

CERTIFICATE OF ANALYSIS

65X MGA14 (batch B)

Certified Reference Material Information

Type: MAGNESIUM / ALUMINIUM / ZINC (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	Zn	Mn	Cu	Si	Fe	Ni	Sn
Value ¹	9.50	0.752	0.246	0.0181	0.205	0.0219	0.0069	0.014
Uncertainty ²	0.06	0.006	0.006	0.0009	0.010	0.0018	0.0004	0.001

Element	Pb	Be	Ag	Cd	Ce	La	Hg
Value ¹	0.0086	0.0018	0.0047	0.0015	0.0151	0.0074	(0.031)
Uncertainty ²	0.0012	0.0001	0.0002	0.0001	0.0005	0.0011	-

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 2nd February 2017

C. Eveleigh

Method of Preparation

This reference material was produced from commercial-purity magnesium, with the addition of major alloying ingredients and traces of pure elements or binaries. All discs are the product of one melt, which was cleaned under a low-melting flux and sequentially cast into iron chill moulds. The first 2mm has been removed from the working face of the discs, to minimise surface effects.

Sampling

Samples for chemical analysis were taken from several positions throughout the casting process. Approximately 10% of all discs were selected for non-destructive homogeneity checking.

Homogeneity

Samples representative of the batch were checked for uniformity using an optical emission spectrometer. The testing procedure was in accordance with ASTM E826 and the material found acceptable.

From this test data, 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 - 2005, 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: Magnesium and magnesium alloys are generally prepared by milling or turning on a lathe, avoiding the use of lubricants and ensuring that 'sparking' does not occur during the process. 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, and should be done immediately prior to analysis to minimise the effects of surface oxidation.

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.

Safety

Finely-divided magnesium may ignite. Sand should be available in the event of a fire. Water should never be used.

In OES the sample should be of sufficient mass to prevent excessive heating during sparking and the discharge chamber should be regularly cleaned as directed by the instrument manufacturer.

Analytical Data

Percentage element by weight

Sample	Al	Zn	Mn	Cu	Si	Fe	Ni	Sn
1	9.3650	0.7465	0.2354	0.0165	0.1930	0.0199	0.0060	0.0132
2	9.4030	0.7470	0.2383	0.0166	0.1941	0.0201	0.0066	0.0133
3	9.4563	0.7481	0.2453	0.0169	0.2044	0.0206	0.0067	0.0133
4	9.4920	0.7497	0.2467	0.0169	0.2058	0.0209	0.0067	0.0138
5	9.5060	0.7498	0.2470	0.0170	0.2080	0.0210	0.0070	0.0138
6	9.5313	0.7500	0.2488	0.0170	0.2089	0.0217	0.0070	0.0141
7	9.5446	0.7509	0.2496	0.0179	0.2092	0.0220	0.0070	0.0141
8	9.5500	0.7520	0.2510	0.0183	0.2109	0.0221	0.0071	
9	9.5586	0.7540	0.2540	0.0185	0.2110	0.0234	0.0072	
10	9.5660	0.7552		0.0187		0.0234	0.0072	
11		0.7557		0.0199		0.0239	0.0077	
12		0.7569		0.0203		0.0243		
13		0.7570		0.0208				
Mean	9.4973	0.7518	0.2462	0.0181	0.2050	0.0219	0.0069	0.0137
Std Dev	0.0690	0.0037	0.0059	0.0015	0.0069	0.0015	0.0004	0.0004
C_(95%)	0.0493	0.0022	0.0046	0.0009	0.0053	0.0010	0.0003	0.0004

Sample	Pb	Be	Ag	Cd	Ce	La	Hg
1	0.0068	0.0015	0.0043	0.0013	0.0143	0.0052	0.0276
2	0.0068	0.0015	0.0045	0.0014	0.0145	0.0057	0.0295
3	0.0069	0.0016	0.0046	0.0014	0.0148	0.0058	0.0296
4	0.0070	0.0017	0.0046	0.0015	0.0149	0.0063	0.0322
5	0.0074	0.0018	0.0047	0.0015	0.0149	0.0070	0.0322
6	0.0080	0.0018	0.0049	0.0015	0.0150	0.0077	0.0324
7	0.0083	0.0018	0.0050	0.0015	0.0156	0.0079	
8	0.0090	0.0018		0.0015	0.0159	0.0079	
9	0.0091	0.0018		0.0016	0.0161	0.0092	
10	0.0091	0.0018		0.0016		0.0095	
11	0.0094	0.0019		0.0016		0.0097	
12	0.0098	0.0020					
13	0.0098	0.0020					
14	0.0103	0.0022					
15	0.0106						
Mean	0.0086	0.0018	0.0047	0.0015	0.0151	0.0074	0.0306
Std Dev	0.0013	0.0002	0.0002	0.0001	0.0006	0.0016	0.0020
C_(95%)	0.0007	0.0001	0.0002	0.0001	0.0005	0.0011	0.0021

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	Middlesbrough, UK	UKAS accreditation	0239
Sheffield Analytical Services	Sheffield, UK	UKAS accreditation	0012
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation	0492
Laboratory Testing, Inc	Hatfield, PA, USA	A2LA accreditation	0117
Genitest Inc	Montreal, QC, Canada	PRI accreditation	123077
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation	0173
Bureau Veritas CPS Ltd	Chennai, India	NABL accreditation	0025
TCR Engineering Services PVT. Ltd	Mumbai, India	NABL accreditation	0367
Raghavendra Spectro Metallurgical Laboratory	Bangalore, India	NABL accreditation	0371
Institute of Non-ferrous Metals	Gliwice, Poland	PCA accreditation	AB274
TEC Eurolab SRL	Modena, Italy	ACCREDIA accreditation	52
Mineral and Metallurgical Laboratories	Bangalore, India		
AMG Superalloys UK Ltd	Rotherham, UK		
Analyticka Laborator Lithea sro	Brno, Czech Republic		
Coleshill Laboratories Ltd	Coleshill, UK		

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, 6-10	3	5	gravimetric (8-hydroxyquinoline)
Zinc	1, 3, 4, 6, 7, 9-12	2, 5, 13	8	volumetric (EDTA)
Manganese	2, 4, 6, 7, 9	3	1, 5, 8	photometric (periodate)
Copper	3-6, 8-11, 13	1, 2, 7	12	photometric (dithizone)
Silicon	1-3, 6, 7	-	4, 8, 9	gravimetric (perchloric acid)
Iron	2, 4, 5, 7-12	3, 6	5, 10	photometric (molybdenum blue)
Nickel	1-4, 7-10	5, 6, 11	1	photometric (orthophenanthroline)
Tin	1, 3, 4, 6, 7	2, 5		
Lead	3-6, 8, 9, 11-13, 15	1, 2, 7, 10	14	gravimetric (sulfide)
Berilium	2-9, 11-13	1, 10, 14		
Silver	1, 2, 4-6	3, 7		
Cadmium	1, 3, 6-11	2, 4, 5		
Cerium	1-9	-		
Lanthanum	1-11	-		
Mercury	2-6	-	1	CV-AAS

Notes

This Certified Reference Material has been produced and certified in accordance with the requirements of ISO Guide 34-2009, ISO Guide 31-2015 and ISO Guide 35-2006, 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 to a depth of 10 mm. 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 February 2037, 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.

The material to which this certificate of analysis refers is supplied subject to our general conditions of sale.