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-M322

AlMn1Cu

Certified Values

Element	Mass fraction [1] in %	Uncertainty [2] in %
Si	0.696	0.021
Fe	0.475	0.014
Cu	0.200	0.006
Mn	1.310	0.018
Mg	0.226	0.005
Cr	0.1185	0.0024
Ni	0.0293	0.0005
Zn	0.1053	0.0020
Ti	0.0279	0.0009
	in mg/kg	**in mg/kg**
Be	7.2	0.2
Bi	76.5	2.8
Ca	19.9	1.7
Cd	10.1	0.3
Co	9.7	0.4
Ga	57.7	3.0
Li[3]	18.1[3]	0.8
Na[4]	15.7[4]	1.1
Pb	92.0	2.5
Sn	97.7	2.4
V	114.1	2.5
Zr	98.0	1.9

[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(Li) = (N-48) x 0.030903 + 18.1**

[4] Depending on the individual sample number: **M(Na) = (N-48) x 0.040625 + 15.7**

This certificate is valid until 08/2051.

Sample-No. N: _____

Values for information

Element	Mass fraction [1] in mg/kg	Uncertainty [2] in mg/kg
B	3.6	1.2

[1] Values were not certified, but given for information, because the uncertainty from the inter-laboratory certification was considerably larger than the expected range.

[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 and X-ray 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

ALERIS Rolled Products Germany GmbH, Koblenz, Germany
AMAG Austria Metall AG, Ranshofen, Austria
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
Hydro Aluminium Rolled Products GmbH, R&D, Bonn, Germany
Hydro Aluminium Rolled Products GmbH, Hamburg, Germany
Łukasiewicz Research Network – Institute of Non-Ferrous Metals, Gliwice, Poland
Leichtmetall Aluminium Giesserei Hannover GmbH, Hannover, Germany
Otto Fuchs KG, Meinerzhagen, Germany
revierlabor, Essen, Germany
TRIMET Aluminium SE, Essen, Germany

Means of Accepted Data Sets

	Certified values Mass fraction in %									Mass fraction in mg/kg												Values for information
Line No.	**Si**	**Fe**	**Cu**	**Mn**	**Mg**	**Cr**	**Ni**	**Zn**	**Ti**	**Be**	**Bi**	**Ca**	**Cd**	**Co**	**Ga**	**Li**	**Na**	**Pb**	**Sn**	**V**	**Zr**	***B***
1	0.662	0.453	0.193	1.255	0.217	0.1158	---	0.1036	0.0272	6.81	---	18.9	9.6	9.1	52.9	16.3	12.5	88.7	93.3	112.3	---	*2.36*
2	0.682	0.454	0.196	1.277	0.218	0.1161	0.0287	0.1036	0.0273	6.95	73.5	19.4	9.8	9.2	53.2	16.8	12.5	89.3	93.3	112.6	94.4	*3.00*
3	0.689	0.455	0.198	1.284	0.219	0.1162	0.0288	0.1041	0.0275	7.07	75.9	19.8	9.9	9.4	53.7	17.3	14.9	89.8	95.8	113.7	94.4	*3.51*
4	0.689	0.467	0.198	1.290	0.219	0.1166	0.0289	0.1042	0.0276	7.14	75.9	20.0	10.0	9.4	54.1	17.5	15.9	90.5	96.8	114.0	96.3	*3.65*
5	0.689	0.469	0.198	1.295	0.220	0.1169	0.0289	0.1045	0.0277	7.15	76.0	20.4	10.0	9.4	54.7	17.6	16.7	90.7	97.1	114.1	96.4	*3.86*
6	0.694	0.470	0.199	1.297	0.224	0.1176	0.0291	0.1045	0.0277	7.25	76.1	21.2	10.1	9.6	56.1	17.9	17.3	91.7	97.7	114.1	97.0	*5.17*
7	0.695	0.470	0.200	1.302	0.225	0.1182	0.0291	0.1046	0.0278	7.27	76.1		10.1	9.6	57.0	18.0	17.5	93.2	98.1	114.3	98.2	*< 6*
8	0.698	0.473	0.200	1.304	0.226	0.1188	0.0291	0.1047	0.0279	7.32	76.2		10.2	9.8	58.7	18.5	18.3	93.7	98.4	114.6	98.6	
9	0.706	0.475	0.201	1.305	0.226	0.1188	0.0294	0.1052	0.0279	7.34	77.3		10.2	9.9	59.6	18.7		95.5	98.5	114.8	98.7	
10	0.707	0.477	0.201	1.316	0.228	0.1193	0.0294	0.1053	0.0280	7.38	77.5		10.3	10.0	59.9	19.0		96.7	98.7	115.5	99.7	
11	0.711	0.481	0.202	1.327	0.228	0.1195	0.0295	0.1055	0.0281	7.43	77.6		10.5	10.5	66.4	19.7		---	98.9	115.6	100.0	
12	0.727	0.481	0.202	1.327	0.234	0.1204	0.0297	0.1062	0.0281		79.3		---	10.6	66.6	19.8			100.3	---	100.2	
13		0.483	0.202	1.328	0.234	0.1205	0.0297	0.1069	0.0282				---						103.2	---	101.7	
14		0.486	0.204	1.335	0.239	0.1209	0.0297	0.1077	0.0286													
15		0.497	0.205	1.343	0.244	0.1214	0.0300	0.1083	0.0287													
16		0.502		1.381		---																
M	0.696	0.475	0.200	1.310	0.226	0.1185	0.0293	0.1053	0.0279	7.19	76.5	19.9	10.1	9.7	57.7	18.1	15.7	92.0	97.7	114.1	98.0	*3.6*
s_M	0.017	0.015	0.004	0.030	0.009	0.0019	0.0005	0.0015	0.0005	0.20	1.5	0.8	0.3	0.5	4.8	1.1	2.3	2.7	2.7	1.0	2.4	*1.0*
$\bar{s}_i$	0.007	0.011	0.003	0.011	0.004	0.0011	0.0005	0.0013	0.0005	0.14	1.8	0.9	0.3	0.2	1.7	0.4	0.8	2.1	2.2	1.8	1.5	*0.6*

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 single values of one laboratory. Values given in *Italics* are for information only.

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

Element	Line Number	Method
Co	1, 2, 4, 6, 8, 9, 10	ICP-OES, dissolution with acid
	3, 5	ICP-OES, dissolution with NaOH
	7, 11, 12	ICP-MS, dissolution with acid
Ga	1, 2	ICP-MS, dissolution with acid
	3, 4, 8, 10, 11	ICP-OES, dissolution with acid
	5, 6, 7, 9, 12	ICP-OES, dissolution with NaOH
Li	1, 9	ICP-MS, dissolution with acid
	2, 4, 5	ICP-OES, dissolution with NaOH
	3, 6, 7, 8, 10, 12	ICP-OES, dissolution with acid
	11	FAES, dissolution with acid
Na	1, 3, 4, 5, 6, 8	ICP-OES, dissolution with acid
	2, 7	ETAAS, dissolution with acid
Pb	1, 2, 8	ICP-OES, dissolution with NaOH
	3, 6, 7, 9, 10	ICP-OES, dissolution with acid
	4, 5	ICP-MS, dissolution with acid
Sn	1, 5, 6, 9, 12	ICP-OES, dissolution with acid
	2, 3, 4, 7, 10, 11	ICP-OES, dissolution with NaOH
	8, 13	ICP-MS, dissolution with acid
V	1, 2, 5, 7, 9, 11	ICP-OES, dissolution with NaOH
	3, 4, 6, 8	ICP-OES, dissolution with acid
	10	Spectrophotometry
Zr	2, 4, 7, 12	ICP-OES, dissolution with NaOH
	3, 6, 8, 9, 10	ICP-OES, dissolution with acid
	5	ICP-MS, dissolution with acid
	11	Spectrophotometry
B	*1, 2, 4, 6, 7*	*ICP-OES, dissolution with acid*
	3, 5	*ICP-MS, dissolution with acid*

Abbreviations: 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

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.

Certification Report

A detailed technical report describing the analysis procedures and the treatment of the analytical data used to certify BAM-M322 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 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.	DAkkS Deutsche Akkreditierungsstelle D-RM-11075-01-00

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