

Certified European Reference Material (EURONORM-CRM)

Certificate of chemical analysis

EURONORM-CRM No. 589-2 (Ferro-Titanium)

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

Line. No.	C	Mn	S	Mo	Ni	Al	Cu	Co	Sn	Ti	Zr
1	0.1667	0.2338	0.0087	---	0.1809	3.105	0.0647	0.0136	---	68.32	0.2392
2	0.1702	0.2340	0.0089	---	0.1818	3.133	0.0661	0.0139	0.1555	68.41	0.2458
3	0.1718	0.2347	0.0089	0.5215	0.1828	3.135	0.0662	0.0140	0.1556	68.43	0.2476
4	0.1723	0.2375	0.0090	0.5275	0.1828	3.139	0.0670	0.0140	0.1563	68.54	0.2510
5	0.1729	0.2391	0.0093	0.5314	0.1838	3.142	0.0670	0.0141	0.1574	68.58	0.2499
6	0.1732	0.2418	0.0096	0.5330	0.1852	3.145	0.0676	0.0141	0.1585	68.70	0.2561
7	0.1768	0.2419	0.0096	0.5397	0.1873	3.146	0.0684	0.0148	0.1612	68.76	0.2565
8	0.1785	0.2443	0.0097	0.5411	0.1892	3.147	0.0695	0.0150	0.1617	68.78	0.2626
9	0.1785	0.2460	0.0098	0.5417	0.1893	3.168	0.0701	0.0150	0.1643	68.83	0.2634
10	0.1791	0.2492	0.0098	0.5461	0.1905	3.170	0.0703	0.0152	0.1666	68.97	0.2644
11	0.1814	0.2538	0.0102	0.5498	0.1921	3.172	0.0705	0.0152	0.1736	69.11	0.2664
12	0.1844	0.2549	0.0106	0.5605	0.1976	3.184	0.0713	0.0152	0.1752	69.13	0.2690
13	0.1853	0.2558	0.0111	0.5641	0.1977	3.186	0.0728	0.0153	0.1788	69.33	0.2716
14	0.1854	0.2569	0.0111	0.5648	0.2002	3.216	0.0732	0.0158	0.1799	69.43	0.2775
15	0.1906	0.2580	0.0113	0.5687	0.2018	3.223	0.0744	0.0160	0.1821	69.46	0.2776
16	0.1928	0.2595	0.0119	0.5697	0.2021	3.241	0.0756	0.0160		69.54	
17		0.2600	0.0120	0.5759	0.2042	3.270		0.0164		69.60	
M(M)	0.1787	0.2471	0.0101	0.5490	0.1911	3.172	0.0697	0.0149	0.1662	68.94	0.2599
s(M)	0.0075	0.0095	0.0011	0.0172	0.0080	0.044	0.0032	0.0009	0.0098	0.43	0.0117
C(95%)	0.0040	0.0049	0.0006	0.0096	0.0041	0.023	0.0018	0.0005	0.0057	0.22	0.0065
s(w)	0.0036	0.0045	0.0007	0.0101	0.0042	0.055	0.0020	0.0007	0.0030	0.23	0.0055

Line No.	Si	Cr	V	Ca	Fe	Mg	Pb	Zn
1	0.2971	0.919	1.265	0.0338	21.46	0.0863	0.0050	0.0088
2	0.3014	0.972	1.290	0.0376	21.47	0.0931	0.0056	0.0092
3	0.3150	0.985	1.301	0.0500	21.53	0.0955	0.0056	0.0108
4	0.3177	0.994	1.302		21.58	0.0984	0.0061	0.0165
5	0.3199	1.003	1.310		21.70	0.0999	0.0066	
6	0.3205	1.001	1.321		21.77	0.1088	0.0066	
7	0.3263	1.022	1.327		21.81	0.1086	0.0067	
8	0.3329	1.031	1.415		21.95	0.1178	0.0068	
9	0.3497	1.048	1.489		21.99			
10	0.3498	1.121			22.00			
11	0.3840	1.126			22.03			
12	0.3898	1.129			22.11			
13	0.3913	1.172			22.26			
14	0.3935	1.181			22.30			
15	0.4150	1.198			22.30			
16	0.4223				22.54			
17					22.61			
18					22.61			
M(M)	0.3516	1.060	1.336	0.0404	22.00	0.1010	0.0061	0.0113

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

Additional values for information:

P 0.011; As 0.0026; B 0.0013;
Ba 0.0005; Be 0.00001; Bi 0.0017
Ce 0.00023; Ga 0.0011; Ge 0.00013
Hf 0.0009; Ir 0.00001; Nb 0.082
Pt 0.00002; Rb 0.00013; Re 0.00001
Sb 0.0012; Ta 0.0009; Th 0.00001
W 0.082; U 0.00002

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 Cochran or Grubbs test. Values given in *italic type* are for information only.

CERTIFIED VALUES, mass content in %

	C	Mn	S	Mo	Ni	Al	Cu	Co	Sn	Ti	Zr
M(M)	0.179	0.247	0.0101	0.549	0.191	3.172	0.0697	0.0149	0.166	68.94	0.260
U	0.005	0.005	0.0006	0.014	0.005	0.023	0.0018	0.0006	0.006	0.23	0.007

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, February 2024



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

ECRM 589-2 is available in the form of powder in bottles containing 100 g. The particle size is in the range of 63 – 125 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 Eisenhüttenstadt Forschungs- und Qualitätszentrum GmbH, Eisenhüttenstadt (Germany)
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)
Dunafer 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. Ltd., 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)
SpectroChem, Turku (Finland)
Tata Steel Limited, Jamshedpur (India)
ThyssenKrupp Steel Europe AG, Duisburg (Germany)

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 10 samples taken from the total batch. The mass fractions of the elements of interest were determined either by XRF or combustion analysis.

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, 6, 7, 8, 9, 11, 12, 13	Combustion, infrared absorption, calibration with CaCO ₃
	2	Combustion, infrared absorption, calibration with Na ₂ CO ₃
	3, 4, 15	Combustion, infrared absorption, calibration with BaCO ₃
	5, 16	Combustion, infrared absorption, calibration with CO ₂
	10	Combustion, infrared absorption, calibration with WC
	14	Combustion, infrared absorption, calibration with NaHCO ₃

Element	Line number	Method
Mn	1, 2, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 17 3, 6, 16 8	ICP-OES XRF ICP-MS
S	1, 2, 10, 13, 15 3, 4, 5, 12, 17 6 7, 11 8 9 14 16	Combustion, infrared absorption, calibration with K ₂ SO ₄ Combustion, infrared absorption, calibration with BaSO ₄ Combustion, infrared absorption, calibration with SO ₂ Combustion, infrared absorption, calibration with Cs ₂ SO ₄ ICP-MS Combustion, ultraviolet absorption, calibration with K ₂ SO ₄ Combustion, infrared absorption, calibration with sulfur Combustion, infrared absorption, calibration with CaSO ₄
Mo	3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 5 6, 17	ICP-OES ICP-MS XRF
Ni	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16 5 14 17	ICP-OES MAS, dimethylglyoxime, extraction ICP-MS XRF
Al	1, 2, 4, 6, 7, 9, 11, 13, 14, 15, 16, 17 3 5 8, 10, 12	ICP-OES FAAS ICP-MS XRF
Cu	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14 5, 16 15	ICP-OES XRF ICP-MS
Co	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17 3, 16 14	ICP-OES ICP-MS ETAAS
Sn	2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15 11 13	ICP-OES ICP-MS XRF
Ti	1, 2, 3, 4, 9, 11, 12, 13, 14 5, 6, 10, 15, 16 7 8, 17	ICP-OES XRF MAS, hydrogen peroxide, without separation Titration with a reducing titrant
Zr	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 15 6 14	ICP-OES ICP-MS XRF
Si	1, 3, 7, 12 2 4 5, 6, 8, 9, 11, 13, 15, 16 10 14	XRF <i>Gravimetry, dehydration with sulfuric acid</i> ICP-MS ICP-OES <i>Gravimetry, dehydration with nitrosulfuric acid</i> <i>Gravimetry, dehydration with hydrochloric acid</i>
Cr	1, 2, 3, 4, 5, 6, 7, 10, 11, 14, 15 8, 9, 13 12	ICP-OES XRF FAAS
Mg	1, 2, 4, 5, 6, 7, 8 3	ICP-OES ICP-MS
Pb	1, 3, 5, 6, 7, 8 2 4	ICP-OES ICP-MS ETAAS
V	1, 3, 4, 5, 6, 7, 9 2 8	ICP-OES XRF ICP-MS

Element	Line number	Method
Fe	1, 10, 11, 14	XRF
	2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 16, 17, 18	ICP-OES
	15	Titration with Cr (VI) after reduction with Sn (II)
Ca	1	ICP-MS
	2, 3	ICP-OES
Zn	1	ICP-MS
	2, 3	ICP-OES
	4	ETAAS
P, As, B, Ba, Be, Bi, Ce, Ga, Ge, Hf, Ir, Nb Pt, Rb, Re, Sb, Ta, Th, W, U		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.

Weitere Informationen und Hinweise zu diesem oder anderen zertifizierten Referenzmaterialien oder Referenzmaterialien können unter der oben angegebenen Adresse erhalten werden.

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.

Ytterligare information och rådfrågan om detta eller andra certifierade referensmaterial eller referensmaterial kan erhållas från angiven adress på certifikatet enligt ovan.

Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin

Dr. Sebastian Recknagel
Project Leader CRM