

CERTIFICATE OF ANALYSIS

51X G00H1 (batch D)

Certified Reference Material Information

Type: RESIDUALS IN ALUMINIUM (CAST)
Form and Size: Disc 40-50mm diameter x 15-20mm thick
Produced by: Coleshill Laboratories Limited
Certified and Supplied by: MBH Analytical Limited

Certified Analysis

Percentage element by weight

Element	Cu	Mg	Si	Fe	Mn	Ni	Zn	Pb
Value ¹	0.0132	0.054	0.143	0.835	0.0074	0.230	0.249	0.0021
Uncertainty ²	0.0007	0.003	0.008	0.017	0.0007	0.008	0.010	0.0002

Element	Sn	Ti	Cr	V	Zr	Bi	Sb	Cd
Value ¹	0.097	0.0135	0.0062	0.0080	0.0008	0.024	(0.003)	(0.0001)
Uncertainty ²	0.005	0.0006	0.0004	0.0002	0.0001	0.002	-	-

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 22nd March 2004

C Eveleigh

Method of Preparation

This reference material was produced from commercial-purity aluminium, with the trace elements added as master alloys or pure elements. The melt was degassed using sodium-free flux, and sequentially cast into iron chill moulds. 2mm has been removed from the cast face of each disc, to minimise any surface effects.

Sampling

Samples for chemical analysis, and discs for homogeneity checks, were taken from several positions throughout the casting process. Approximately 8% of all discs were incorporated into the schedule for non-destructive homogeneity checking.

Homogeneity

The discs were checked for batch uniformity using an optical emission spectrometer. One additional disc was checked for vertical uniformity using the same method. Multiple measurements were taken from each surface under test.

For each of the surfaces checked, the differences between the averaged result and the overall mean value were evaluated to ensure that the overall homogeneity of the material comprising the batch satisfied the definition given in ISO guide 30 - 1992.

Using the individual data from each check, standard deviation values were derived for each element. These values were combined with the 95% half-width confidence intervals ($C_{(95\%)}$) obtained from the wet analysis programme, using the square-root of the summed squares, to derive the final uncertainty values.

The results from the vertical uniformity check indicated that these samples are within homogeneity acceptance limits for at least the first 10mm of depth.

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.

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: 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 four consistent replicate analyses is recommended to optimise precision and accuracy. 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
1	0.012	0.047	0.120	0.804	0.0056	0.213	0.233	0.0015
2	0.012	0.0490	0.13	0.811	0.0070	0.219	0.235	0.00165
3	0.0121	0.0515	0.132	0.825	0.007	0.219	0.24	0.0020
4	0.013	0.052	0.14	0.833	0.0070	0.222	0.241	0.0020
5	0.0131	0.053	0.148	0.841	0.0070	0.225	0.245	0.0022
6	0.0134	0.0558	0.148	0.849	0.0072	0.228	0.249	0.0022
7	0.0136	0.056	0.150	0.853	0.0072	0.23	0.250	0.0022
8	0.014	0.0587	0.152	0.860	0.0078	0.234	0.254	0.0023
9	0.014	0.059	0.152		0.0090	0.241	0.269	0.0023
10	0.015	0.060	0.154		0.0091	0.244	0.273	0.0024
11						0.250		
Mean	0.0132	0.054	0.143	0.835	0.0074	0.230	0.249	0.0021
Std Dev	0.0010	0.004	0.012	0.020	0.0010	0.012	0.013	0.0003
C_(95%)	0.0007	0.003	0.008	0.017	0.0007	0.008	0.010	0.0002

Sample	Sn	Ti	Cr	V	Zr	Bi	Sb	Cd
1	0.0856	0.012	0.0050	0.0075	0.0007	0.020	0.001	0.00008
2	0.090	0.0122	0.005	0.0078	0.0007	0.021	0.0023	0.0001
3	0.095	0.013	0.0059	0.0080	0.0008	0.0216	0.0030	0.0001
4	0.0968	0.0132	0.0061	0.0080	0.0009	0.024	0.0038	0.0001
5	0.099	0.0133	0.0062	0.008	0.0009	0.024	0.004	<0.0001
6	0.099	0.0135	0.0063	0.0081	<0.001	0.024	0.0047	<0.0001
7	0.101	0.0138	0.00645	0.0082		0.024	<0.005	<0.0005
8	0.1035	0.0140	0.0065	0.0082		0.026		
9	0.104	0.0142	0.0066	0.0086		0.0277		
10		0.0144	0.0070					
11		0.0144	0.0072					
Mean	0.097	0.0135	0.0062	0.0080	0.0008	0.024	(0.003)	(0.0001)
Std Dev	0.006	0.0008	0.0007	0.0003	0.0001	0.002	-	-
C_(95%)	0.005	0.0006	0.0004	0.0002	0.0001	0.002	-	-

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

Zurich Certification Ltd	West Bromwich, England	UKAS accreditation 0584
Scientifics Ltd	Harwell, England	UKAS accreditation 0322
Coleshill Laboratories Ltd	Birmingham, England	UKAS accreditation 0121
Universal Scientific Laboratory Pty	Milperra, NSW, Australia	NATA accreditation 492
Laboratory Testing Inc	Hatfield, PA, USA	A2LA accreditation 0117
Ithaca Materials Research & Testing	Lansing, NY, USA	A2LA accreditation 1140
Central Iron & Steel Research Inst	Beijing, China	CNAL accreditation 0435
Institute of Iron & Steel Technology	Shanghai, China	CNAL accreditation 0783
RWTUV Laboratory	Brno, Czech Republic	CIA accreditation 1060
Fu Shun Aluminium Smelter	Fu Shun District, China	
Anglo-American Research Labs Pty Ltd	Johannesburg, South Africa	
Genitest Inc	Montreal, Canada	

Note: to achieve National Accreditation (eg UKAS, A2LA, NATA, CNAL, CIA), test houses are required to demonstrate conformity to the general requirements of EN ISO/IEC 17025 and ISO9002.

Analytical Methods Used

ELEMENT	RESULT No. & METHOD		
	ICP-AES	FAAS	OTHER
Copper	2, 4, 5, 7-10	1, 6	3 photometric (neocuprone)
Magnesium	1-5, 8-10	6, 7	
Silicon	1, 2, 4, 6, 7, 9, 10	-	3, 8 gravimetric (perchloric acid)
Iron	1, 4-8	3	5 photometric (molybdenum yellow)
Manganese	1, 3-6, 7, 9, 10	2	2 photometric (orthophenanthroline)
Nickel	1-4, 7, 8, 10, 11	6	8 photometric (periodate)
Zinc	1-5, 8-10	6, 7	5, 9 photometric (DMGO, α -fural dioxime)
Lead	2-4, 7-10	1, 5	6 ICP-MS
Tin	1-3, 6-9	5	4 photometric (phenylfluorone)
Titanium	1, 3-9	11	2, 10 photometric (di-antipyryl methane)
Chromium	1, 2, 4-7, 9-11	8	3 photometric (1, 2 diphenyl hydrazine)
Vanadium	1, 2, 4-6, 8, 9	3	7 photometric (N-benzoyl-p-h)
Zirconium	1-5	-	6 photometric (xylenol orange)
Bismuth	1-3, 5-9	4	
Antimony	1-4, 6, 7	5	
Cadmium	1-4, 7	5, 6	

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 35-1989, taking into account the requirements of ASTM E1724, ASTM E1831 and the ISO Guide to the Expression of Uncertainty in Measurement (GUM). This batch was originally certified in January 2004, and the certificate has been up-issued only to incorporate new results.

The combination of alloying elements used in a complex material of this type, coupled with the unidirectional solidification effects associated with chill casting, may lead 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. Material to the rear of the disc, to a depth of ~5mm, is not certified.

This material will remain stable 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 January 2024, 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.