in cooperation with the WG 'Aluminium'
of the Committee of Chemists of GDMB

# CERTIFICATE OF ANALYSIS

## ERM®-EB315a

| AlSi9Cu3 | | |
|---|---|---|
| | Certified value [1] | Uncertainty [2] |
| Element | Mass fraction in % | |
| Si | 9.88 | 0.18 |
| Fe | 0.621 | 0.014 |
| Cu | 2.46 | 0.08 |
| Mn | 0.311 | 0.009 |
| Mg | 0.446 | 0.023 |
| Cr | 0.0274 | 0.0004 |
| Ni | 0.0955 | 0.0022 |
| Zn | 0.801 | 0.010 |
| Ti | 0.142 | 0.006 |
| Ga | 0.0089 | 0.0003 |
| Pb | 0.077 | 0.003 |
| Sn | 0.0764 | 0.0020 |
| | Mass fraction in mg/kg | |
| Be | 4.33 | 0.16 |
| Bi | 36 | 4 |
| Cd | 7.9 | 1.0 |
| Sb | 51 | 10 |
| V | 47.0 | 2.3 |
| Zr | 31.0 | 1.9 |

[1] Unweighted mean value of the means of accepted sets of data, each set being obtained in a different laboratory and/or with a different method of determination. The values are traceable to the SI (Système International d'Unités) by the use of pure substances of known stoichiometry for calibration. All values were confirmed in an inter-laboratory comparison using spark optical emission spectrometry.

[2] Estimated expanded uncertainty *U* with a coverage factor of *k* = 2, corresponding to a level of confidence of about 95%, as defined in the ISO/IEC Guide 98-3:2008 [Uncertainty of measurement -- Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)].

This certificate is valid until 04/2067.

Accepted as an ERM®, Berlin, 2017-05-31

BAM Department 1
Analytical Chemistry;
Reference Materials

BAM Division 1.6
Inorganic Reference Materials

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| Informative Values | | |
|---|---|---|
| Element | Mass fraction [1] in mg/kg | Uncertainty [2] in mg/kg |
| B | 2.1 | 2.0 |
| Co | 1.4 | 0.7 |
| Hg | 22 | 6 |
| P | 7 | 4 |

Indicative values were not certified, nevertheless given for information, when the number of accepted data sets was considered to be too low (< 5), when the uncertainty from the inter-laboratory certification was considerably larger than the expected range or when homogeneity test data was not sufficient.

[1] Unweighted mean value of the means of accepted sets of data, each set being obtained in a different laboratory and/or with a different method of determination. The values are traceable to the SI (Système International d'Unités) by the use of pure substances of known stoichiometry for calibration. All values were confirmed in an inter-laboratory comparison using spark optical emission spectrometry.

[2] Estimated expanded uncertainty $U$ with a coverage factor of $k = 2$ (B, Hg: $k = 3$, Co: $k = 2.5$), corresponding to a level of confidence of about 95%, as defined in the ISO/IEC Guide 98-3:2008 [Uncertainty of measurement -- Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)].

## NOTE

European Reference Material ERM®-EB315a was produced and certified under the responsibility of Bundesanstalt für Materialforschung und -prüfung (BAM) in cooperation with the Committee of Chemists of GDMB Society of Metallurgists and Miners according to the principles laid down in the technical guidelines of the European Reference Materials® co-operation agreement between BAM-LGC-JRC. Information on these guidelines is available on the Internet (http://www.erm-crm.org).

## DESCRIPTION OF THE SAMPLE

ERM-EB315a was prepared by casting. The Certified Reference Material (CRM) is available in the form of discs (65 mm diameter and 30 mm height).

## INTENDED USE

The CRM is intended for establishing or checking the calibration of spark optical emission and X-ray fluorescence spectrometers (excluding micro-analysis) for the analysis of samples of similar matrix composition. The minimum sample size for wet chemical analysis is 0.2 g.

## INSTRUCTIONS FOR USE

Before use, the surface of the material must be prepared by milling or turning on a lathe. For wet chemical analysis chips have to be prepared by turning or milling of the sample surface.

## STORAGE

The material should be stored in a dry and clean environment at room temperature (approx. 20 °C).

## MEANS OF ACCEPTED DATA SETS

Certified values, mass fraction in %

| Line no. | Si | Fe | Cu | Mn | Mg | Cr | Ni | Zn | Ti | Ga | Pb | Sn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 9.725 | 0.6007 | 2.306 | 0.2955 | 0.4326 | 0.0268 | 0.0888 | 0.7815 | 0.1367 | 0.0085 | 0.0706 | 0.0729 |
| **2** | 9.791 | 0.6028 | 2.385 | 0.2997 | 0.4372 | 0.0271 | 0.0897 | 0.7922 | 0.1380 | 0.0087 | 0.0726 | 0.0733 |
| **3** | 9.798 | 0.6067 | 2.446 | 0.3007 | 0.4394 | 0.0272 | 0.0903 | 0.7923 | 0.1401 | 0.0088 | 0.0728 | 0.0740 |
| **4** | 9.807 | 0.6117 | 2.447 | 0.3031 | 0.4436 | 0.0273 | 0.0931 | 0.7965 | 0.1408 | 0.0089 | 0.0733 | 0.0751 |
| **5** | 9.860 | 0.6138 | 2.464 | 0.3041 | 0.4458 | 0.0274 | 0.0944 | 0.7975 | 0.1412 | 0.0089 | 0.0758 | 0.0760 |
| **6** | 9.946 | 0.6207 | 2.468 | 0.3085 | 0.4481 | 0.0277 | 0.0950 | 0.8023 | 0.1414 | 0.0089 | 0.0765 | 0.0766 |
| **7** | 9.949 | 0.6217 | 2.472 | 0.3147 | 0.4492 | 0.0277 | 0.0950 | 0.8028 | 0.1420 | 0.0090 | 0.0770 | 0.0779 |
| **8** | 9.962 | 0.6228 | 2.475 | 0.3152 | 0.4504 | 0.0277 | 0.0964 | 0.8038 | 0.1433 | 0.0090 | 0.0770 | 0.0782 |
| **9** | 9.968 | 0.6241 | 2.490 | 0.3162 | 0.4506 | 0.0278 | 0.0969 | 0.8059 | 0.1437 | 0.0090 | 0.0785 | 0.0796 |
| **10** | 9.992 | 0.6291 | 2.547 | 0.3184 | 0.4512 | 0.0278 | 0.0969 | 0.8076 | 0.1446 | | 0.0793 | 0.0800 |
| **11** | | 0.6302 | 2.548 | 0.3216 | 0.4512 | | 0.0970 | 0.8110 | 0.1473 | | 0.0801 | |
| **12** | | 0.6320 | | 0.3218 | 0.4521 | | 0.0983 | 0.8130 | | | 0.0801 | |
| **13** | | 0.6370 | | 0.3220 | | | 0.0988 | | | | 0.0814 | |
| **14** | | 0.6390 | | | | | 0.1012 | | | | 0.0845 | |
| **15** | | | | | | | 0.1013 | | | | | |
| $M$ | 9.880 | 0.6209 | 2.459 | 0.3109 | 0.4459 | 0.0274 | 0.0955 | 0.8005 | 0.1417 | 0.0089 | 0.0771 | 0.0764 |
| $s_M$ | 0.095 | 0.0123 | 0.069 | 0.0094 | 0.0064 | 0.0004 | 0.0038 | 0.0090 | 0.0030 | 0.0002 | 0.0039 | 0.0026 |
| $\bar{s}_i$ | 0.057 | 0.0087 | 0.023 | 0.0057 | 0.0046 | 0.0005 | 0.0021 | 0.0096 | 0.0014 | 0.0003 | 0.0016 | 0.0009 |

Certified values, mass fraction in mg/kg

Indicative value, mass fraction in mg/kg

| Line no. | Be | Bi | Cd | Sb | V | Zr | | *B* | *Co* | *Hg* | *P* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 4.00 | 33.01 | 7.08 | 42.8 | 44.0 | 28.7 | | *0.30* | *0.79* | *20.2* | *6.12* |
| **2** | 4.13 | 33.15 | 7.33 | 44.1 | 44.3 | 29.9 | | *< 1* | *0.85* | *20.6* | *6.35* |
| **3** | 4.29 | 34.18 | 7.38 | 45.5 | 46.5 | 30.0 | | *2.18* | *0.85* | *26.0* | *6.35* |
| **4** | 4.29 | 34.41 | 7.62 | 48.4 | 46.8 | 30.0 | | *2.99* | *1.00* | | *8.77* |
| **5** | 4.31 | 36.46 | 7.72 | 54.5 | 47.0 | 30.5 | | *3.07* | *1.30* | | |
| **6** | 4.33 | 37.80 | 7.75 | 54.7 | 47.3 | 30.8 | | | *1.54* | | |
| **7** | 4.47 | 39.31 | 8.00 | 55.2 | 47.5 | 31.0 | | | *2.46* | | |
| **8** | 4.52 | 39.58 | 8.10 | 56.0 | 47.5 | 31.1 | | | *2.70* | | |
| **9** | 4.59 | 39.71 | 8.40 | 56.8 | 48.6 | 31.1 | | | | | |
| **10** | | | 8.43 | | 49.1 | 31.7 | | | | | |
| **11** | | | 8.93 | | 49.1 | 31.8 | | | | | |
| **12** | | | --- | | 50.1 | 34.7 | | | | | |
| $M$ | 4.33 | 36.40 | 7.88 | 50.9 | 47.3 | 31.0 | | *2.14* | *1.44* | *22.3* | *6.90* |
| $s_M$ | 0.19 | 2.80 | 0.56 | 5.7 | 1.9 | 1.5 | | *1.29* | *0.76* | *3.3* | *1.26* |
| $\bar{s}_i$ | 0.09 | 0.23 | 0.23 | 2.2 | 0.6 | 0.8 | | *0.57* | *0.04* | *0.6* | *0.29* |

The laboratory mean values have been examined statistically to eliminate outlying values. Where a " --- " appears in the table it indicates that an outlying value has been omitted. Each laboratory mean consists of at least 3 but usually 6 single values.

$M$ : mean of laboratory means $s_M$ : standard deviation of laboratory means

$\bar{s}_i$ : averaged repeatability standard deviation (square root of the mean of laboratory variances)

## ANALYTICAL METHOD USED FOR CERTIFICATION

| Element | Line no. | Method |
|---|---|---|
| Si | 1, 2, 9 | Spectrophotometry |
| | 3, 5, 6, 7, 8, 10 | ICP-OES, dissolution with NaOH |
| | 4 | ICP-OES, dissolution with acid |
| Fe | 1, 2, 5, 6, 10, 11 | ICP-OES, dissolution with NaOH |
| | 3, 9, 14 | ICP-OES, dissolution with acid |
| | 4 | FAAS, dissolution with acid |
| | 7 | XRF |
| | 8 | FAAS, dissolution with NaOH |
| | 12 | Spectrophotometry |
| | 13 | ICP-MS, dissolution with acid |
| Cu | 1, 10 | FAAS, dissolution with acid |
| | 2, 4 | ICP-OES, dissolution with acid |
| | 3, 5, 7, 8, 9, 11 | ICP-OES, dissolution with NaOH |
| | 6 | XRF |
| Mn | 1, 5 | FAAS, dissolution with acid |
| | 2, 7, 12 | ICP-OES, dissolution with acid |
| | 3, 10 | XRF |
| | 4, 6, 8, 9, 11, 13 | ICP-OES, dissolution with NaOH |
| Mg | 1, 3, 6, 10, 11, 12 | ICP-OES, dissolution with NaOH |
| | 2, 5, 8 | ICP-OES, dissolution with acid |
| | 4 | XRF |
| | 7, 9 | FAAS, dissolution with acid |
| Cr | 1, 4, 5, 7, 8 | ICP-OES, dissolution with NaOH |
| | 2 | XRF |
| | 3, 10 | ICP-OES, dissolution with acid |
| | 6 | ICP-MS, dissolution with acid |
| | 9 | FAAS, dissolution with acid |
| Ni | 1, 6, 7, 8, 10, 11 | ICP-OES, dissolution with NaOH |
| | 2, 12, 15 | ICP-OES, dissolution with acid |
| | 3, 13 | XRF |
| | 4 | FAAS, dissolution with acid |
| | 5, 14 | ICP-MS, dissolution with acid |
| | 9 | ETAAS, dissolution with acid |
| Zn | 1 | XRF |
| | 2, 3, 5, 7, 11, 12 | ICP-OES, dissolution with NaOH |
| | 4, 6, 8 | ICP-OES, dissolution with acid |
| | 9, 10 | FAAS, dissolution with acid |
| Ti | 1, 3, 11 | ICP-OES, dissolution with acid |
| | 2, 4, 5, 6, 7, 9 | ICP-OES, dissolution with NaOH |
| | 8 | XRF |
| | 10 | Spectrophotometry |
| Ga | 1, 9 | ICP-OES, dissolution with acid |
| | 2, 3 | ICP-MS, dissolution with acid |
| | 4, 5, 6, 7, 8 | ICP-OES, dissolution with NaOH |

| Element | Line no. | Method |
|---|---|---|
| Pb | 1, 5, 6, 7, 9 | ICP-OES, dissolution with NaOH |
| | 2 | FAAS, dissolution with acid |
| | 3, 4, 8, 12 | ICP-OES, dissolution with acid |
| | 10, 11 | ICP-MS, dissolution with acid |
| | 13 | ETAAS, dissolution with acid |
| | 14 | XRF |
| Sn | 1 | XRF |
| | 2, 4, 5, 6, 7 | ICP-OES, dissolution with NaOH |
| | 3, 8, 9 | ICP-OES, dissolution with acid |
| | 10 | ICP-MS, dissolution with acid |
| Be | 1, 6 | ICP-OES, dissolution with acid |
| | 2, 3, 8 | ICP-OES, dissolution with NaOH |
| | 4, 5, 9 | ICP-MS, dissolution with acid |
| | 7 | ETAAS, dissolution with acid |
| Bi | 1, 2, 6, 8 | ICP-OES, dissolution with acid |
| | 3 | ICP-OES, dissolution with NaOH |
| | 4, 5, 9 | ICP-MS, dissolution with acid |
| | 7 | ETAAS, dissolution with acid |
| Cd | 1 | FAAS, dissolution with acid |
| | 2, 6, 9 | ICP-MS, dissolution with acid |
| | 3, 5, 7, 10 | ICP-OES, dissolution with acid |
| | 4 | ETAAS, dissolution with acid |
| | 8, 11 | ICP-OES, dissolution with NaOH |
| Sb | 1, 3, 4, 7, 9 | ICP-OES, dissolution with acid |
| | 2 | ICP-OES, dissolution with NaOH |
| | 5, 6, 8 | ICP-MS, dissolution with acid |
| V | 1, 5, 6, 8 | ICP-OES, dissolution with acid |
| | 2, 4, 12 | ICP-MS, dissolution with acid |
| | 3, 7, 9 | ICP-OES, dissolution with NaOH |
| | 10 | XRF |
| | 11 | Spectrophotometry |
| Zr | 1, 9 | ICP-MS, dissolution with acid |
| | 2, 6, 7 | ICP-OES, dissolution with NaOH |
| | 3 | XRF |
| | 4, 8, 10, 11, 12 | ICP-OES, dissolution with acid |
| | 5 | Spectrophotometry |
| *B* | *1, 4* | *ICP-MS, dissolution with acid* |
| | *2, 5* | *ICP-OES, dissolution with acid* |
| | *3* | *ICP-OES, dissolution with NaOH* |
| *Co* | *1, 2, 3* | *ICP-MS, dissolution with acid* |
| | *4, 5* | *ICP-OES, dissolution with acid* |
| | *6* | *XRF* |
| | *7, 8* | *ICP-OES, dissolution with NaOH* |
| *Hg* | *1* | *ICP-MS, dissolution with acid* |
| | *2* | *CVAFS* |
| | *3* | *ICP-OES, dissolution with NaOH* |

| Element | Line no. | Method |
|---|---|---|
| *P* | *1* | *ICP-OES, dissolution with NaOH* |
| | *2, 3, 4* | *ICP-OES, dissolution with acid* |

**Abbreviations**:

| | |
|---|---|
| CVAFS: | Cold vapour atomic fluorescence spectrometry |
| ETAAS: | Electrothermal atomic absorption spectrometry |
| FAAS: | Flame atomic absorption spectrometry |
| ICP-OES: | Inductively coupled plasma optical emission spectrometry |
| ICP-MS: | Inductively coupled plasma mass spectrometry |
| XRF: | X-ray fluorescence spectrometry |

## PARTICIPANTS

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## TECHNICAL REPORT

A detailed technical report describing the analysis procedures and the treatment of the analytical data used to certify ERM®-EB315a is available on request or can be downloaded from BAM website (www.bam.de).

Supply of this Reference Material by:

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BAM holds an accreditation as a reference material producer according to ISO Guide 34 in combination with ISO/IEC 17025. This accreditation is valid only for the scope as specified in the certificate D-RM-11075-01-00.

DAkkS is a signatory of the multilateral agreement (MLA) between EA, ILAC and IAF for mutual acceptance.

DAkkS Deutsche Akkreditierungsstelle D-RM-11075-01-00