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

European Reference Materials

CERTIFICATE OF ANALYSIS

ERM®-EB389

CuNi25			
	Certified value [1]	Uncertainty [2]	
Element	Mass fraction in %		
Cu	74.3	±	0.5
Ni	24.7	±	0.5
Fe	0.107	±	0.006
Mn	0.415	±	0.011
Zn	0.1125	±	0.0026
Zr	0.098	±	0.011
Mg	0.067	±	0.009
Element	Mass fraction in mg/kg		
Pb	98	±	23
Cr	153	±	6
Co	770	±	28
Ti	660	±	18
Sn	262	±	34
Bi	44	±	10
Sb	46	±	5
Cd	16	±	3
P	93	±	17

[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 measurement. The values are traceable to the SI (Système International d'Unités) by the use of sufficiently pure substances of known stoichiometry for calibration.

[2] Estimated expanded uncertainty *U* with a coverage factor of about *k*=2, corresponding to a level of confidence of about 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (1995) ISO, Geneva.

This certificate is valid until 09/2057; this validity may be extended as further evidence of stability becomes available.
The minimum sample size for wet chemical analysis is 0.5 g.

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NOTE

European Reference Material ERM®-EB389 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).

Indicative Values[1)]

	Indicative value [2)]	Uncertainty [3)]	
Element	Mass fraction in mg/kg		
Al	123	±	10
S	308	±	23
Si	349	±	37
C	216	±	24
B	23	±	6

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

2) 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 measurement. The values are traceable to the SI (Système International d'Unités) by the use of sufficiently pure substances of known stoichiometry for calibration. For C and S some of the laboratories used CRMs for calibration. Values for these elements are therefore given as indicative.

3) Estimated expanded uncertainty *U* with a coverage factor of about *k*=2, corresponding to a level of confidence of about 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (1995) ISO, Geneva.

DESCRIPTION OF THE SAMPLE

The Reference Material is available in the form of discs (40 mm diameter, 30 mm thickness).

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

Before use, the surface of the material must be cleaned by milling or turning on a lathe. An area of approx. 10 mm diameter in the centre of the discs should not be used for spark emission spectrometry.

STORAGE

The material should be stored at ambient conditions in a dry and clean environment.

PARTICIPANTS

- Allgemeine Gold- und Silberscheideanstalt AG, Pforzheim (Germany)
- Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)
  - Working group „Metal Analysis; Metal Reference Materials“
  - Working group „Activation and Gas Analysis“
- Centre de Développement des Industries de Mise en Forme des Matériaux (CTIF), Sèvres (France)
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- KM Europa Metal AG, Osnabrück (Germany)
- Norddeutsche Affinerie AG, Hamburg (Germany)
- ThyssenKrupp VDM, Werdohl (Germany)
- W.C. Heraeus, Hanau (Germany)
- Wieland-Werke AG, Vöhringen (Germany)

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

Certified values
Mass fraction in %

Mass fraction in mg/kg

Indicative values
Mass fraction in mg/kg

Line No.	Cu	Ni	Fe	Mn	Zn	Zr	Mg	Pb	Cr	Co	Ti	Sn	Bi	Sb	Cd	P	*Al*	*S*	*Si*	*C*	*B*
1	74.14	24.41	0.0993	0.402	0.1100	0.0950	0.0662	86.6	143.8	751	648	240.0	39.85	---	---	84.1	*100.2*	*287*	*320*	*196*	*19.5*
2	74.15	24.52	0.1007	0.407	0.1108	0.0953	0.0662	92.3	148.5	752	651	249.3	40.53	42.8	13.92	88.0	*118.9*	*293*	*333*	*199*	*21.1*
3	74.16	24.63	0.1053	0.408	0.1111	0.0954	0.0665	92.7	149.8	761	655	249.8	41.73	44.7	14.72	88.9	*119.8*	*293*	*366*	*200*	*21.6*
4	74.24	24.64	0.1058	0.409	0.1122	0.0954	0.0667	95.9	151.8	761	656	259.5	44.44	45.0	14.82	90.1	*123.0*	*293*	*379*	*226*	*25.6*
5	74.26	24.71	0.1065	0.419	0.1123	0.0957	0.0668	97.3	152.6	765	656	259.8	46.07	45.0	15.41	90.3	*123.4*	*302*		*228*	*27.5*
6	74.29	24.72	0.1067	0.420	0.1127	0.0970	0.0673	101.8	154.7	772	660	261.5	47.64	45.6	15.95	94.6	*125.5*	*326*		*247*	
7	74.29	24.74	0.1071	0.421	0.1127	0.0992	0.0684	103.0	155.1	774	662	269.8	50.05	45.9	16.22	96.8	*132.2*	*331*			
8	74.30	24.75	0.1073	0.422	0.1147	0.0994	0.0685	104.3	155.9	778	667	273.0		46.1	16.45	98,7	*132.5*	*336*			
9	74.30	24.79	0.1077	0.423	0.1163	0.1007	0.0687	107.6	157.5	781	688	279.3		47.0	17.03	102.7	*142.8*				
10	74.41	24.82	0.1087			0.1016		---	158.6	785		281.5		48.3			*146.9*				
11	74.45	24.82	0.1105							790				48.9							
12		24.98	0.1136																		
13																					
M :	74.27	24.71	0.107	0.415	0.113	0.0975	0.0673	97.9	153	770	660	262	44.3	45.9	15.6	93	*127*	*308*	*349*	*216*	*23.1*
s_M:	0.100	0.150	0.004	0.008	0.002	0.0025	0.0011	6.8	5	14	12	14	3.9	1.8	1.1	6	*14*	*20*	*28*	*21*	*3.4*
$\overline{s}_i$:	0.031	0.090	0.0011	0.0023	0.0008	0.0013	0.00062	6.1	2.6	7	6	9	2.0	1.3	0.24	5	*1.8*	*8*	*6*	*5*	*0.9*

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).

M: mean of means of data sets
s_M: standard deviation of means of data sets*

$$\overline{s_i} = \sqrt{\sum_{j=1}^{N} s_j^2 / N}$$

*calculated of at least 4 but usually 6 single values

ANALYTICAL METHOD USED FOR CERTIFICATION

Element	Line no.	Method
Cu	1, 2	Inductively coupled plasma – optical emission spectrometry
	3, 4, 5, 6, 7, 8, 9, 10, 11	Electrogravimetry
Ni	1, 5, 6, 8, 10, 11	Inductively coupled plasma – optical emission spectrometry
	2, 3, 9, 12	Gravimetry
	4	Electrogravimetry
Fe	1, 3, 4, 5, 6, 8, 9, 10, 12	Inductively coupled plasma – optical emission spectrometry
	2	Spectrophotometry
	7, 11	Flame atomic absorption spectrometry
Mn	1, 3, 4, 7, 9	Inductively coupled plasma – optical emission spectrometry
	2, 6, 8	Spectrophotometry
	5	Flame atomic absorption spectrometry
Zn	1, 2, 3, 7, 8, 9	Inductively coupled plasma – optical emission spectrometry
	4, 5, 6	Flame atomic absorption spectrometry
Zr	1, 2, 3, 4, 5, 6, 7	Inductively coupled plasma – optical emission spectrometry
	8	Spectrophotometry
	9	Photon activation analysis
Mg	1, 2, 3, 5, 9	Inductively coupled plasma – optical emission spectrometry
	4, 6, 7, 8	Flame atomic absorption spectrometry
Pb	1, 3, 4, 5, 6, 7, 9	Inductively coupled plasma – optical emission spectrometry
	2	Flame atomic absorption spectrometry
	8	Electrothermal atomic absorption spectrometry
Cr	1	Photon activation analysis
	2	Neutron activation analysis
	3	Electrothermal atomic absorption spectrometry
	4, 5, 6, 8, 9, 10	Inductively coupled plasma – optical emission spectrometry
	7	Flame atomic absorption spectrometry
Co	1	Photon activation analysis
	2	Electrothermal atomic absorption spectrometry
	3, 5, 7, 8, 9, 10, 11	Inductively coupled plasma – optical emission spectrometry
	4	Neutron activation analysis
	6	Flame atomic absorption spectrometry
Ti	1, 2, 3, 4, 5, 6, 7, 8	Inductively coupled plasma – optical emission spectrometry
	9	Spectrophotometry
Sn	1, 9	Flame atomic absorption spectrometry
	2	Electrothermal atomic absorption spectrometry
	3	Photon activation analysis
	4, 5, 6, 7, 8, 10	Inductively coupled plasma – optical emission spectrometry
Bi	1, 2, 3, 4, 7	Inductively coupled plasma – optical emission spectrometry
	5	Flame atomic absorption spectrometry
	6	Electrothermal atomic absorption spectrometry

Element	Line no.	Method
Sb	2, 3, 4, 7, 9, 11	Inductively coupled plasma – optical emission spectrometry
	5	Photon activation analysis
	6	Flame atomic absorption spectrometry
	8	Neutron activation analysis
	10	Spectrophotometry
Cd	2, 3, 4, 6, 8, 9	Inductively coupled plasma – optical emission spectrometry
	5	Electrothermal atomic absorption spectrometry
	7	Flame atomic absorption spectrometry
P	1, 2, 3, 5, 6, 7, 8	Inductively coupled plasma – optical emission spectrometry
	4, 9	Spectrophotometry
Al	*1, 2, 3, 4, 5, 7, 8, 10*	*Inductively coupled plasma – optical emission spectrometry*
	6	*Flame atomic absorption spectrometry*
	9	*Electrothermal atomic absorption spectrometry*
S	*1, 2, 4, 5, 6*	*Combustion, infrared absorption*
	3, 8	*Inductively coupled plasma – optical emission spectrometry*
	7	*Spectrophotometry*
Si	*1, 2, 4*	*Inductively coupled plasma – optical emission spectrometry*
	3	*Gravimetry*
C	*1, 2, 3, 4, 5, 6*	*Combustion, infrared absorption*
B	*1*	*Spectrophotometry*
	2, 3, 4, 5	*Inductively coupled plasma – optical emission spectrometry*

TECHNICAL REPORT

A detailed technical report (in German) describing the analysis procedures and the treatment of the analytical data used to certify ERM®-EB389 is available on request.

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

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