

CERTIFICATE OF ANALYSIS

511X G3000B2 (batch B)

Certified Reference Material Information

Type: ALUMINIUM / MAGNESIUM (CAST)
Form and Size: Disc 40-50mm diameter x 15-20mm thick
Manufactured 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 | Sn |
|--------------------------|------|------|------|-------|------|-------|-------|-------|-------|
| Value ¹ | 0.20 | 0.68 | 0.23 | 0.335 | 0.81 | 0.063 | 0.098 | 0.137 | 0.105 |
| Uncertainty ² | 0.01 | 0.01 | 0.02 | 0.006 | 0.05 | 0.007 | 0.004 | 0.006 | 0.005 |

| Element | Ti | Cr | V | Co | Mo | Ga | Be | Cd | Li |
|--------------------------|-------|-------|--------|-------|---------|-------|--------|----------|-------|
| Value ¹ | 0.111 | 0.200 | <0.005 | 0.007 | (0.059) | 0.012 | 0.0017 | (0.0007) | 0.017 |
| Uncertainty ² | 0.009 | 0.012 | - | 0.002 | 0.004 | 0.002 | 0.0003 | - | 0.005 |

Note: values given in parentheses are not certified - they are provided for information only.

Definitions

- ¹ The certified values are derived from the 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 (page 3). When appropriate, these values have been modified to account for additional information from the material homogeneity checks.

Certified by:

MBH ANALYTICAL LIMITED

on 30th November 2000

Method of Preparation

This reference material was produced from commercial-purity aluminium, pure elements and master alloys. The melt was degassed using sodium-free degasser, 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, and discs for homogeneity checks, were taken from various positions within the casting process.

Homogeneity

Samples representative of the batch were checked for vertical uniformity using an optical emission spectrometer.

Multiple measurements were taken from each surface under test.

The mean value of the material was then calculated from the multiple measurement averages.

For each of the surfaces checked, the differences between the averaged result and the overall mean value were evaluated to ensure that the homogeneity of the material satisfied the acceptance criteria defined in ISO guide 30 - 1992, and fell within 95% probability limits.

Chemical Analysis

Analysis was carried out on millings taken from samples representative of the product. It was performed by participating laboratories mostly operating within the terms of EN ISO/IEC 17025 - 2000, using documented standard methods of analysis.

The individual values listed overpage are usually the average of each analyst's results.

Usage

Intended use: With optical emission and X-ray fluorescence spectrometers.

Recommended method of use: Aluminium and aluminium alloys are generally prepared by machining on 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 | Sn |
|--------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 1 | 0.184 | 0.67 | 0.205 | 0.33 | 0.76 | 0.053 | 0.09 | 0.13 | 0.10 |
| 2 | 0.19 | 0.67 | 0.22 | 0.33 | 0.778 | 0.056 | 0.095 | 0.13 | 0.10 |
| 3 | 0.19 | 0.674 | 0.22 | 0.33 | 0.78 | 0.060 | 0.097 | 0.13 | 0.10 |
| 4 | 0.195 | 0.69 | 0.23 | 0.33 | 0.80 | 0.06 | 0.10 | 0.133 | 0.103 |
| 5 | 0.202 | 0.69 | 0.24 | 0.334 | 0.856 | 0.06 | 0.10 | 0.138 | 0.104 |
| 6 | 0.21 | 0.692 | 0.25 | 0.34 | 0.86 | 0.07 | 0.101 | 0.14 | 0.11 |
| 7 | 0.215 | | 0.251 | 0.34 | 0.86 | 0.07 | 0.105 | 0.147 | 0.115 |
| 8 | 0.22 | | 0.253 | 0.343 | | 0.071 | | 0.147 | |
| Mean | 0.201 | 0.681 | 0.234 | 0.335 | 0.813 | 0.063 | 0.098 | 0.137 | 0.105 |
| Std Dev | 0.013 | 0.011 | 0.018 | 0.006 | 0.044 | 0.007 | 0.005 | 0.007 | 0.006 |
| C_(95%) | 0.011 | 0.011 | 0.015 | 0.005 | 0.041 | 0.006 | 0.004 | 0.006 | 0.005 |

| Sample | Ti | Cr | V | Co | Mo | Ga | Be | Cd | Li |
|--------------------------|--------------|--------------|------------------|---------------|--------------|--------------|---------------|-----------------|--------------|
| 1 | 0.10 | 0.19 | 0.001 | 0.0058 | 0.054 | 0.010 | 0.0013 | 0.0006 | 0.01 |
| 2 | 0.10 | 0.19 | <0.002 | 0.006 | 0.0586 | 0.0117 | 0.0014 | 0.0007 | 0.015 |
| 3 | 0.103 | 0.19 | <0.002 | 0.008 | 0.06 | 0.012 | 0.0014 | 0.0008 | 0.018 |
| 4 | 0.110 | 0.19 | 0.003 | 0.0080 | 0.061 | 0.013 | 0.0018 | <0.001 | 0.020 |
| 5 | 0.11 | 0.20 | <0.005 | 0.009 | 0.063 | 0.013 | 0.002 | | 0.020 |
| 6 | 0.12 | 0.21 | <0.005 | <0.01 | | | 0.002 | | |
| 7 | 0.12 | 0.212 | <0.01 | | | | | | |
| 8 | 0.122 | 0.218 | | | | | | | |
| Mean | 0.111 | 0.200 | <0.005 | 0.0074 | 0.059 | 0.012 | 0.0017 | (0.0007) | 0.017 |
| Std Dev | 0.009 | 0.012 | - | 0.0014 | 0.003 | 0.001 | 0.0003 | - | 0.004 |
| C_(95%) | 0.008 | 0.010 | - | 0.0017 | 0.004 | 0.001 | 0.0003 | - | 0.005 |

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

| | | |
|------------------------------------|------------------------|---------------------|
| Coleshill Laboratories Ltd | Birmingham, England | UKAS approval 0121 |
| RoTech Laboratories | Wednesbury, England | UKAS approval 0366 |
| Sheffield Assay Office | Sheffield, England | UKAS approval 0012 |
| Bodycote Materials Testing Ltd | Middlesbrough, England | UKAS approval 0239 |
| Metals Technology Testing Ltd | Sheffield, England | UKAS approval 0963 |
| London & Scandinavian Met Co | Rotherham, England | UKAS approval 1091 |
| Laboratory Testing Inc | Hatfield, Pa, USA | A2LA approval 0117 |
| Central Iron & Steel Research Inst | Beijing, China | National reg. E0584 |
| Shiva Analyticals Ltd | Bangalore, India | |

Analytical Methods Used

| | | | | |
|-------------|------|-----|-----|------------------------------------|
| Copper: | FAAS | ICP | OES | photometric (oxalyl dihydrazide) |
| Magnesium: | FAAS | ICP | OES | |
| Silicon: | FAAS | ICP | OES | gravimetric perchloric acid) |
| Iron: | FAAS | ICP | | photometric (orthophenanthroline) |
| Manganese: | FAAS | ICP | OES | photometric (periodate) |
| Nickel: | FAAS | ICP | OES | photometric (dimethyl glyoxime) |
| Zinc: | FAAS | ICP | OES | |
| Lead: | FAAS | ICP | | |
| Tin: | FAAS | ICP | | photometric (phenylfluorone) |
| Titanium: | FAAS | ICP | | photometric (di-antipyryl methane) |
| Chromium: | FAAS | ICP | OES | photometric (diphenylcarbazide) |
| Vanadium: | FAAS | ICP | | |
| Cobalt: | FAAS | ICP | | |
| Molybdenum: | FAAS | ICP | | photometric (thiocyanate) |
| Gallium: | FAAS | ICP | | |
| Beryllium: | FAAS | ICP | | |
| Cadmium: | FAAS | ICP | | |
| Lithium: | FAAS | ICP | | |

Notes

This Certified Reference Material has been produced in accordance with the requirements of ISO Guide 34-2000, ISO Guide 31-2000, ISO Guide 35-1989, and ASTM Guides E1724 and E1831.

To achieve UKAS (UK Accreditation Scheme) approval, test houses must demonstrate conformity to the general requirements of EN ISO/IEC 17025 and ISO9002.

The combination of alloying elements used in a complex cast material of this type may produce a structure which exhibits micro-porosity on the rear (engraved) surface of the disc. In addition, the unidirectional solidification effects associated with semi-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.

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