Certified European Reference Material (EURONORM-CRM)

Certificate of chemical analysis

EURONORM-CRM No. 578-2
(Ferro-Molybdenum)

Laboratory mean values (4 determinations), mass content in %

Line. No.	C	P	S	Mo	Ni	Cu	Co	Sb	Sn
1	0.0154	0.0195	0.0282	71.86	0.0276	0.3384	0.0059	0.00140	0.00275
2	0.0168	0.0201	0.0282	71.86	0.0278	0.3396	0.0063	0.00140	0.00294
3	0.0175	0.0215	0.0288	71.90	0.0285	0.3427	0.0065	0.00150	0.00295
4	0.0180	0.0218	0.0295	71.92	0.0290	0.3450	0.0066	0.00154	0.00296
5	0.0185	0.0218	0.0295	71.99	0.0292	0.3459	0.0066	0.00158	0.00296
6	0.0187	0.0222	0.0298	72.09	0.0292	0.3474	0.0066	0.00167	0.00297
7	0.0189	0.0222	0.0303	72.10	0.0295	0.3488	0.0067	0.00172	0.00298
8	0.0190	0.0223	0.0303	72.13	0.0298	0.3491	0.0068	0.00181	0.00302
9	0.0200	0.0223	0.0310	72.17	0.0301	0.3500	0.0068	0.00188	0.00303
10	0.0204	0.0223	0.0311	72.19	0.0301	0.3501	0.0070	0.00202	0.00315
11	0.0211	0.0223	0.0316	72.25	0.0301	0.3512	0.0070	0.00203	0.00320
12	0.0217	0.0224	0.0318	72.25	0.0302	0.3525	0.0072	0.00209	0.00325
13	0.0218	0.0229	0.0320	72.27	0.0303	0.3526	0.0077	0.00210	0.00331
14	0.0221	0.0236	0.0326	72.32	0.0313	0.3535	0.0079	0.00213	0.00333
15	0.0225	0.0242	0.0329	72.46	0.0316	0.3538	0.0081		
16	0.0233		0.0330	72.52	0.0323	0.3540			
17	0.0239		0.0330	72.53	0.0324	0.3541			
18			0.0334	72.57		0.3575			
19			0.0335			0.3592			
M(M)	0.0200	0.0221	0.0311	72.19	0.0299	0.3497	0.0069	0.00177	0.00305
s(M)	0.0025	0.0012	0.0018	0.24	0.0014	0.0056	0.0006	0.00027	0.00017
C(95%)	0.0013	0.0007	0.0009	0.12	0.0008	0.0027	0.0004	0.00016	0.00010
s(w)	0.0010	0.0009	0.0009	0.21	0.0007	0.0044	0.0003	0.00015	0.00014

Line No.	*Si*	*Mn*	*Cr*	*Fe*	*Pb*	*Bi*
1	*0.1643*	*0.00585*	*0.0088*	*26.59*	*0.00033*	-------
2	*0.1684*	*0.00638*	*0.0090*	*26.86*	*0.00036*	*0.00012*
3	*0.1690*	*0.00640*	*0.0092*	*26.95*	*0.00039*	*0.00013*
4	*0.1693*	*0.00643*	*0.0093*	*27.16*	*0.00039*	*0.00013*
5	*0.1702*	*0.00657*	*0.0098*	*27.17*	*0.00039*	*0.00014*
6	*0.1737*	*0.00680*	*0.0106*	*27.20*	*0.00042*	
7	*0.1745*	*0.00683*	*0.0106*	*27.28*	*0.00042*	
8	*0.1752*	*0.00685*	*0.0110*	*27.39*		
9	*0.1776*	*0.00703*	*0.0117*	*27.46*		
10	*0.1882*	*0.00712*	*0.0117*	*27.57*		
11	*0.1888*	*0.00749*	*0.0118*	*27.60*		
12	*0.1900*	*0.00815*	*0.0119*	*27.66*		
13	*0.1963*	*0.00842*	*0.0121*	*27.78*		
14	*0.1967*	*0.00843*	*0.0140*	*27.97*		
15	*0.2025*	*0.00903*	*0.0146*			
16	*0.2054*	*0.00943*	*0.0148*			
17	*0.2087*	*0.00950*	*0.0148*			
18	*0.2150*		*0.0150*			
M(M)	*0.1845*	*0.00745*	*0.0117*	*27.33*	*0.00039*	*0.00011*

M(M): Mean of the intralaboratory means
s(M): Standard deviation of the intralaboratory means
s(w): Intralaboratory standard deviation

Additional values for information:

As 0.0092; 0.0104; B 0.0005
Ba 0.0001; Ca 0.0029
Ce 0.0003; Ga 0.0007; Mg 0.002
Pt 0.00002; Rb 0.0001; Re 0.0037
Ta 0.00001; Ti 0.003; V 0.0017
W 0.014; Zn 0.0009; Zr 0.0005

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 by either the an outlying value has been omitted by either the Cochran or Grubbs test..

Values given in *italic type* are for information only.

CERTIFIED VALUES, mass content in %

	C	**P**	**S**	**Mo**	**Ni**	**Cu**	**Co**	**Sb**	**Sn**
M(M)	**0.0200**	**0.0221**	**0.0311**	**72.19**	**0.0299**	**0.3497**	**0.0069**	**0.0018**	**0.00305**
U	0.0014	0.0007	0.0010	0.18	0.0007	0.0029	0.0004	0.0003	0.00012

U is the estimated expanded uncertainty 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).

$$U = k \cdot u_c \quad \text{with} \quad u_c = \sqrt{u_{char}^2 + u_{bb}^2}$$

with u_{char} = uncertainty contribution from characterization and u_{bb} = uncertainty contribution from possible inhomogeneities.

Berlin, Oktober 2023

BAM
Bundesanstalt für Materialforschung und -prüfung

This certified reference material was prepared and issued by Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin after approval by all the participating laboratories and all the producing organisations: (France - ArcelorMittal Maizières SAS; Germany - Bundesanstalt für Materialforschung und -prüfung (BAM); Nordic Countries - Jernkontoret Nordic CRM Working Group)

Description of the sample

The ECRM 578-2 is available in the form of powder in glass bottles containing 100 g. The particle size is in the range of 100 – 160 µm.

Sale of the reference material: Bundesanstalt für Materialforschung und -prüfung (BAM), Richard-Willstätter-Straße 11, 12489 Berlin (www.webshop.bam.de).

Participating laboratories

Afarak Elektrowerk Weisweiler GmbH, Eschweiler (Germany)
AG der Dillinger Hüttenwerke, Dillingen-Saar (Germany)
Alleima Tube AB, Sandviken (Sweden)
ALS Scandinavia AB, Luleå (Sweden)
ArcelorMittal Maizières Research SAS, Maizières-lès-Metz (France)
Bruker AXS GmbH, Karlsruhe (Germany)
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)
Chemad GmbH, Duisburg (Germany)
CMC POLAND Sp. z o.o., Zawiercie (Poland)
CSIR-National Metallurgical Laboratory, Jamshedpur (India)
Dunaferr Labor Nonprofit Ltd., Dunaújváros (Hungary)
Elementar Analysensysteme GmbH, Langenselbold (Germany)
Eltra GmbH, Haan (Germany)
Höganäs Sweden AB, Höganäs (Sweden)
Horn & Co. Analytics GmbH, Wenden-Hünsborn (Germany)
IFW Dresden e.V., Dresden (Germany)
Inspectorate Griffith India Pvt. Lyd., Bhubaneswar Laboratory, Bhubaneswar (India)
Łukasiewicz Research Network – Upper Silesian Institute of Technology, Gliwice (Poland)
Narema, Närpiö (Finland)
Österreichisches Gießerei-Institut (ÖGI), Leoben (Austria)
Saarstahl AG, Völklingen (Germany)
Salzgitter Flachstahl GmbH, Salzgitter (Germany)
Tata Steel Limited, Jamshedpur (India)
ThyssenKrupp Steel Europe AG, Duisburg (Germany)
Treibacher Industrie AG, Althofen (Austria)
voestalpine Böhler Edelstahl GmbH & Co KG, Kapfenberg (Austria)

Intended use and stability

This ECRM is intended for the verification of analytical methods, such as those used by the participating laboratories, for the calibration of analytical instruments in cases where the calibration with primary substances (pure stoichiometric metals or compounds) is not possible, and for establishing values for secondary reference materials.
It will remain stable, provided that the bottle remains sealed and is stored in a cool and dry atmosphere. When the bottle has been opened the lid should be secured immediately after use. If the contents should become discoloured (eg. oxidised) due to atmospheric contamination they should be discarded.
The minimum sample intake from the homogeneity test is 200 mg.
This certificate is valid until there is a revocation from the producer of the material.

Homogeneity

The homogeneity of the reference material was tested on 15 samples taken from the total batch. The mass fractions of the elements of interest were determined either by XRF, ICP-OES, or combustion analysis. No evidence of inhomogeneities was found.

Traceability

The assigned values for this material are achieved by inter-laboratory characterization, each laboratory using the method of their choice, details of which are given below. These methods are either stoichiometric analytical techniques or methods which are calibrated against pure metals or stoichiometric compounds. Most methods used were either international or national standard methods or methods which are technically equivalent.

Methods used

Element	Line number	Method
C	1, 5, 7	Combustion, infrared absorption, calibration with $BaCO_3$
	2, 4, 6, 9, 12, 13, 16, 17	Combustion, infrared absorption, calibration with $CaCO_3$
	3, 15	Combustion, infrared absorption, calibration with CO_2
	8	Combustion, infrared absorption, calibration with Na_2CO_3
	10	Combustion, infrared absorption, calibration with sucrose
	11	Combustion, infrared absorption, calibration with WC
	14	Combustion, infrared absorption, calibration with $NaHCO_3$
P	1, 11, 14	ICP-MS
	2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 15	ICP-OES
	6	Acidimetric titration of ammonium phosphomolybdate
S	1, 6, 9, 12, 13, 14, 18	Combustion, infrared absorption, calibration with K_2SO_4
	2, 5, 7, 17	Combustion, infrared absorption, calibration with $BaSO_4$
	3, 19	ICP-OES
	4	ICP-MS
	8, 12	Combustion, ultraviolet absorption, calibration with K_2SO_4
	10	Combustion, infrared absorption, calibration with SO_2
	11	Combustion, infrared absorption, calibration with sulfur
	15	Combustion, infrared absorption, calibration with $CaSO_4$
	16	Combustion, infrared absorption, calibration with Cs_2SO_4
Mo	1, 2, 3, 8, 9, 10, 11, 14, 16, 18	ICP-OES
	4, 5, 13, 15, 17	XRF
	6, 7, 12	Gravimetric with 8-hydroxyquinoline
Ni	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 15, 16	ICP-OES
	9, 14	ICP-MS
	13	MAS, dimethylglyoxime, extraction
	17	XRF
Cu	1, 12	ICP-MS
	2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19	ICP-OES
	8	FAAS
	9	XRF
Co	1, 7, 10, 12	ICP-MS
	2, 3, 4, 5, 6, 8, 9, 11, 13, 14, 15	ICP-OES
Sb	1, 2, 3, 4, 5, 6, 7	ICP-MS
	8, 9, 10, 11, 13, 14	ICP-OES
	12	ETAAS
Sn	1, 2, 4, 5, 6, 7, 8, 10, 12, 13, 14	ICP-OES
	3, 5, 6, 9, 11	ICP-MS
Si	*1*	*XRF*
	2, 3, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16, 18	*ICP-OES*
	4	*Gravimetry, dehydration with nitrosulfuric acid*
	7, 15	*Gravimetry, dehydration with hydrochloric acid*
	17	*ICP-MS*
Mn	*1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, 14*	*ICP-OES*
	9, 15, 17	*ICP-MS*
	12	*MAS, periodate oxidation*
	16	*XRF*
Cr	*1, 3, 4, 5, 6, 7, 10, 12, 13, 14, 15, 16, 17, 18*	*ICP-OES*
	2	*XRF*
	8, 9, 11	*ICP-MS*
Fe	*1, 8, 11*	*XRF*
	2, 3, 4, 5, 6, 7, 9, 10, 12, 13	*ICP-OES*
	14	*FAAS*
Pb	*1*	*ETAAS*
	2, 3, 4, 5, 6, 7	*ICP-MS*

Element	Line number	Method
Bi	*2, 3, 4, 5*	*ICP-MS*
As, B, Ba, Ca, Ce, Ga, Ge, Mg, Pt, Rb, Re, Ta, Ti, V, W, Zn, Zr		*ICP-MS*

Abbreviations:

ETAAS:	Electrothermal atomic absorption spectrometry	ICP-MS:	Inductively coupled plasma – Mass spectrometry
FAAS:	Flame atomic absorption spectrometry	MAS:	Spectrophotometry
ICP-OES:	Inductively coupled plasma - optical emission spectrometry	XRF:	X-Ray fluorescence

Further information

For information regarding the preparation, certification and supply of these European Certified Reference Materials (EURONORM-CRMs) and the use of the statistical information given on this certificate, please refer either to the producer of this Certified Reference Material or to Technical Reports CEN/TR 10317 and CEN/TR 10350, both of which are available from the national standards body in your country. Further information and advice on this or other Certified Reference Materials or Reference Materials may be obtained from the address above.

Angaben über Herstellung, Zertifizierung und Bezugsmöglichkeiten dieser Europäischen Zertifizierten Referenzmaterialien (EURONORM-ZRM) sowie über die Anwendungen der in diesem Zertifikat enthaltenen statistischen Daten sind erhältlich beim Hersteller dieses zertifizierten Referenzmaterials, dessen Adresse auf diesem Zertifikat angegeben ist oder sie finden sich in den CEN-Reports CEN/TR 10317 und CEN/TR 10350, beide zu beziehen durch die nationalen Normenorganisationen.
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Pour disposer d'informations sur la fabrication, la certification et la distribution des Matériaux de Référence Certifiés Européens (EURONORM-MRC) ainsi que sur l'utilisation des informations statistiques données sur ce certificat, se reporter soit au producteur de ce Matériau de Référence Certifié, soit aux Rapports Techniques CEN/TR 10317 et CEN/TR 10350. On peut se procurer ces deux documents auprès des organismes nationaux de normalisation.
D'autres informations et avis au sujet de ce Matériau de Référence Certifié, ou de tout autre Matériau de Référence Certifié ou Matériau de Référence peuvent être demandés en contactant l'adresse figurant plus haut dans ce Certificat.

För information angående tillverkning, certifiering och anskaffning av dessa europeiska certifierade referensmaterial (EURONORM CRM) och för användning av statistisk information, som angivits i detta certifikat, refereras antingen till producenten av detta certifierade referensmaterial eller till Teknisk Rapport CEN/TR 10317 och CEN/TR 10350 som kan erhållas från den nationella standardiseringsorganisationen.
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Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin

S. Recknagel

Dr. Sebastian Recknagel
Project Leader CRM

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.

DAkkS
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Akkreditierungsstelle
D-RM-11075-01-00