

CERTIFICATE OF ANALYSIS

56X G14H4 (batch C)

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
Value ¹	3.82	1.72	0.504	0.251	0.122	2.37	0.091
Uncertainty ²	0.04	0.05	0.009	0.005	0.002	0.04	0.003

Element	Pb	Sn	Ti	Cr	Co	V
Value ¹	0.050	0.037	0.069	0.0309	0.0288	0.0252
Uncertainty ²	0.002	0.002	0.003	0.0014	0.0015	0.0009

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 23rd March 2009
C Eveleigh

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 degassed using sodium-free flux, prior to casting 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 - 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

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
1	3.720	1.634	0.484	0.240	0.117	2.297	0.086
2	3.78	1.638	0.488	0.240	0.120	2.300	0.0864
3	3.785	1.65	0.495	0.245	0.121	2.302	0.0871
4	3.788	1.662	0.498	0.248	0.122	2.338	0.0882
5	3.808	1.67	0.498	0.249	0.122	2.36	0.092
6	3.823	1.727	0.503	0.251	0.122	2.362	0.0933
7	3.841	1.765	0.506	0.253	0.122	2.368	0.0950
8	3.844	1.798	0.512	0.253	0.123	2.370	0.0955
9	3.85	1.802	0.516	0.256	0.123	2.411	0.0980
10	3.86	1.803	0.522	0.257	0.124	2.416	
11	3.868	1.819	0.523	0.257	0.124	2.420	
12				0.259	0.125	2.43	
13						2.466	
Mean	3.815	1.724	0.504	0.251	0.122	2.372	0.091
Std Dev	0.044	0.075	0.013	0.006	0.002	0.054	0.004
C_(95%)	0.030	0.050	0.009	0.004	0.002	0.033	0.003

Sample	Pb	Sn	Ti	Cr	Co	V
1	0.047	0.0326	0.063	0.026	0.025	0.022
2	0.048	0.0328	0.0632	0.0282	0.026	0.0228
3	0.0483	0.0355	0.0635	0.029	0.0260	0.024
4	0.0494	0.0358	0.0652	0.029	0.0266	0.0240
5	0.0494	0.036	0.0669	0.030	0.0291	0.0241
6	0.0509	0.0382	0.0678	0.0312	0.0292	0.0250
7	0.051	0.0385	0.0685	0.0318	0.0295	0.0255
8	0.0510	0.0390	0.0695	0.0320	0.0302	0.0255
9	0.0515	0.0395	0.0705	0.0320	0.0302	0.0256
10	0.0521	0.0404	0.0706	0.0322	0.0306	0.026
11	0.0522	0.0414	0.0723	0.0326	0.0313	0.0264
12	0.0526		0.0724	0.0332	0.032	0.0269
13			0.075	0.0343		0.0270
14			0.0777			0.0277
Mean	0.0503	0.0372	0.0690	0.0309	0.0288	0.0252
Std Dev	0.0018	0.0029	0.0045	0.0023	0.0023	0.0016
C_(95%)	0.0012	0.0020	0.0026	0.0014	0.0015	0.0009

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	UKAS accreditation 0239
Sheffield Assay Office	Sheffield, England	UKAS accreditation 0012
Universal Scientific Laboratory Pty	Milperra, NSW, Australia	NATA accreditation 0492
Genitest Inc	Montreal, Canada	PRI accreditation 123077
Institute of Iron & Steel Technology	Shanghai, China	CNAL accreditation 0783
Luo Yang Copper Co	Luo Yang, He Nan, China	CNAL accreditation 0173
South-West Aluminium Group	Jiulong Puo, Sichuan, China	CNAL accreditation T007
Sargam Metals Pvt Ltd	Chennai, India	NABL accreditation T025
TCR Engineering Servs Pvt Ltd	Mumbai, India	NABL accreditation T367
Raghavendra SpectroMet Laboratory	Bangalore, India	NABL accreditation T371
De Bruyn Spectroscopic Solutions	Johannesburg, South Africa	
Calimet SA de CV	San Nicolas de los Garza, NL, Mexico	
London & Scandinavian Met. Co	Rotherham, England	
Colehill Laboratories Ltd	Birmingham, England	

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	2, 3, 5-8	4, 9-11	1	volumetric (thiosulfate)
Magnesium	1, 2, 6, 8, 10	3-5, 7, 9, 11		
Silicon	1, 9, 11	-	4, 5, 8, 10	gravimetric (perchloric acid) photometric (molybdenum blue)
Iron	2-4, 6, 7, 9, 12	5, 8, 10, 11	2, 3, 6, 7	
Manganese	3, 6, 8-10, 12	1, 4, 7, 11	1	photometric (orthophenanthroline)
Nickel	1, 2, 5, 7, 8, 10, 12	4, 6, 9, 11, 13	2, 5	photometric (periodate)
Zinc	1, 3, 5-7	2, 4, 8, 9	3	volumetric (dimethyl glyoxime)
Lead	1-7, 10	8, 9, 11, 12		
Tin	1, 4-6, 8, 11	7, 10	2, 3	photometric (phenylfluorone)
Titanium	1, 3, 5, 8, 11-14	2, 7	9	ICP-MS
Chromium	2-6, 11-13	1, 7-10	6, 9, 10	photometric (di-antipyryl methane)
Cobalt	1, 2, 5, 7, 9-12	3, 4, 6, 8	4	ICP-MS
Vanadium	1, 3, 4, 6, 8-11	2, 5, 13	7, 12	photometric (5-bromo-PADAP)

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 the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

The unidirectional solidification effects associated with semi-chill casting of this alloy, 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 14mm. Material to the rear of the disc, to a depth of ~6mm, 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 March 2029, 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 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.