

Bundesanstalt für Materialforschung und -prüfung (BAM)

in cooperation with the Committee of Chemists of the GDMB
Gesellschaft der Metallurgen und Bergleute e.V.

Certified Reference Material

BAM-M323

AlFe1

Certified Values

Element	Mass fraction ¹⁾ in %	Uncertainty ²⁾ in %
Si	0.147	0.005
Fe	1.000	0.012
Cu	0.0182	0.0004
Mn	0.0471	0.0009
Mg	0.0203	0.0013
Cr	0.0106	0.0003
Ga	0.0141	0.0003
Zn	0.0286	0.0006
Ti	0.0189	0.0006
	in mg/kg	in mg/kg
Be	5.3	0.3
Bi	15.0	1.7
Ca	17	4
Cd	20.2	0.9
Co	21.3	1.3
Hg	19.9	1.1
Li ³⁾	6.0 ³⁾	0.7
Na ⁴⁾	8.8 ⁴⁾	1.4
Ni	92.3	2.7
Pb	44.1	1.3
Sb	40	4
Sn	16.3	0.6
V	89.2	2.8
Zr	49.4	1.3

¹⁾ Unweighted mean value of the means of accepted sets of data (consisting of at least 5 single results), each set being obtained by a different laboratory and/or a different method of measurement.

²⁾ Estimated expanded uncertainty U with a coverage factor of $k = 2$, corresponding to a level of confidence of approx. 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement, (GUM, ISO/IEC Guide 98-3:2008).

³⁾ Depending on the individual sample number: $M(\text{Li}) = (N-48) \times 0.033161 + 6.0$

⁴⁾ Depending on the individual sample number: $M(\text{Na}) = (N-48) \times 0.04788 + 8.8$

This certificate is valid until 05/2052.

Sample-No. N: _____

Informative Values

Element	Mass fraction ¹⁾ in mg/kg	Uncertainty ²⁾ in mg/kg
B	2.6	0.7
<p>¹⁾ Values were not certified, but given for information, when the number of accepted data sets was considered to be too low (< 5) or when the uncertainty from the inter-laboratory certification was considerably larger than the expected range or in case there were hints that the material was not homogeneous enough.</p> <p>²⁾ Estimated expanded uncertainty U with a coverage factor of $k = 2$, corresponding to a level of confidence of approx. 95 %, as defined in the Guide to the expression of uncertainty in measurement, (GUM, ISO/IEC Guide 98-3:2008).</p>		

Sample Description

The Reference Material is available in the form of discs (approx. 65 mm diameter and 30 mm height).

Recommended Use

The CRM is intended for establishing or checking the calibration of spark optical emission spectrometers 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 must be prepared by turning or milling of the sample surface.

An area 8 mm in diameter in the centre of the discs should be avoided for spark optical emission spectrometry.

Transport and Storage

The material should be stored in a dry and clean environment at room temperature. Transport can be done under normal ambient conditions.

Participating Laboratories

AMAG Austria Metall AG, Ranshofen, Austria
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
Constellium, Centre de Recherches de Voreppe, Voreppe, France
Speira GmbH, R&D, Bonn, Germany
Hydro Aluminium Rolled Products GmbH, Hamburg, Germany
Łukasiewicz Research Network – Institute of Non-Ferrous Metals, Gliwice, Poland
revierlabor, Essen, Germany
TRIMET Aluminium SE, Essen, Germany

Metrological Traceability

To ensure traceability of the certified mass fractions to the SI (Système International d'Unités) calibration was performed using standard solutions prepared from pure metals or stoichiometric compounds or with traceable commercial calibration solutions.

Means of Accepted Data Sets

Certified values
Mass fraction in %

Line No.	Si	Fe	Cu	Mn	Mg	Cr	Ga	Zn	Ti
1	0.1355	0.993	0.0170	0.0446	0.0170	0.0097	0.0133	0.0272	0.0174
2	0.1369	0.995	0.0172	0.0458	0.0173	0.0103	0.0136	0.0275	0.0174
3	0.1388	0.996	0.0176	0.0458	0.0186	0.0105	0.0137	0.0278	0.0185
4	0.1440	0.997	0.0182	0.0463	0.0188	0.0105	0.0138	0.0280	0.0186
5	0.1461	0.998	0.0182	0.0465	0.0202	0.0105	0.0139	0.0281	0.0189
6	0.1493	1.001	0.0183	0.0466	0.0202	0.0105	0.0144	0.0284	0.0189
7	0.1501	1.001	0.0184	0.0470	0.0202	0.0106	0.0144	0.0285	0.0190
8	0.1504	1.003	0.0185	0.0473	0.0204	0.0109	0.0145	0.0286	0.0192
9	0.1515	1.004	0.0185	0.0476	0.0205	0.0110	0.0145	0.0288	0.0193
10	0.1569	1.006	0.0185	0.0478	0.0210	0.0111	0.0147	0.0290	0.0194
11	0.1579	1.007	0.0186	0.0481	0.0211	0.0111	0.0148	0.0291	0.0195
12		---	0.0188	0.0490	0.0230			0.0292	0.0199
13				0.0493	0.0253			0.0294	0.0200
14								0.0305	
<i>M</i>	0.1470	1.000	0.0182	0.0471	0.0203	0.0106	0.0141	0.0286	0.0189
<i>s_M</i>	0.0076	0.005	0.0006	0.0014	0.0023	0.0005	0.0005	0.0009	0.0008
\bar{s}_i	0.0018	0.006	0.0004	0.0006	0.0005	0.0004	0.0003	0.0005	0.0004

Certified values
Mass fraction in mg/kg

Values for
information

Line No.	Be	Bi	Ca	Cd	Co	Hg	Li	Na	Ni	Pb	Sb	Sn	V	Zr	B
1	4.52	12.8	14.0	18.5	17.9	17.9	4.2	6.4	87.7	42.0	35.0	15.9	83.1	46.3	2.12
2	4.87	13.2	14.8	18.7	19.6	19.8	4.7	7.2	88.0	42.5	38.4	16.0	86.8	46.7	2.15
3	4.88	13.5	17.2	19.6	19.7	19.8	4.7	8.4	89.0	43.0	38.8	16.1	87.2	47.8	2.69
4	5.03	14.2	18.4	19.8	20.0	20.3	5.3	9.9	89.7	43.2	38.9	16.2	88.1	47.9	3.23
5	5.34	14.9	18.8	19.9	20.1	20.8	5.5	10.1	90.2	43.4	40.0	16.3	88.3	48.0	
6	5.46	14.9		20.2	20.9	21.0	5.7	10.5	91.5	44.2	40.6	16.4	88.8	48.8	
7	5.46	15.1		20.3	21.6		6.0		91.5	44.4	41.4	16.4	89.1	49.3	
8	5.52	15.4		20.6	21.8		6.7		91.8	45.3	43.1	16.4	89.6	49.5	
9	5.65	15.6		20.6	22.1		6.8		94.2	45.8		16.4	93.5	51.2	
10	5.67	16.1		21.0	22.2		7.0		96.2	46.9		16.5	97.5	51.2	
11	5.67	16.9		21.1	22.7		7.2		98.9			---		51.8	
12	5.75	17.8		22.4	23.6		8.1		99.0					52.0	
13				---	24.5									52.2	
<i>M</i>	5.32	15.0	16.6	20.2	21.3	19.9	6.0	8.8	92.3	44.1	39.5	16.3	89.2	49.4	2.55
<i>s_M</i>	0.40	1.5	2.2	1.1	1.9	1.1	1.2	1.7	4.0	1.6	2.4	0.3	4.0	2.1	0.52
<i>s_i</i>	0.24	0.9	0.6	0.4	0.5	1.1	0.4	1.0	2.0	1.3	1.7	0.7	1.4	0.8	0.18

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. A data set consists of at least 5 but usually 6 single values of one laboratory.

M : mean of laboratory means

s_M : standard deviation of laboratory means

s_i : averaged repeatability standard deviation (square root of the mean of laboratory variances)

Analytical Method used for Certification

Element	Line Number	Method
Si	1, 4, 6, 7, 8, 10, 11 2, 3 5, 9	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid Spectrophotometry
Fe	1, 2, 3, 4, 8, 9 5, 6, 11 7 10	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid FAAS, dissolution with acid Spectrophotometry
Cu	1, 4, 6, 12 2, 3, 7, 8, 9, 10, 11 5	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH FAAS, dissolution with acid
Mn	1, 3, 8, 9, 11 2 4, 5, 7, 10, 12, 13 6	ICP-OES, dissolution with acid FAAS, dissolution with acid ICP-OES, dissolution with NaOH Spectrophotometry
Mg	1, 4, 5, 6, 10, 11, 12 2 3, 7, 8, 9 13	ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid ICP-OES, dissolution with acid FAAS, dissolution with acid
Cr	1, 3, 5, 6, 11 2, 4, 7, 8, 9, 10	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH
Ga	1, 3, 6, 8, 10 2, 4, 9 5, 7, 11	ICP-OES, dissolution with acid ICP-MS, dissolution with acid ICP-OES, dissolution with NaOH
Zn	1, 2, 6, 9, 12 3, 4, 10, 11, 13, 14 5, 8 7	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid ICP-MS, dissolution with acid FAAS, dissolution with acid
Ti	1, 4, 8, 9, 11 2 3, 5, 6, 7, 10, 12 13	ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid ICP-OES, dissolution with acid Spectrophotometry
Be	1, 5, 8, 9, 10 2, 4, 6, 7, 11 3, 12	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
Bi	1, 3, 10, 11 2, 4, 6, 8, 9 5, 7, 12	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid ICP-MS, dissolution with acid
Ca	1, 2, 3, 4, 5	ICP-OES, dissolution with acid
Cd	1, 3, 4, 7, 9, 10 2, 11, 12 5, 6, 8	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
Co	1, 2, 5, 13 3, 4 6, 7, 8, 9, 10, 11, 12	ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid ICP-OES, dissolution with acid

Element	Line Number	Method
Hg	1	ICP-MS, dissolution with acid
	2	ICP-OES, dissolution with NaOH
	3, 5	ICP-OES, dissolution with acid
	4	Atomic fluorescence spectrometry
	6	CVAAS
Li	1, 7, 9, 12	ICP-OES, dissolution with acid
	2, 4, 11	ICP-MS, dissolution with acid
	3, 5, 8, 10	ICP-OES, dissolution with NaOH
	6	FAES, dissolution with acid
Na	1, 2, 4, 5, 6	ICP-OES, dissolution with acid
	3	ETAAS, dissolution with acid
Ni	1, 3, 5, 6, 7	ICP-OES, dissolution with acid
	2, 4, 8, 9, 12	ICP-OES, dissolution with NaOH
	10, 11	ICP-MS, dissolution with acid
Pb	1, 2, 4, 8, 9	ICP-OES, dissolution with acid
	3, 5, 7	ICP-MS, dissolution with acid
	6, 10	ICP-OES, dissolution with NaOH
Sb	1, 2, 3, 5, 8	ICP-OES, dissolution with acid
	4, 6, 7	ICP-MS, dissolution with acid
Sn	1, 2, 7, 10	ICP-OES, dissolution with NaOH
	3, 5, 9	ICP-MS, dissolution with acid
	4, 6, 8	ICP-OES, dissolution with acid
V	1, 3, 4, 10	ICP-OES, dissolution with acid
	2, 5, 6, 7, 9	ICP-OES, dissolution with NaOH
	8	Spectrophotometry
Zr	1, 5, 9, 11	ICP-OES, dissolution with acid
	2, 4, 12	ICP-MS, dissolution with acid
	3	Spectrophotometry
	6, 7, 8, 10, 13	ICP-OES, dissolution with NaOH
<i>B</i>	<i>1, 2, 3</i>	<i>ICP-OES, dissolution with acid</i>
	<i>4</i>	<i>ICP-MS, dissolution with acid</i>

Abbreviations:

CVAAS – Cold vapor atomic absorption spectrometry

ETAAS – Electrothermal atomic absorption spectrometry

FAAS – Flame atomic absorption spectrometry

FAES – Flame atomic emission spectrometry

ICP-OES – Inductively coupled plasma - optical emission spectrometry

ICP-MS – Mass spectrometry with inductively coupled plasma

Technical Report

A detailed technical report describing the analysis procedures and the treatment of the analytical data used to certify BAM-M323 is available on request or can be downloaded from BAM website (www.bam.de).

Accepted as BAM-CRM on
Bundesanstalt für Materialforschung und -prüfung (BAM)



Dr. S. Richter
Committee for Certification

Dr. S. Recknagel
Project Coordinator

BAM holds an accreditation as a reference material producer according to ISO/IEC 17034. 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.



This Reference Material is offered by:

Bundesanstalt für Materialforschung und -prüfung (BAM)
Richard-Willstätter-Str. 11, 12489 Berlin

Phone: +49 30 8104 2061
Fax: +49 30 8104 72061

Email: sales.crm@bam.de
Internet: www.webshop.bam.de