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

European Reference Materials

CERTIFICATE OF ANALYSIS

ERM®-EB384

Pure copper

ausverkauft / out of stock

Certified Values		
	Certified value [1]	Uncertainty [2]
Element	Mass fraction in mg/kg	
Ag	10.3	0.4
Al	13.0	0.8
As	5.0	0.4
Bi	3.34	0.22
Cd	3.95	0.09
Co	3.88	0.16
Cr	6.53	0.21
Fe	32.8	1.9
Mg	14.6	0.5
Mn	6.88	0.15
Ni	5.7	0.4
Pb	5.7	0.5
Sb	12.0	0.4
Se	4.24	0.19
Te	7.0	0.5

[1] Unweighted mean value of the means of accepted sets of data (at least 4 but usually 6), each set being obtained in a different laboratory and/or a different method of measurement. The values are traceable to the SI (Système International d'Unités) via calibration using sufficiently pure metals or substances of known stoichiometry.

[2] Estimated expanded uncertainty *U* with a coverage factor of about *k*=2, corresponding to a level of confidence of 95 %, as defined in the Guide to the expression of uncertainty in measurement, ISO, 1993.

This certificate is valid until 01/2056; this validity may be extended as further evidence of stability becomes available.

The minimum sample size for wet chemical analysis is 0.5 g.

NOTE

European Reference Material ERM®-EB384 was originally certified as BAM-M384. It was produced and certified under the responsibility of Bundesanstalt für Materialforschung und –prüfung (BAM) in cooperation with the Committee of Chemists of the GDMB, Gesellschaft für Bergbau, Metallurgie, Rohstoff- und Umwelttechnik according to the principles laid down in the technical guidelines of the European Reference Materials® co-operation agreement between BAM-LGC-IRMM. Information on these guidelines is available on the Internet (http://www.erm-crm.org).

Accepted as an ERM®, Berlin, 2008-04-25.

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Indicative Values[3)]

	Indicative value [4)]	Uncertainty [5)]
Element	Mass fraction in mg/kg	
S	4.1	1.0
Si	5.0	0.7
Sn	10.2	0.9
Ti	2.10	0.23
Zn	12.7	2.1
Element	Mass fraction in mg/kg	
Zr	< 9	

[3)] Values were not certified, but given as indicative values, when the number of accepted data sets was considered to be too low, when the spread from the round robin certification was considerably larger than the state of the practice or when only 'lower as' values were reported from the round robin certification.

[4)] Unweighted mean value of the means of accepted sets of data, each set being obtained in a different laboratory and/or a different method of measurement. The values are traceable to the SI (Système International d'Unités) via calibration using sufficiently pure substances of known stoichiometry.

[5)] Estimated expanded uncertainty *U* with a coverage factor of about *k*=2, corresponding to a level of confidence of 95 %, as defined in the Guide to the expression of uncertainty in measurement, ISO, 1993.

DESCRIPTION OF THE SAMPLE

The Reference Material is available in the form of discs (40 mm diameter and 30 mm height). It is intended for establishing and checking the calibration of optical emission and X-ray spectrometers for the analysis of samples of similar materials.

MEANS OF ACCEPTED DATA SETS (FOR ONE METHOD AT ONE LABORATORY, RESPECTIVELY)

Mass fraction in mg/kg

Certified values

Line no.	Ag	Al	As	Bi	Cd	Co	Cr	Fe	Mg	Mn	Ni	Pb	Sb	Se	Te
1	9.06	---	4.08	3.03	3.82	3.58	6.01	---	---	6.55	4.69	4.34	---	---	6.28
2	9.68	11.38	4.67	3.10	3.86	3.61	6.31	29.10	13.88	6.69	5.15	5.28	10.86	---	6.39
3	9.78	11.72	4.74	3.14	3.86	3.80	6.38	29.30	13.94	6.73	5.16	5.32	11.14	4.02	6.45
4	9.87	13.09	4.91	3.43	3.87	3.80	6.43	30.43	14.70	6.75	5.68	5.53	11.39	4.10	6.54
5	9.88	13.21	5.19	3.46	3.94	3.83	6.48	31.17	14.71	6.76	5.72	5.78	11.73	4.22	6.99
6	10.10	13.31	5.22	3.59	3.95	3.86	6.54	31.35	14.74	6.85	5.75	5.98	12.01	4.23	7.02
7	10.14	13.61	5.22	3.61	4.05	3.90	6.55	32.66	14.91	6.88	5.81	6.00	12.10	4.45	7.42
8	10.20	13.80	5.23	---	4.06	3.97	6.58	32.80	15.02	6.94	5.89	6.22	12.17	4.46	7.57
9	10.22	13.88	5.41		4.11	4.25	6.60	33.26	15.29	7.07	6.06	6.28	12.22		7.90
10	10.37		5.52		---	4.25	6.65	33.34		7.20	6.23	6.30	12.30		---
11	10.44		---				7.27	33.38		7.27	6.87		12.31		
12	11.08						---	37.10					12.38		
13	11.20							39.45					12.44		
14	11.65												12.55		
15													13.04		
M :	10.26	13.00	5.02	3.34	3.95	3.88	6.53	32.78	14.65	6.88	5.73	5.70	12.05	4.24	6.95
s_M:	0.672	0.940	0.428	0.243	0.107	0.227	0.305	3.014	0.496	0.222	0.586	0.610	0.584	0.181	0.579
$\bar{s}_i$:	0.221	0.416	0.217	0.135	0.141	0.097	0.185	0.957	0.324	0.120	0.224	0.203	0.324	0.136	0.226

Indicative values

S	Si	Sn	Ti	Zn	Zr
2.29	4.33	8.96	1.66	8.56	0.21
3.61	4.80	9.11	1.92	8.95	0.35
3.81	5.06	9.12	2.02	9.74	0.44
4.10	5.09	9.20	2.03	10.57	0.55
4.46	5.79	9.50	2.03	14.08	1.28
4.92		9.58	2.23	14.13	2.19
5.7		9.61	2.42	14.24	2.56
		9.89	2.50	15.46	3.68
		11.30		15.52	3.77
		11.99		15.81	4.15
		12.00			5.67
		12.28			6.64

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 (Grubbs 95 %). A data set consists of at least 4 but usually 6 single values of one laboratory. " < "-values have not been considered in statistical evaluation.

M : mean of means of data sets

$\bar{s}_i$: mean of standard deviations of data sets under repeatability conditions

s_M : standard deviation of means of data sets

TECHNICAL REPORT

A detailed technical report (in German) describing the analysis procedures and the treatment of the analytical data used to certify ERM®-EB384 is available on request.

ANALYTICAL METHOD USED FOR CERTIFICATION

Element	Line no.	Method
Ag	1	Arc emission spectroscopy
	2, 3, 4, 6, 13	Atomic emission spectrometry with inductively coupled plasma
	5	Electrothermal atomic absorption spectrometry
	7, 10	Neutron activation analysis
	8, 11, 12	Mass spectrometry with inductively coupled plasma
	9	Activation analysis with high-energy photons
	14	Synchrotron X-Ray fluorescence spectroscopy
Al	2, 3, 4, 5	ICP OES
	6, 8, 9	Mass spectrometry with inductively coupled plasma
	7	ICP OES after electrolytic Cu separation
As	1	Arc emission spectroscopy
	2, 3	Mass spectrometry with inductively coupled plasma
	4	ICP OES after electrolytic Cu separation
	5	Electrothermal atomic absorption spectrometry
	6, 9, 10	ICP OES
	7	Activation analysis with high-energy photons
	8	Neutron activation analysis
Bi	1	ICP OES after Lanthanum precipitation
	2	ICP OES after electrolytic Cu separation
	3	Arc emission spectroscopy
	4, 7	Mass spectrometry with inductively coupled plasma
	5	ICP OES
	6	Electrothermal atomic absorption spectrometry
Cd	1	Activation analysis with high-energy photons
	2, 4, 7, 8	ICP OES
	3	Electrothermal atomic absorption spectrometry
	5, 6	Mass spectrometry with inductively coupled plasma
	9	Electrothermal atomic absorption spectrometry after electrolytic Cu separation
Co	1, 8, 10	Mass spectrometry with inductively coupled plasma
	2	Electrothermal atomic absorption spectrometry
	3, 5, 6	ICP OES
	4, 9	Neutron activation analysis
	7	ICP OES after electrolytic Cu separation
Cr	1, 8	Mass spectrometry with inductively coupled plasma
	2	Neutron activation analysis
	3, 5, 7, 9	ICP OES
	4	ICP OES after electrolytic Cu separation
	6	Electrothermal atomic absorption spectrometry
	10	Activation analysis with high-energy photons
	11	ICP OES after Lanthanum precipitation
Fe	2	Arc emission spectroscopy
	3, 4, 5, 6, 10	ICP OES
	7, 13	Mass spectrometry with inductively coupled plasma
	8	Photometry
	9	Electrothermal atomic absorption spectrometry after Lanthanum precipitation
	11	Electrothermal atomic absorption spectrometry
	12	Electrothermal atomic absorption spectrometry after electrolytic Cu separation

Element	Line no.	Method
Mg	2, 4, 6, 7	ICP OES
	3, 8, 9	Mass spectrometry with inductively coupled plasma
	5	ICP OES after electrolytic Cu separation
Mn	1, 4, 7	Mass spectrometry with inductively coupled plasma
	2, 3, 5, 6, 8	ICP OES
	9	ICP OES after electrolytic Cu separation
	10	Electrothermal atomic absorption spectrometry
	11	Activation analysis with high-energy photons
Ni	1, 6, 11	Mass spectrometry with inductively coupled plasma
	2	Activation analysis with high-energy photons
	3, 5	Electrothermal atomic absorption spectrometry
	4, 7, 8	ICP OES
	9	ICP OES after electrolytic Cu separation
	10	Arc emission spectroscopy
Pb	1, 7	ICP OES after Lanthanum precipitation
	2, 5	ICP OES
	3	ICP OES after electrolytic Cu separation
	4, 6, 10	Mass spectrometry with inductively coupled plasma
	8	Electrothermal atomic absorption spectrometry
	9	Arc emission spectroscopy
S	1	IR-detection after combustion (gas calibration)
	2, 5	Photometry
	3, 7	Titration
	4, 6	Sparc emission spectrometry
Sb	2, 14	Mass spectrometry with inductively coupled plasma
	3	Arc emission spectroscopy
	4	ICP OES after Lanthanum precipitation
	5, 9, 13	ICP OES
	6, 12	Neutron activation analysis
	7	Synchrotron X-Ray fluorescence spectroscopy
	8	Photometry
	10	Activation analysis with high-energy photons
	11	Electrothermal atomic absorption spectrometry
	15	Atomic Absorption Spectrometry after hydride generation
Se	3	Neutron activation analysis
	4, 5	ICP OES
	6	Electrothermal atomic absorption spectrometry
	7	ICP OES after Lanthanum precipitation
	8	Mass spectrometry with inductively coupled plasma
Si	1, 2, 3, 4	Sparc emission spectrometry
	5	ICP OES
Sn	1, 2, 3, 6, 10	ICP OES
	4, 9	ICP OES after Lanthanum precipitation
	5	Electrothermal atomic absorption spectrometry
	7, 8	Mass spectrometry with inductively coupled plasma
	11	Activation analysis with high-energy photons
	12	Synchrotron X-Ray fluorescence spectroscopy

Element	Line no.	Method
Te	1, 8	ICP OES
	2	Arc emission spectroscopy
	3	Electrothermal atomic absorption spectrometry
	4, 7	ICP OES after Lanthanum precipitation
	5	Synchrotron X-Ray fluorescence spectroscopy
	6, 9	Mass spectrometry with inductively coupled plasma
Ti	1, 3, 7	Mass spectrometry with inductively coupled plasma
	2, 4, 5, 6	ICP OES
	8	ICP OES after electrolytic Cu separation
Zn	1, 5, 7, 9, 10	ICP OES
	2, 3	Neutron activation analysis
	4, 6	Mass spectrometry with inductively coupled plasma
	8	ICP OES after electrolytic Cu separation
Zr	1, 9	Mass spectrometry with inductively coupled plasma
	2, 3, 5, 6	ICP OES
	4	ICP OES after electrolytic Cu separation
	7, 8, 11, 12	Sparc emission spectrometry
	10	Activation analysis with high-energy photons

Abbreviation: ICP OES - Atomic emission spectrometry with inductively coupled plasma

PARTICIPANTS

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- Laboratory I.11 (Metal Analysis)
- Laboratory I.43 (activation analysis, Gas Analysis)
- Project Group I.1902

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INTENDED USE

The CRM is intended for establishing and checking the calibration of optical emission and X-ray spectrometers for the analysis of samples of similar materials.

INSTRUCTIONS FOR USE, STORAGE

Before use, the surface of the material must be cleaned by milling or turning on a lathe.The material should be stored at ambient conditions in a dry and clean environment.

Supply of Reference Materials by Bundesanstalt für Materialforschung und –prüfung:

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