MBH ANALYTICAL LTD

HOLLAND HOUSE • QUEENS ROAD • BARNET • EN5 4DJ • ENGLAND • TEL: +44 (0)20 8441 2024 • FAX: +44 (0)20 8449 0810

email: info@mbh.co.uk web: www.mbh.co.uk

CERTIFICATE OF ANALYSIS

43X Z15 (batch D)

Certified Reference Material Information

Type:	ZINC/ALUMINIUM/COPPER ALLOY (CAST)
Form and Size:	Disc ~50mm diameter
Produced by:	MBH Analytical Ltd
Certified and supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Al	Cu	Mg	Cd	Fe	Pb
Value [1]	**8.33**	**1.18**	**0.0236**	**0.0036**	**0.0056**	**0.0029**
Uncertainty [2]	0.05	0.03	0.0005	0.0001	0.0010	0.0002

Element	Sn	Ni	Mn	Bi	Sb
Value [1]	**0.0020**	**0.0082**	**0.0067**	**0.0055**	**(0.0010)**
Uncertainty [2]	0.0006	0.0003	0.0001	0.0010	-

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 uncertainties are value judgements, based on 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:

on 5th August 2019

MBH ANALYTICAL LIMITED _____

C Eveleigh

Method of Preparation

This reference material was produced from commercial-purity zinc, with the major alloys and traces added as pure elements or master alloys. The metal was cast from the bulk melt by sequential transfer of aliquots into individual iron chill moulds. At least 1mm has been machined from the lower surface of each disc, to minimise surface effects.

Sampling

Samples for chemical analysis were taken from throughout the casting process. In addition, approximately 10% of all discs, chosen at random from the complete batch, were selected for non-destructive homogeneity testing.

Homogeneity

The discs were checked for sample and batch uniformity using an optical emission spectrometer. 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, 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 compositional variation 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

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:	Zinc and zinc alloys are generally prepared by machining on a mill or 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.
	For OES the sample should be of sufficient mass to prevent excess heating during sparking, and the discharge chamber should be regularly cleaned as directed by the instrument manufacturer.
	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	Al	Cu	Mg	Cd	Fe	Pb
1	8.271	1.140	0.0224	0.0032	0.0048	0.0023
2	8.273	1.151	0.0225	0.0033	0.0050	0.0024
3	8.300	1.155	0.0225	0.0033	0.0052	0.0025
4	8.301	1.162	0.0227	0.0034	0.0052	0.0025
5	8.306	1.165	0.0232	0.0034	0.0054	0.0027
6	8.307	1.165	0.0232	0.0034	0.0055	0.0028
7	8.320	1.182	0.0232	0.0035	0.0058	0.0029
8	8.323	1.189	0.0234	0.0036	0.0058	0.0029
9	8.331	1.192	0.0236	0.0036	0.0059	0.0029
10	8.333	1.197	0.0237	0.0036	0.0060	0.0031
11	8.352	1.208	0.0239	0.0037	0.0063	0.0032
12	8.375	1.216	0.0241	0.0037	0.0065	0.0033
13	8.393		0.0243	0.0037		0.0034
14	8.404		0.0247	0.0038		0.0036
15			0.0249	0.0039		
16			0.0257	0.0041		
Mean	**8.328**	**1.177**	**0.0236**	**0.0036**	**0.0056**	**0.0029**
Std Dev	0.041	0.024	0.0010	0.0002	0.0005	0.0004
$C_{(95\%)}$	0.024	0.015	0.0005	0.0001	0.0003	0.0002

Sample	Sn	Ni	Mn	Bi	Sb
1	0.0013	0.0073	0.0061	0.0045	0.0003
2	0.0013	0.0076	0.0065	0.0045	0.0007
3	0.0015	0.0076	0.0065	0.0046	0.0009
4	0.0017	0.0076	0.0065	0.0047	0.0010
5	0.0017	0.0077	0.0066	0.0051	0.0011
6	0.0020	0.0080	0.0067	0.0054	0.0017
7	0.0020	0.0081	0.0067	0.0058	<0.001
8	0.0025	0.0082	0.0067	0.0058	<0.001
9	0.0026	0.0083	0.0068	0.0058	
10	0.0027	0.0083	0.0068	0.0059	
11	0.0027	0.0085	0.0068	0.0060	
12		0.0085	0.0069	0.0062	
13		0.0088	0.0070	0.0063	
14		0.0089		0.0064	
15		0.0090			
16		0.0091			
Mean	**0.0020**	**0.0082**	**0.0067**	**0.0055**	**(0.0010)**
Std Dev	0.0005	0.0006	0.0002	0.0007	-
$C_{(95\%)}$	0.0004	0.0003	0.0001	0.0004	-

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

Element Ltd	Middlesbrough, England	UKAS accreditation 0239
Sheffield Analytical Services	Sheffield, England	UKAS accreditation 0012
Anchorcert Analytical	Birmingham, England	UKAS accreditation 0667
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 0492
Genitest, Inc	Montreal, Canada	PJ accreditation L17-153
Shanghai Jinyi Test Tech Co	Shanghai, China	CNAS accreditation L0041
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation 0173
Raghavendra SpectroMet Laboratory	Bangalore, India	NABL accreditation T371
TCR Engineering Services Ltd	Mumbai, India	NABL accreditation 0367
Institute of Non-Ferrous Metals	Gliwice, Poland	PCA accreditation AB274
Tec-Eurolab	Campogalliano, Italy	ACCREDIA accreditation 52
Mineral & Metallurgical Laboratories	Bangalore, India	
INCDMNR-IMNR	Pantelimon, Romania	
AMG Superalloys UK Ltd	Rotherham, England	
Analyticka Laborator Lithea sro	Brno, Czech Republic	

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	
Aluminium	1, 2, 4-8, 11, 12, 14	3	10	volumetric (EDTA)
			9, 13	photometric (chrome azurol S)
Copper	1, 4-7, 10-12	2, 3, 9	8	volumetric (iodimetric)
Magnesium	1, 3-10, 13, 14, 16	2, 11, 12, 15		
Cadmium	1-3, 5-8, 10, 12, 13, 15, 16	4, 9, 11, 14		
Iron	3-6, 8-10	1, 7, 11, 12	2	photometric (orthophenanthroline)
Lead	1, 2, 4-6, 8-11, 14	3, 7, 12, 13		
Tin	1-5, 7, 9-11	6, 8		
Nickel	1-8, 12, 14, 15	9-11, 16	13	photometric (dimethyl glyoxime)
Manganese	3, 5-13	1, 2, 4		
Bismuth	1-8, 10, 12-14	9, 11		
Antimony	2, 4-8	1, 3		

Notes

This Certified Reference Material has been produced and certified 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).

The unidirectional solidification effects associated with this method of 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 13mm. Material to the rear of the disc, to a depth of ~7mm, is not certified.

This material is liable to superficial corrosion. There is also a possibility for microstructural changes due to recrystallisation, and diffusion effects may lead to the concentration of some elements at the surface. For X-ray and other superficial sampling techniques, it is therefore recommended that the surface is refreshed immediately prior to use. In all other respects, this sample 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 August 2039, 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.