

CERTIFICATE OF ANALYSIS

31X TB5 (batch B)

Certified Reference Material Information

Type: TRACE ELEMENTS IN 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	Zn	Fe	Ni	Al	Mn	Si	P
Value ¹	0.129	0.575	35.62	0.094	0.106	0.0711	0.283	0.111	0.0255
Uncertainty ²	0.002	0.008	0.12	0.002	0.002	0.0016	0.005	0.002	0.0003

Element	As	Bi	Sb	Cr	Co	Cd	Ag	Cu
Value ¹	0.396	0.292	0.229	0.0031	0.0202	0.49	0.216	61.49
Uncertainty ²	0.007	0.008	0.005	0.0002	0.0006	0.01	0.003	0.07

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 6th July 2018

C Eveleigh

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 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.

Sampling

Samples for chemical analysis were taken from various positions throughout the batch. At least 15% of all discs were selected for non-destructive homogeneity testing.

Homogeneity

Samples representative of the batch were checked for uniformity using an optical emission spectrometer.

For all accepted material, through-batch variation values were derived for each element as an indicator of any minor compositional variation (as determined for the specific sample size and other limitations of 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 operating within the terms of EN ISO/IEC 17025, 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 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.

Of the individual results herein, some have traceability (to the mole) via primary analytical methods. Some are traceable to substances of known stoichiometry. Most have traceability via commercial solutions. Furthermore, some results have additional 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.

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	Mn	Si	P
1	0.1250	0.5606	35.40	0.0898	0.1002	0.0675	0.2690	0.1060	0.0251
2	0.1258	0.5622	35.40	0.0899	0.1012	0.0687	0.2692	0.1068	0.0251
3	0.1259	0.5650	35.51	0.0901	0.1040	0.0696	0.2701	0.1095	0.0253
4	0.1270	0.5660	35.52	0.0919	0.1041	0.0697	0.2738	0.1100	0.0253
5	0.1280	0.5703	35.55	0.0924	0.1045	0.0698	0.2756	0.1101	0.0254
6	0.1280	0.5716	35.64	0.0927	0.1050	0.0701	0.2764	0.1106	0.0255
7	0.1284	0.5720	35.66	0.0932	0.1050	0.0708	0.2790	0.1111	0.0255
8	0.1300	0.5742	35.74	0.0937	0.1060	0.0710	0.2821	0.1120	0.0258
9	0.1310	0.5755	35.78	0.0949	0.1073	0.0715	0.2828	0.1129	0.0260
10	0.1330	0.5761	35.80	0.0960	0.1073	0.0727	0.2865	0.1130	0.0261
11	0.1334	0.5790	35.86	0.0966	0.1083	0.0728	0.2890	0.1170	
12	0.1353	0.5830		0.0971	0.1099	0.0733	0.2900		
13		0.5834		0.0986	0.1100	0.0737	0.2908		
14		0.5853			0.1110	0.0748	0.2920		
15		0.5870					0.2930		
16		0.5880					0.3020		
Mean	0.1292	0.5750	35.62	0.0936	0.1060	0.0711	0.2826	0.1108	0.0255
Std Dev	0.0034	0.0088	0.16	0.0029	0.0032	0.0021	0.0098	0.0030	0.0004
C_(95%)	0.0021	0.0047	0.11	0.0017	0.0018	0.0012	0.0052	0.0020	0.0003

Sample	As	Bi	Sb	Cr	Co	Cd	Ag	Cu
1	0.3753	0.2800	0.2148	0.0026	0.0189	0.4708	0.2110	61.39
2	0.3810	0.2860	0.2187	0.0027	0.0194	0.4720	0.2110	61.42
3	0.3820	0.2860	0.2232	0.0027	0.0195	0.4756	0.2118	61.43
4	0.3860	0.2876	0.2260	0.0028	0.0198	0.4759	0.2140	61.43
5	0.3919	0.2884	0.2280	0.0029	0.0199	0.4780	0.2160	61.44
6	0.3956	0.2919	0.2284	0.0030	0.0199	0.4970	0.2163	61.47
7	0.3973	0.2923	0.2286	0.0031	0.0201	0.5000	0.2186	61.49
8	0.4010	0.2970	0.2310	0.0032	0.0201	0.5049	0.2190	61.55
9	0.4020	0.2980	0.2330	0.0032	0.0203	0.5050	0.2210	61.63
10	0.4045	0.2984	0.2342	0.0033	0.0203	0.5080	0.2253	61.64
11	0.4056	0.3080	0.2370	0.0034	0.0206			
12	0.4082		0.2373	0.0034	0.0206			
13	0.4133		0.2410	0.0036	0.0213			
14					0.0214			
Mean	0.3957	0.2921	0.2293	0.0031	0.0202	0.4887	0.2164	61.49
Std Dev	0.0117	0.0078	0.0075	0.0003	0.0007	0.0154	0.0047	0.09
C_(95%)	0.0071	0.0052	0.0045	0.0002	0.0004	0.0110	0.0033	0.06

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
Sheffield Assay Office
Anchorcert Analyticaql
Universal Scientific Laboratory Pty Ltd
Shanghai Jinyi Test Technology Co
Luo Yang Copper
Shandong Metallurgical & Science Research
Raghavendra Spectromet Laboratory
TCR Engineering Services Pvt Ltd
Institute of Non-Ferrous Metals
TEC-Eurolab SRL
INCDMNR-IMNR
Mineral & Metallurgical Laboratories
AMG Superalloys UK Ltd
Analyticka Laborator Lithea sro

Middlesbrough, England
Sheffield, England
Birmingham, England
Milperra, NSW, Australia
Shanghai, China
Luo Yang, He Nan, China
Jinan, Shandong, China
Bangalore, India
Mumbai, India
Gliwice, Poland
Modena, Italy
Pantelimon, Romania
Bangalore, India
Rotherham, England
Brno, Czech Republic

UKAS accreditation 0239
UKAS accreditation 0012
UKAS accreditation 0667
NATA accreditation 0492
CNAL accreditation 0783
CNAL accreditation 0173
CNAS accreditation 1461
NABL accreditation 0371
NABL Accreditation 0367
PCA accreditation AB274
Accredia accreditation 52

Note: to achieve the above accreditation (UKAS, 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	1-5, 7, 9-11	12	6	volumetric (iodine)
			8	photometric (phenyl fluorone)
Lead	1-3, 6, 8-10, 12-15	4, 5, 7, 11	16	gravimetric (sulfate)
Zinc	5, 6, 8, 11	-	1-4, 7, 9, 10	volumetric (EDTA)
Iron	1, 3, 5-11, 13	12	2	volumetric (redox)
			4	photometric (orthophenanthroline)
Nickel	2-4, 6-12	1, 5, 13	14	photometric (dimethyl glyoxime)
Aluminium	1-4, 6, 8, 10, 11, 13, 14	5, 12	7	photometric (chrome azurol)
			9	volumetric (EDTA)
Manganese	1, 4-6, 8-10, 12, 13, 15, 16	2, 3, 11, 14	7	volumetric (arsenite)
Silicon	2, 3, 6-8, 10	-	1, 4, 5	photometric (molybdenum yellow)
			9, 11	gravimetric (perchloric acid)
Phosphorus	1-5, 7	-	6	volumetric (alkalimetric)
			8-10	photometric (molybdenum blue)
Arsenic	1, 2, 5-13	3	4	photometric (turbidity)
Bismuth	3-10	1, 8	2	photometric (iodide)
			11	gravimetric
Antimony	1-3, 5-7, 10-13	4	8	photometric (crystal violet)
			9	volumetric (permanganate)
Chromium	2-8, 11-13	1, 9, 10		
Cobalt	1, 4-6, 8-10, 12-14	2, 3, 7	11	gravimetric
Cadmium	1-4, 6, 8, 9	7, 10	5	gravimetric
Silver	2, 3, 5-7, 10	1, 4, 8, 9		
Copper	4, 6	-	1-3, 7	volumetric (thiosulfate)
			5, 8-10	electrogravimetric

Notes

This Certified Reference Material has been produced and certified in accordance with the requirements of ISO Guide 34, ISO Guide 31 and ISO Guide 35, 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 ~5 mm, is not certified.

This material will remain stable indefinitely, 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 July 2038, 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, for the calibration or control of methods involving dissolution.

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.