

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-M324

AlMn1Mg1Cu

Certified Values

Element	Mass fraction ¹⁾ in %	Uncertainty ²⁾ in %
Si	0.348	0.005
Fe	0.501	0.007
Cu	0.198	0.003
Mn	1.072	0.011
Mg	1.201	0.019
Cr	0.0258	0.0005
Ga	0.0306	0.0004
Zn	0.176	0.003
Ti	0.0370	0.0007
	in mg/kg	in mg/kg
B	9.8	1.9
Be	8.7	0.3
Bi	9.0	1.3
Ca	13.7	1.2
Cd	45.4	1.8
Co	48.9	1.3
Hg	7.2	1.1
Li	10.1	0.8
Ni	88.8	2.1
Pb	46.8	2.0
Sb	42	6
Sn	87.3	1.8
Sr	17.3	1.4
V	91.5	2.8
Zr	19.5	1.0
<p>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.</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>		

This certificate is valid until 05/2052.

Informative Values

Element	Mass fraction ¹⁾ in mg/kg	Uncertainty ²⁾ in mg/kg
Na	9.0	1.6

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.

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).

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
Suisse Technology Partners, Neuhausen, Switzerland
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	---	0.492	---	1.032	1.151	0.0248	0.0295	0.169	0.0362
2	0.340	0.495	0.194	1.054	1.174	0.0249	0.0299	0.172	0.0363
3	0.342	0.496	0.194	1.054	1.178	0.0250	0.0301	0.173	0.0364
4	0.343	0.500	0.195	1.055	1.186	0.0254	0.0301	0.175	0.0364
5	0.345	0.500	0.195	1.064	1.189	0.0256	0.0303	0.175	0.0367
6	0.348	0.500	0.197	1.065	1.190	0.0256	0.0304	0.175	0.0367
7	0.349	0.501	0.197	1.073	1.193	0.0258	0.0307	0.175	0.0368
8	0.349	0.501	0.200	1.076	1.195	0.0259	0.0307	0.177	0.0369
9	0.350	0.502	0.200	1.079	1.210	0.0260	0.0309	0.177	0.0370
10	0.350	0.502	0.200	1.083	1.211	0.0261	0.0310	0.178	0.0372
11	0.352	0.503	0.200	1.084	1.219	0.0264	0.0310	0.178	0.0374
12	0.361	0.503	0.201	1.086	1.221	0.0266	0.0311	0.180	0.0374
13		0.504	0.201	1.088	1.238	0.0274	0.0312	0.180	0.0376
14		0.505	0.204	1.096	1.263		0.0316	0.183	0.0378
15		0.505		1.097					0.0378
16									0.0381
<i>M</i>	0.348	0.501	0.198	1.072	1.201	0.0258	0.0306	0.176	0.0370
<i>s_M</i>	0.006	0.004	0.003	0.019	0.029	0.0007	0.0006	0.004	0.0006
\bar{s}_i	0.004	0.006	0.002	0.011	0.014	0.0003	0.0003	0.003	0.0004

Certified values
Mass fraction in mg/kg

Values for
information

Line No.	B	Be	Bi	Ca	Cd	Co	Hg	Li	Ni	Pb	Sb	Sn	Sr	V	Zr	Na
1	7.99	---	---	12.3	41.6	46.3	4.1	9.5	84.5	---	35.1	85.2	---	88.9	18.0	7.6
2	9.37	---	8.09	12.3	42.5	47.1	5.7	9.6	84.8	45.1	39.0	85.6	16.6	89.4	18.2	8.9
3	9.76	8.06	8.25	13.1	43.3	47.5	6.5	9.6	86.8	45.7	40.0	86.0	16.8	89.7	18.4	9.0
4	10.77	8.10	8.55	13.9	43.8	48.0	7.4	9.7	87.7	45.8	40.2	86.3	17.0	89.8	18.8	9.2
5	11.24	8.42	8.65	14.0	44.5	48.0	7.5	9.7	88.0	46.3	41.4	86.8	17.2	90.0	18.9	9.3
6		8.51	8.67	14.3	44.6	48.2	7.9	9.8	88.4	46.8	41.7	87.4	17.4	90.2	19.1	9.7
7		8.58	8.97	16.1	44.9	48.5	8.1	9.9	89.0	46.8	42.4	87.4	17.6	90.7	19.7	
8		8.61	8.99		45.2	49.0	8.1	9.9	89.5	46.9	42.5	88.3	17.6	91.4	20.3	
9		8.68	9.00		45.3	49.2	9.6	10.3	89.6	47.1	43.3	88.4	18.1	92.1	20.4	
10		8.69	9.46		45.3	49.3		10.5	90.1	47.9	43.4	88.7		93.2	20.4	
11		8.84	9.74		46.5	49.8		10.7	90.2	48.0	45.7	89.7		95.4	20.5	
12		8.93	10.35		46.6	49.8		10.7	90.4	48.6	49.1			97.5	20.6	
13		9.00			47.8	51.5		10.7	90.8						20.8	
14		9.00			48.2	51.8		11.1	93.5							
15		9.37			50.3											
<i>M</i>	9.83	8.68	8.97	13.7	45.4	48.9	7.2	10.1	88.8	46.8	42.0	87.3	17.3	91.5	19.5	9.0
<i>s_M</i>	1.28	0.37	0.67	1.3	2.3	1.6	1.6	0.6	2.4	1.1	3.5	1.5	0.5	2.7	1.1	0.8
\bar{s}_i	0.30	0.10	0.36	0.9	0.7	0.8	0.5	0.2	1.8	1.1	1.3	1.4	0.2	1.3	0.6	0.4

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

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

Analytical Method used for Certification

Element	Line Number	Method
Si	2, 3, 5, 7, 8, 9, 10, 11 4, 12 6	ICP-OES, dissolution with NaOH Spectrophotometry ICP-OES, dissolution with acid
Fe	1 2, 3, 4, 6, 7, 9, 14, 15 5 8, 10, 11, 12, 13	FAAS, dissolution with acid ICP-OES, dissolution with NaOH Spectrophotometry ICP-OES, dissolution with acid
Cu	2, 5, 7, 8, 10, 12, 13 3 4, 6, 9, 11, 14	ICP-OES, dissolution with NaOH FAAS, dissolution with acid ICP-OES, dissolution with acid
Mn	1, 4, 6, 7, 10, 12, 13, 14 2, 3, 5, 11, 15 8 9	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid FAAS, dissolution with acid Spectrophotometry
Mg	1, 3, 5, 9, 11 2, 4, 6, 7, 8, 12, 13, 14 10	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH FAAS, dissolution with acid
Cr	1, 2, 3, 7, 11, 13 4, 5, 6, 8, 9, 12 10	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
Ga	1, 2, 5, 7, 8, 10 3, 12 4, 6, 9, 11, 13, 14	ICP-OES, dissolution with acid ICP-MS, dissolution with acid ICP-OES, dissolution with NaOH
Zn	1 2, 3, 5, 8, 9, 12, 13 4, 6, 7, 10, 11, 14	FAAS, dissolution with acid ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid
Ti	1, 2, 4, 8, 11, 12 3 5, 6, 7, 9, 14, 15, 16 10, 13	ICP-OES, dissolution with acid Spectrophotometry ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
B	1 2, 4, 5 3	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid ICP-MS, dissolution with acid
Be	3, 4, 7, 9, 11 5, 8, 10, 12, 13, 14 6, 15	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
Bi	2, 3, 9 4, 6, 7, 11 5, 8, 10, 12	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid ICP-MS, dissolution with acid
Ca	1, 2, 3, 4, 5, 6, 7	ICP-OES, dissolution with acid
Cd	1, 3, 13, 14, 15 2, 4, 6, 7, 9, 10, 12 5, 8, 11	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid ICP-MS, dissolution with acid

Element	Line Number	Method
Co	1, 2, 7, 11, 14 3, 4, 5, 6, 9, 10 8, 12, 13	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid ICP-MS, dissolution with acid
Hg	1 2, 3, 5, 7 4, 8 6 9	ICP-OES, dissolution with NaOH ICP-OES, dissolution with acid ICP-MS, dissolution with acid Atomic fluorescence spectrometry CVAAS
Li	1, 2, 7, 10, 11, 13, 14 3, 6 4, 8, 9, 12 5	ICP-OES, dissolution with acid ICP-MS, dissolution with acid ICP-OES, dissolution with NaOH FAES, dissolution with acid
Ni	1, 2, 4, 6, 10, 13 3, 5, 7, 8, 11 9, 12, 14	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
Pb	2, 3, 7, 9, 11 4, 5 6, 8, 10, 12	ICP-OES, dissolution with acid ICP-MS, dissolution with acid ICP-OES, dissolution with NaOH
Sb	1, 2, 3, 6, 7, 11 4, 5, 8, 9 10, 12	ICP-OES, dissolution with acid ICP-MS, dissolution with acid ICP-OES, dissolution with NaOH
Sn	1, 3, 4 2, 5, 6, 8, 10 7, 9, 11	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
Sr	2, 4, 5, 6, 7, 8 3 9	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
V	1, 3, 12 2, 4, 5, 7, 8, 9 6 10, 11	ICP-OES, dissolution with acid ICP-OES, dissolution with NaOH Spectrophotometry ICP-MS, dissolution with acid
Zr	1, 4, 5, 6 2 3, 7, 8, 9, 11, 13 10, 12	ICP-OES, dissolution with acid Spectrophotometry ICP-OES, dissolution with NaOH ICP-MS, dissolution with acid
Na	1, 2, 3, 4, 5 6	<i>ICP-OES, dissolution with acid</i> <i>ETAAS, 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-M324 is available on request or can be downloaded from BAM website (www.bam.de).

Accepted as BAM-CRM on 2022-05-30

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.



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