.711	9.186	0.0262	1.298
Std Dev	0.0008	0.0010	0.0022	0.034	0.051	0.093	0.0036	0.016
C_(95%)	0.0005	0.0009	0.0018	0.023	0.034	0.066	0.0026	0.012

Sample	Mg	P	Cr	Co	Ag	C	Cu
1	0.00020	0.0007	0.0013	0.0026	0.0007	0.0029	80.90
2	0.0002	0.0008	0.0016	0.0029	0.0007	0.0037	80.98
3	0.00029	0.001	0.0016	0.0030	0.00076	0.0040	80.99
4	0.0003	0.0012	0.0019	0.0032	0.0008	0.0056	81.07
5	0.0004	0.0013	0.0020	0.0040	0.0010	0.0057	81.10
6	0.0004	0.0014	0.0020	0.0044		0.0063	81.13
7	0.00048		0.0020	0.0053		0.0069	81.20
8			0.0020				
9			0.0022				
Mean	0.00032	0.0011	0.0018	0.0036	0.0008	0.0050	81.05
Std Dev	0.00011	0.0003	0.0003	0.0010	0.0001	0.0015	0.10
C_(95%)	0.00010	0.0003	0.0002	0.0009	0.0002	0.0014	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

Sheffield Assay Office	Sheffield, England	UKAS accreditation 0012
Bodycote Materials Testing Ltd	Middlesbrough, England	UKAS accreditation 0639
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 0492
Institute of Iron & Steel Technology	Shanghai, China	CNAL accreditation 0783
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation 0173
RWTUV Laboratory	Brno, Czech Republic	CAI accreditation 1060
Sargam Metals Pvt Ltd	Chennai, India	NABL accreditation 0025
TCR Engineering Services Pvt Ltd	Mumbai, India	NABL accreditation 0367
Westmoreland Mech Testing & Research	Youngstown, PA, USA	
Genitest Inc	Montreal, Canada	
Coleshill Laboratories Ltd	Coleshill, England	

Note: to achieve National Accreditation (eg UKAS, NATA, CNAL, CAI, NABL), 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	4, 6-10	1, 5	2 ICP-MS 3 photometric (phenyl fluorone)
Lead	1, 2, 4, 6	3, 5, 7	
Zinc	3, 4, 5, 6	1, 2, 7, 8	
Iron	2, 3, 5, 7, 8, 10, 11	6, 9	1 photometric (orthophenanthroline) 4 volumetric (dichromate)
Nickel	2, 5, 6, 9-11	7, 8	1, 4 photometric (dimethyl glyoxime) 3 gravimetric (dimethyl glyoxime)
Aluminium	1-5, 7, 8	10	6 volumetric (EDTA) 9 photometric (chrome azurol-S)
Silicon	1, 3-5, 7, 8	-	6, 9 photometric (molybdenum blue) 2, 10 gravimetric (perchloric acid)
Manganese	2-5, 8, 9	1, 10	6 volumetric (ferrous ammonium sulfate) 7 photometric (periodate)
Magnesium	2, 3, 5, 6	1, 7	4 ICP-MS
Phosphorus	1, 3, 6	-	2 volumetric (alkalimetric) 4, 5 photometric (molybdenum blue)
Chromium	1, 3, 5, 7-9	2, 4, 6	
Cobalt	2, 3, 6, 7	1, 4, 5	
Silver	2, 3, 5	1, 4	
Carbon	-	-	all combustion (infra-red detection)
Copper	3, 6, 7	-	1, 4, 5 electrogravimetric 2 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).

This product has been found to be of satisfactory homogeneity across the full diameter, although in accordance with normal practice for OES use, it is appropriate to avoid using the central portion of ~12mm diameter.

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 April 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.