

# CERTIFICATE OF ANALYSIS

**54X G25D4 (batch P)**

## Certified Reference Material Information

Type: ALUMINIUM / SILICON (CHILL CAST)

Form and Size: Disc, ~50mm diameter

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
Value <sup>1</sup>	0.148	0.151	7.22	0.14	0.195	0.0665	0.207	0.142
Uncertainty <sup>2</sup>	0.002	0.002	0.03	0.01	0.004	0.0016	0.004	0.004

Element	Sn	Ti	Cr	Co	V	Be	Bi	Cd
Value <sup>1</sup>	0.077	0.0978	0.043	0.0204	0.0542	0.0067	0.0705	0.0070
Uncertainty <sup>2</sup>	0.002	0.0016	0.003	0.0005	0.0009	0.0003	0.0009	0.0002

## Definitions

- <sup>1</sup> 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.
- <sup>2</sup> 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 18th May 2016

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## **Method of Preparation**

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

## **Sampling**

Samples for chemical analysis were taken from various positions throughout the casting sequence. Approximately 10% of all discs were selected for non-destructive homogeneity testing.

## **Homogeneity**

Samples representative of the batch were checked for uniformity using an optical emission spectrometer. Multiple measurements were taken from each surface under test.

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 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**

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. 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.

For optical emission spectroscopy, 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
1	0.1415	0.1480	7.195	0.1260	0.1842	0.0623	0.1980	0.1321
2	0.1438	0.1491	7.202	0.1283	0.1856	0.0626	0.2010	0.1323
3	0.1441	0.1495	7.208	0.1330	0.1878	0.0636	0.2013	0.1327
4	0.1448	0.1498	7.210	0.1370	0.1884	0.0642	0.2020	0.1330
5	0.1460	0.1507	7.212	0.1386	0.1900	0.0645	0.2048	0.1372
6	0.1480	0.1508	7.223	0.1426	0.1918	0.0649	0.2051	0.1384
7	0.1480	0.1510	7.225	0.1504	0.1921	0.0655	0.2056	0.1407
8	0.1486	0.1520	7.226	0.1510	0.1926	0.0658	0.2078	0.1418
9	0.1490	0.1523	7.229	0.1510	0.1930	0.0661	0.2079	0.1440
10	0.1505	0.1530	7.231		0.1960	0.0661	0.2107	0.1460
11	0.1511		7.235		0.1989	0.0665	0.2110	0.1460
12	0.1516		7.240		0.1990	0.0698	0.2130	0.1464
13	0.1519				0.1992	0.0699	0.2161	0.1490
14	0.1520				0.2000	0.0703	0.2180	0.1500
15					0.2007	0.0705		0.1502
16					0.2130	0.0721		0.1521
<b>Mean</b>	<b>0.1479</b>	<b>0.1506</b>	<b>7.220</b>	<b>0.1398</b>	<b>0.1945</b>	<b>0.0665</b>	<b>0.2073</b>	<b>0.1420</b>
<b>Std Dev</b>	0.0034	0.0015	0.014	0.0097	0.0072	0.0030	0.0059	0.0070
<b>C<sub>(95%)</sub></b>	0.0020	0.0011	0.009	0.0074	0.0038	0.0016	0.0034	0.0037

Sample	Sn	Ti	Cr	Co	V	Be	Bi	Cd
1	0.0707	0.0944	0.0365	0.0195	0.0514	0.0063	0.0687	0.0068
2	0.0718	0.0945	0.0367	0.0197	0.0517	0.0063	0.0695	0.0069
3	0.0721	0.0947	0.0370	0.0199	0.0525	0.0064	0.0695	0.0069
4	0.0730	0.0957	0.0370	0.0199	0.0530	0.0065	0.0695	0.0069
5	0.0735	0.0958	0.0390	0.0201	0.0545	0.0068	0.0697	0.0069
6	0.0738	0.0971	0.0392	0.0201	0.0547	0.0069	0.0704	0.0070
7	0.0776	0.0975	0.0401	0.0202	0.0548	0.0070	0.0712	0.0070
8	0.0779	0.0976	0.0416	0.0203	0.0550	0.0072	0.0713	0.0070
9	0.0795	0.0977	0.0450	0.0207	0.0551	0.0073	0.0713	0.0071
10	0.0799	0.0996	0.0461	0.0207	0.0551		0.0718	0.0071
11	0.0801	0.1000	0.0482	0.0210	0.0553		0.0723	0.0071
12	0.0801	0.1010	0.0490	0.0212	0.0554			0.0071
13	0.0803	0.1011	0.0496	0.0213	0.0559			0.0071
14	0.0806	0.1028	0.0499					0.0072
15			0.0502					
<b>Mean</b>	<b>0.0765</b>	<b>0.0978</b>	<b>0.0430</b>	<b>0.0204</b>	<b>0.0542</b>	<b>0.0067</b>	<b>0.0705</b>	<b>0.0070</b>
<b>Std Dev</b>	0.0038	0.0027	0.0054	0.0006	0.0015	0.0004	0.0012	0.0001
<b>C<sub>(95%)</sub></b>	0.0022	0.0016	0.0030	0.0004	0.0009	0.0003	0.0008	0.0001

Note: C<sub>(95%)</sub> 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
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation	0173
Shanghai JinYi Test Technology Co. Ltd	Shanghai, China	CNAL accreditation	0783
Bureau Veritas CPS Ltd.	Chennai, India	NABL accreditation	0025
Shandong Metallurgical & Science Research	Jinan, Shandong, China	CNAS accreditation	1461
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 Limited	Coleshill, UK		

Note: to achieve the above accreditation (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, 6-8, 10-13	2, 3, 5, 9	14	volumetric (thiosulfate)
Magnesium	1-3, 6-9	4, 5, 10		
Silicon	3, 8, 10, 11	-	1, 4, 12	photometric (molybdenum blue)
Iron	2, 4, 5, 9, 10, 12	1, 3, 6-10	2, 5-7, 9	gravimetric (perchloric acid)
Manganese	1, 3, 4, 6, 9, 11-15	2, 7, 8,	11	volumetric (redox)
Nickel	1, 3, 4, 6, 8, 9, 11, 12, 14-16	2, 5, 7, 10	5, 10	photometric (periodate)
Zinc	1-3, 6-9, 10, 12, 14	4, 5, 11	16	volumetric (bismuthate)
Lead	1, 3, 5-7, 10-12, 14-16	2, 4, 8, 9	13	gravimetric (dimethyl glyoxime)
Tin	1, 4, 6, 7, 9-12, 14	2, 5, 8	13	gravimetric
Titanium	1-4, 8-10, 13, 14	7, 8	3	photometric (sulphide)
Chromium	2-4, 6, 7, 9-13, 15	1, 5, 8	13	photometric (phenyl fluorone)
Cobalt	1-4, 6-10, 13	5, 11, 12	13	volumetric (iodate)
Vanadium	1, 2, 4, 5, 7, 8, 10-12	3, 13	5, 11, 12	photometric (DAP, peroxide)
Beryllium	1-3, 5, 7-9	4, 6	14	volumetric (peroxi-di-sulphate)
Bismuth	1, 3, 5-11	2, 4		
Cadmium	1-6, 8, 10, 12-13	7, 9, 11, 14	6	photometric (n-benzoyl-n-PH)
			9	volumetric (peroxi-di-sulfate)

## 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 ~12 mm. Material to the rear of the disc, to a depth of ~3 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 original analysis. Technical support for this certification will therefore expire in May 2036, 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 preparation, analysis and certification of this product were supervised by L Maxim, Technical Director, MBH Analytical Ltd.

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