

# CERTIFICATE OF ANALYSIS

## 32X ALB9 (batch B)

### Certified Reference Material Information

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

### Assigned Values

#### Percentage element by weight

Element	Sn	Pb	Zn	Fe	Ni	Al	Si	As
Value <sup>1</sup>	0.061	0.377	1.17	3.13	1.21	13.86	0.282	0.0275
Uncertainty <sup>2</sup>	0.002	0.006	0.03	0.05	0.02	0.09	0.007	0.0012

Element	P	Mn	Co	Cr	Mg	Ag	C	Cu
Value <sup>1</sup>	(0.054)	0.090	0.0259	(0.064)	0.205	0.042	(0.006)	79.24
Uncertainty <sup>2</sup>	-	0.002	0.0008	-	0.006	0.003	-	0.06

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

### Definitions

- <sup>1</sup> 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.
- <sup>2</sup> 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 24th August 2007



## **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 a sequence of multiple chill moulds with feeding systems designed to ensure sound discs. At least 2mm has been removed from the chill-cast face of the discs, to minimise surface effects.

## **Sampling**

Samples for chemical analysis were taken from various positions throughout the casting process. Over 15% of all discs were selected for non-destructive homogeneity testing.

## **Homogeneity**

The discs were checked for sample and batch uniformity using an optical emission spectrometer. One additional disc was checked for vertical uniformity using the same method.

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 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, described 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	As
1	0.0567	0.366	1.104	3.012	1.165	13.71	0.264	0.0252
2	0.0572	0.366	1.110	3.050	1.171	13.72	0.275	0.0256
3	0.0575	0.370	1.117	3.105	1.195	13.78	0.279	0.0260
4	0.0576	0.371	1.127	3.105	1.196	13.83	0.282	0.0265
5	0.0588	0.376	1.14	3.107	1.20	13.85	0.285	0.0272
6	0.0595	0.377	1.143	3.11	1.204	13.87	0.288	0.0275
7	0.0623	0.377	1.175	3.123	1.210	13.88	0.288	0.0279
8	0.0626	0.379	1.195	3.192	1.213	13.94	0.290	0.0289
9	0.0632	0.387	1.20	3.200	1.223	13.98	0.290	0.0291
10	0.0650	0.389	1.213	3.217	1.25	13.99		0.0307
11	0.0653	0.394	1.231	3.228	1.261			
12			1.235					
<b>Mean</b>	<b>0.0605</b>	<b>0.377</b>	<b>1.166</b>	<b>3.132</b>	<b>1.208</b>	<b>13.86</b>	<b>0.282</b>	<b>0.0275</b>
<b>Std Dev</b>	0.0032	0.009	0.048	0.070	0.029	0.10	0.009	0.0017
<b>C<sub>(95%)</sub></b>	0.0022	0.006	0.031	0.050	0.020	0.07	0.007	0.0012

Sample	P	Mn	Co	Cr	Mg	Ag	C	Cu
1	0.0462	0.0853	0.0235	0.0585	0.195	0.0372	0.0040	79.16
2	0.0466	0.0860	0.0243	0.0590	0.199	0.0382	0.0050	79.21
3	0.051	0.088	0.0249	0.0596	0.204	0.0387	0.006	79.22
4	0.0520	0.0897	0.0250	0.0605	0.204	0.0395	0.0065	79.22
5	0.0525	0.0902	0.0255	0.0607	0.208	0.0403	0.0074	79.23
6	0.0550	0.0903	0.0257	0.0676	0.208	0.0420	0.0096	79.24
7	0.0553	0.0916	0.0260	0.0711	0.209	0.0430		79.26
8	0.0614	0.0924	0.0262	0.0758	0.216	0.0454		79.31
9	0.0665	0.0926	0.0265			0.0457		79.34
10		0.0932	0.0266			0.0469		
11			0.0268					
12			0.0275					
13			0.0280					
<b>Mean</b>	<b>0.054</b>	<b>0.0899</b>	<b>0.0259</b>	<b>0.064</b>	<b>0.205</b>	<b>0.0417</b>	<b>(0.006)</b>	<b>79.24</b>
<b>Std Dev</b>	0.007	0.0027	0.0013	0.007	0.006	0.0034	-	0.05
<b>C<sub>(95%)</sub></b>	0.005	0.0020	0.0008	0.005	0.005	0.0025	-	0.04

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  
Universal Scientific Laboratory Pty Ltd  
Institute of Iron & Steel Technology  
Luo Yang Copper Co  
TCR Engineering Services Ltd  
Sargam Metals Pvt Ltd  
TUV-Nord Laboratory  
Institute of Non-Ferrous Metals  
Colonial Metals Co  
De Bruyn Spectroscopic Solutions Ltd  
Coleshill Laboratories Ltd  
Genitest, Inc

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

UKAS accreditation 0239  
UKAS accreditation 0012  
NATA accreditation 0492  
CNAL accreditation 0783  
CNAL accreditation 0173  
NABL accreditation 0367  
NABL accreditation 0025  
CAI accreditation 1060  
PCA accreditation AB274

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, 2, 4, 6, 7, 9-11	3, 5, 8	
Lead	1-5, 9-11	6, 7, 8	
Zinc	3, 4, 6-11	1, 2, 5	12 volumetric (EDTA)
Iron	1, 2, 4, 5, 7, 10, 11	3, 6	8 photometric (orthophenanthroline)
			9 volumetric (dichromate)
Nickel	2-4, 6, 8, 10, 11	5, 9	1 photometric (dimethyl glyoxime)
			7 volumetric (dimethyl glyoxime)
Aluminium	1, 5, 6, 8-10	2, 4	3 photometric (chrome azurol S)
			7 volumetric (EDTA)
Silicon	1, 6, 8, 9	-	2, 3, 4 gravimetric (perchloric acid)
			5, 7 photometric (molybdenum blue)
Arsenic	1-3, 6, 7, 9, 10	4, 8	5 ICP-MS
Phosphorus	1, 2, 4, 6-9	-	3 photometric (molybdenum yellow)
			5 volumetric (alkalimetric)
Manganese	1, 4-10	2, 3	
Cobalt	1, 4-6, 8-13	2, 3, 7-9	
Chromium	2-7	1, 8	
Magnesium	4-8	1, 2, 3	
Silver	1, 3-5, 8, 9	2, 6, 7, 10	
Carbon	-	-	all combustion (infra-red detection)
Copper	1, 8	-	2, 5, 6 electrogravimetric
			3, 4, 7, 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 semi-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 15mm. 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 2027, although we reserve the right to make changes as issue revisions, in the intervening period.

This sample 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.