

CERTIFICATE OF ANALYSIS

31X CZ132 (batch A)

Certified Reference Material Information

Type: LEADED BRASS (WROUGHT)
Form and Size: Disc 40mm diameter
Manufactured by: DIEHL Metall, Germany
Certified and Supplied by: MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Mn	Ni	Si	Al
Value ¹	0.160	2.05	39.90	0.165	0.0007	0.0510	(0.004)	0.0007
Uncertainty ²	0.004	0.02	0.14	0.004	0.0001	0.0012	-	0.0002

Element	Co	Sb	As	Ag	Cd	S	Cu
Value ¹	0.0009	0.0054	0.0119	0.0050	0.0012	0.0008	57.63
Uncertainty ²	0.0001	0.0007	0.0006	0.0004	0.0001	0.0002	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 _____

on 7th January 2019

C Eveleigh

Method of Preparation

This reference material was produced from commercial wrought barstock to BS12165 CZ132, with nominal composition approximating to UNS C38000. The detailed metallurgical history of this material is unknown.

Sampling

Samples for chemical analysis were taken from various positions throughout the bar. Approximately 10% 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 mostly 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. Note this sample is liable to the effects of Pb smearing, and care needs to be taken during the preparation of the surface, to minimise this effect.

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	Mn	Ni	Si	Al
1	0.1500	2.008	39.68	0.1585	0.0005	0.0479	0.0030	0.0003
2	0.1562	2.018	39.71	0.1600	0.0006	0.0485	0.0032	0.0004
3	0.1565	2.022	39.77	0.1609	0.0006	0.0488	0.0041	0.0005
4	0.1584	2.026	39.83	0.1610	0.0006	0.0492	0.0043	0.0006
5	0.1590	2.033	39.86	0.1610	0.0007	0.0498	0.0045	0.0006
6	0.1590	2.044	39.94	0.1615	0.0007	0.0501	0.0052	0.0007
7	0.1592	2.044	39.99	0.1623	0.0008	0.0502	0.0054	0.0009
8	0.1601	2.050	40.00	0.1638	0.0008	0.0510	0.0057	0.0009
9	0.1614	2.062	40.11	0.1660	0.0008	0.0511		0.0010
10	0.1660	2.071	40.12	0.1690	0.0008	0.0513		0.0010
11	0.1668	2.076		0.1695	0.0008	0.0516		0.0012
12	0.1683	2.097		0.1723	0.0009	0.0531		
13		2.105		0.1732		0.0539		
14		2.109		0.1748		0.0540		
15						0.0547		
Mean	0.1601	2.054	39.90	0.1653	0.0007	0.0510	(0.0044)	0.0007
Std Dev	0.0051	0.033	0.16	0.0055	0.0001	0.0021	-	0.0003
C_(95%)	0.0032	0.019	0.11	0.0032	0.0001	0.0012	-	0.0002

Sample	Co	Sb	As	Ag	Cd	S	Cu
1	0.0005	0.0036	0.0100	0.0038	0.0010	0.00049	57.41
2	0.0006	0.0041	0.0104	0.0042	0.0011	0.00050	57.47
3	0.0007	0.0043	0.0108	0.0043	0.0011	0.00080	57.50
4	0.0007	0.0047	0.0117	0.0046	0.0011	0.00083	57.65
5	0.0008	0.0048	0.0118	0.0048	0.0011	0.00088	57.66
6	0.0008	0.0050	0.0119	0.0048	0.0012	0.00090	57.70
7	0.0008	0.0053	0.0122	0.0052	0.0012	0.00092	57.75
8	0.0009	0.0063	0.0122	0.0052	0.0012	0.00107	57.88
9	0.0010	0.0063	0.0125	0.0053	0.0012		
10	0.0010	0.0064	0.0125	0.0055	0.0013		
11	0.0011	0.0067	0.0131	0.0056	0.0013		
12	0.0012	0.0071	0.0133	0.0060	0.0013		
13	0.0013			0.0062	0.0013		
14	0.0013				0.0015		
Mean	0.0009	0.0054	0.0119	0.0050	0.0012	0.00080	57.63
Std Dev	0.0003	0.0011	0.0010	0.0007	0.0001	0.00020	0.16
C_(95%)	0.0001	0.0007	0.0006	0.0004	0.0001	0.00017	0.13

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 Analytical Services Ltd
Anchorcert Analytical
Universal Scientific Laboratory Pty Ltd
Shanghai Jinyi Test Technology Co
Luo Yang Copper
Genitest, Inc
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
Montreal, Canada
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
PJ accreditation 95510
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	2, 4-7, 9, 11, 12	1, 3	8 10 photometric (phenyl fluorone) volumetric (iodate)
Lead	1-5, 8-10, 12, 13	7, 11, 14	6 gravimetric (sulfate)
Zinc	1, 2, 6	8	3-5, 7, 9, 10 volumetric (EDTA)
Iron	1-3, 5-8, 12-14	4, 11	9 10 volumetric (redox) photometric (orthophenanthroline)
Manganese	2-6, 9-12	1, 7, 8	
Nickel	1, 2, 4-7, 9-11, 13, 15	8, 12, 14	3 photometric (dimethyl glyoxime)
Silicon	1, 2, 4, 8	-	3, 5-7 photometric (molybdenum yellow)
Aluminium	1-5, 7-9, 11	6, 10	
Cobalt	1-4, 6-10, 12, 13	5, 11, 14	
Antimony	2, 3, 6-12	1, 4, 5	
Arsenic	1-8, 10, 11	9	12 photometric (turbidity)
Silver	1-3, 6, 7, 9-11, 13	4, 5, 8	12 gravimetric (chloride)
Cadmium	1-5, 8, 9, 11-13	6, 7, 10, 14	
Sulfur	4-6, 8	-	
Copper	1, 7, 8	-	2, 4, 6 3, 5 electrogravimetric volumetric (thiosulfate)

Notes

This Certified Reference Material has been produced and certified, wherever possible, in accordance with the requirements of ISO 17034 and the associated Guides, taking into account the requirements of the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

This certification is applicable to the whole of the disc. However, in accordance with normal practice for emission spectrometry, it is appropriate to avoid usage of the centre of the disc, ~8 mm diameter.

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 January 2039, 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 procurement, 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.