

CERTIFICATE OF ANALYSIS

61X MGP4 (batch A)

Certified Reference Material Information

Type: MAGNESIUM WITH IMPURITIES (CAST)
Form and Size: Disc 45mm Diameter x 20mm Thickness
Produced by: KRR Metals Ltd
Certified and supplied by: MBH Analytical Ltd

Certified Analysis

Percentage element by weight

Element	Al	Zn	Mn	Zr	Cu	Si	Fe	Ni
Value ¹	0.0247	0.0158	0.0100	0.030	0.0108	0.037	(0.0044)	0.0028
Uncertainty ²	0.0010	0.0011	0.0009	0.003	0.0007	0.005	-	0.0002

Element	Ca	Sn	Pb	Ag	Be	Cd	Ce	La
Value ¹	0.028	0.0067	0.0066	0.0203	<0.0001	0.0071	0.0041	0.0030
Uncertainty ²	0.005	0.0004	0.0009	0.0009	-	0.0006	0.0001	0.0002

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 8th May 2006

C Eveleigh

Method of Preparation

This reference material was produced from commercial-purity magnesium, with the addition of traces, mostly as pure elements or binaries. All discs are the product of one melt, which was cleaned under a low-melting flux and poured into cast iron stick moulds. Each stick was sliced to yield a number of discs

Sampling

Samples for chemical analysis and discs for homogeneity checks were taken from several positions throughout the batch.

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 - 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, 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

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: 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	Zr	Cu	Si	Fe	Ni
1	0.023	0.013	0.0081	0.0255	0.0092	0.0291	0.003	0.0025
2	0.023	0.014	0.0084	0.0298	0.0095	0.034	0.0037	0.0025
3	0.0235	0.015	0.009	0.0299	0.0100	0.0396	0.0038	0.0027
4	0.0245	0.0158	0.0097	0.03	0.0107	0.04	0.0039	0.0028
5	0.0246	0.0158	0.0099	0.032	0.011	0.040	0.004	0.003
6	0.0247	0.0159	0.010		0.011	0.042	0.0051	0.003
7	0.025	0.0160	0.0108		0.0112		0.0056	0.003
8	0.025	0.0162	0.0109		0.0116		0.0062	0.0031
9	0.0258	0.018	0.011		0.012			
10	0.0275	0.018	0.012		0.012			
Mean	0.0247	0.0158	0.0100	0.0294	0.0108	0.037	0.0044	0.0028
Std Dev	0.0014	0.0015	0.0012	0.0024	0.0010	0.005	0.0011	0.0002
C_(95%)	0.0010	0.0011	0.0009	0.0030	0.0007	0.005	0.0009	0.0002

Sample	Ca	Sn	Pb	Ag	Be	Cd	Ce	La
1	0.021	0.0059	0.0051	0.019	<0.0001	0.0059	0.004	0.0026
2	0.0241	0.0061	0.0051	0.019	<0.0001	0.0066	0.004	0.0028
3	0.025	0.0065	0.0058	0.0205	<0.0001	0.007	0.0041	0.003
4	0.026	0.0069	0.006	0.0206	<0.0001	0.0070	0.0041	0.003
5	0.0276	0.0070	0.0063	0.0208	<0.0001	0.0071	0.0042	0.0030
6	0.028	0.007	0.0073	0.021	<0.0002	0.0074	0.0043	0.0033
7	0.031	0.007	0.0078	0.0215	<0.0002	0.008		
8	0.032	0.007	0.008		<0.0005	0.008		
9	0.037	0.0072	0.008					
Mean	0.0280	0.0067	0.0066	0.0203	<0.0001	0.0071	0.0041	0.0030
Std Dev	0.0048	0.0005	0.0012	0.0010	-	0.0007	0.0001	0.0002
C_(95%)	0.0037	0.0004	0.0009	0.0009	-	0.0006	0.0001	0.0002

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 Ltd	Middlesbrough, England	NAMAS accreditation 0239
RoTech Laboratories	Wednesbury, England	NAMAS accreditation 0366
Metals Technology Testing Ltd	Sheffield, England	NAMAS accreditation 0963
Sheffield Assay Office	Sheffield, England	NAMAS accreditation 0012
Laboratory Testing Inc	Hatfield, PA, USA	A2LA accreditation 0117
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 0492
Central Iron & Steel Research Inst	Beijing, China	CNAL accreditation 0435
Shiva Technologies	Syracuse, NY, USA	
DSM Magnesium Research Institute	Beer-Sheva, Israel	
Shiva Analytical Ltd	Bangalore, India	
US Magnesium LLC	Salt Lake City, UT, USA	

Note: to achieve National Accreditation (eg NAMAS, NATA, A2LA, CNAL), test houses were originally required to demonstrate conformity to the general requirements of ISO Guide 25-1990. Since the date of first certification for this product, the Guide has been revised to ISO/IEC 17025.

Analytical Methods Used

ELEMENT	RESULT No. & METHOD			
	ICP-AES	GD-MS	FAAS	OTHER
Aluminium	6, 7, 8, 9, 10	1	3, 4, 5	2 photometric (chromazurol-S)
Zinc	3, 4, 5, 6, 9	2	1, 7, 8, 10	
Manganese	2, 3, 5, 6, 7	9	1, 4, 8, 10	
Zirconium	1, 3	-	4, 5	2 photometric (arsenazo-III)
Copper	3, 4, 5, 8, 9	1	2, 6, 7, 10	
Silicon	1, 5	-	2, 4, 6	3 photometric (molybdenum blue)
Iron	1, 2, 4, 5	6	3, 7	8 photometric (1,10-phenanthroline)
Nickel	2, 4, 5, 6	3	7, 8	1 photometric (α -fural dioxime)
Calcium	1, 2, 8, 9	3	4, 5, 6, 7	
Tin	1, 2, 5, 6, 7	3	4, 8	9 photometric (phenyl fluorone)
Lead	2, 3, 4, 6, 8	1	7, 9	5 square-wave polarographic
Silver	3, 4, 6, 7	-	1, 2	5 photometric (dithizone)
Beryllium	4, 5, 6, 7, 8	1	2, 3	
Cadmium	3, 4, 5, 6, 7	1	2, 8	
Cerium	1, 2, 3, 4, 5, 6	-		
Lanthanum	1, 2, 3, 4, 5, 6	-		

Notes

This Certified Reference Material was originally analysed in August 2000. The certificate has since been revised twice, to incorporate additional results, and the formatting has been improved. The batch has been made 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 ASTM E1724 and the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

This certification is applicable to the whole of the disc, although in accordance with normal practice for emission spectrometry, it is appropriate to avoid use of the middle portion of ~12mm diameter.

Precautions should be taken to protect this material from extremes of temperature and atmospheric moisture. It is not chemically stable, and will quickly develop a non-metallic surface film under normal storage conditions. However, it will otherwise remain suitable for long-term use. All production records will be retained for a period of 20 years from the date of original analysis. This certification will therefore expire in August 2020, 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.