

CERTIFICATE OF ANALYSIS

56X G2000J2 (batch D)

Certified Reference Material Information

Type: ALUMINIUM / COPPER (CAST)
Form and Size: Disc 50mm diameter x 20mm thick
Produced by: Coleshill Laboratories Ltd
Certified and Supplied by: MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Cu	Mg	Si	Fe	Mn	Ni	Zn	Pb	Co
Value ¹	3.73	1.292	0.517	1.38	0.837	0.149	0.711	1.114	0.056
Uncertainty ²	0.04	0.013	0.004	0.02	0.008	0.003	0.012	0.014	0.002

Element	Sn	Ti	Cr	Zr	Bi	V	Ag	Be	Li
Value ¹	0.092	0.096	0.0200	0.188	0.078	(0.18)	0.0446	0.0054	0.0112
Uncertainty ²	0.002	0.003	0.0009	0.003	0.003	-	0.0013	0.0003	0.0008

Note: values 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 6th April 2010

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Method of Preparation

This reference material was produced from commercial-purity aluminium. The main alloys and trace elements were added as pure elements or master alloys. The melt was cast by sequential transfer of aliquots into individual iron moulds. Approximately 2mm has been removed from the cast face of each disc, to minimise any surface effects.

Sampling

Samples for chemical analysis were taken from various positions throughout the batch. Approximately 10% 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.

Using the combined data for 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 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. In addition, some of the results derived as part of this testing programme have 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: Aluminium 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	Cu	Mg	Si	Fe	Mn	Ni	Zn	Pb	Co
1	3.651	1.251	0.508	1.338	0.817	0.141	0.690	1.076	0.0533
2	3.676	1.274	0.510	1.374	0.825	0.143	0.690	1.086	0.0546
3	3.701	1.283	0.513	1.375	0.826	0.144	0.701	1.098	0.0556
4	3.712	1.284	0.516	1.376	0.828	0.147	0.706	1.112	0.0557
5	3.712	1.286	0.516	1.388	0.831	0.147	0.707	1.113	0.0558
6	3.726	1.288	0.517	1.393	0.835	0.148	0.709	1.115	0.0563
7	3.733	1.295	0.522	1.397	0.837	0.150	0.712	1.120	0.0563
8	3.738	1.308	0.522		0.838	0.151	0.722	1.121	0.0566
9	3.755	1.312	0.522		0.843	0.151	0.726	1.123	0.0568
10	3.770	1.313	0.522		0.850	0.152	0.729	1.140	0.0571
11	3.772	1.314	0.524		0.858	0.152	0.729	1.148	0.0580
12	3.781				0.859	0.157			
13	3.810								
Mean	3.73	1.292	0.517	1.377	0.837	0.149	0.711	1.114	0.0560
Std Dev	0.04	0.019	0.005	0.020	0.013	0.005	0.014	0.021	0.0013
C_(95%)	0.03	0.013	0.004	0.018	0.008	0.003	0.010	0.014	0.0008

Sample	Sn	Ti	Cr	Zr	Bi	V	Ag	Be	Li
1	0.0889	0.0935	0.0179	0.183	0.0750	0.1710	0.0423	0.0048	0.0093
2	0.0897	0.0944	0.0187	0.184	0.0753	0.1730	0.0431	0.0049	0.0102
3	0.0905	0.0951	0.0190	0.187	0.0755	0.1735	0.0432	0.0053	0.0105
4	0.0913	0.0953	0.0200	0.188	0.0756	0.1741	0.0446	0.0053	0.0108
5	0.0922	0.0961	0.0200	0.188	0.0777	0.1750	0.0452	0.0054	0.0110
6	0.0925	0.0966	0.0204	0.188	0.0780	0.1784	0.0455	0.0055	0.0115
7	0.0928	0.0969	0.0204	0.189	0.0786	0.1802	0.0455	0.0056	0.0116
8	0.0928	0.0972	0.0205	0.191	0.0788		0.0471	0.0056	0.0116
9	0.0931	0.0977	0.0212	0.195	0.0793			0.0059	0.0117
10		0.0985	0.0223		0.0803			0.0059	0.0137
11		0.0988			0.0806				
Mean	0.0915	0.0964	0.0200	0.188	0.0777	0.1750	0.0446	0.0054	0.0112
Std Dev	0.0015	0.0017	0.0013	0.004	0.0021	0.0032	0.0016	0.0004	0.0012
C_(95%)	0.0012	0.0011	0.0009	0.003	0.0014	0.0030	0.0013	0.0003	0.0008

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 Materials Testing Ltd
Sheffield Assay Office
Universal Scientific Laboratory Pty
Genitest Inc
Institute of Iron & Steel Technology
Luo Yang Copper Co
South-West Aluminium Group
Sargam Metals Pvt Ltd
TCR Engineering Servs Pvt Ltd
Raghavendra SpectroMet Laboratory
De Bruyn Spectroscopic Solutions
London & Scandinavian Met. Co
Coleshill Laboratories Ltd

Middlesbrough, England
Sheffield, England
Milperra, NSW, Australia
Montreal, Canada
Shanghai, China
Luo Yang, He Nan, China
Jiulong Puo, Sichuan, China
Chennai, India
Mumbai, India
Bangalore, India
Johannesburg, South Africa
Rotherham, England
Birmingham, England

UKAS accreditation 0239
UKAS accreditation 0012
NATA accreditation 0492
PRI accreditation 123077
CNAL accreditation 0783
CNAL accreditation 0173
CNAL accreditation T007
NABL accreditation T025
NABL accreditation T367
NABL accreditation T371

Note: to achieve the above accreditation (eg UKAS, NATA, etc), test houses are required to demonstrate conformity to the general requirements of EN ISO/IEC 17025.

Analytical Methods Used

ELEMENT	RESULT No. & METHOD		
	ICP-AES	FAAS	OTHER
Copper	1-4, 8, 9, 11, 13	5-7, 10, 12	
Magnesium	1, 3, 4, 8-11	2, 5-7	
Silicon	1, 9-11	-	5, 6, 8 2-4, 7 2-4 11
Iron	5-7	1	gravimetric (perchloric acid) photometric (molybdenum blue)
Manganese	1, 2, 4, 5, 7-10, 12	3, 6-8	photometric (orthophenanthroline)
Nickel	1, 2, 4-6, 11, 12	3, 7-10	photometric (periodate)
Zinc	1, 2, 4, 5, 9-11	3, 6-8	
Lead	1, 2, 4, 5, 8, 10	3, 6, 7, 9, 11	
Cobalt	1, 3, 6-9, 11	2, 4, 5, 10	
Tin	2-4, 7, 9	1, 5	6, 8 1, 3, 11
Titanium	2, 6-10	4, 5	photometric (phenylfluorone) photometric (di-antipyryl methane)
Chromium	1, 2, 4, 7, 9, 10	3, 5, 6, 8	
Zirconium	1-5, 8, 9	-	6 7 2 1
Bismuth	1, 5-8, 11	3, 4, 9, 10	ICP-MS photometric (xylenol orange)
Vanadium	2-4, 6	5, 7	photometric (brucine)
Silver	1, 5, 8	2-4, 6, 7	photometric (5-bromo-PADAP)
Beryllium	2-4, 9, 10	1, 5, 7, 8	6 5
Lithium	3, 4, 6, 8-10	1, 2, 7	photometric (eriochrome cyanine R) ICP-MS

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 35-2006, 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 for a depth of 12mm. Material to the rear of the disc, to a depth of ~8mm, 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 original analysis. This certification will therefore expire in April 2030, 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.

This batch is a sub-lot of batch C, but with impaired distribution for the vanadium.

The specification, preparation, 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.