

Certificate of Chemical Analysis

Reference Material C101 - C104

Set for Spectral Analysis of Iron-Chromium-Aluminium (FeCrAl) alloys

INFORMATION

Reference Material of Iron-Chromium-Aluminium alloys - Set for spectral analysis is intended for calibration of measuring instruments at definition of chemical composition of FeCrAl alloys by using of Optical Emission and X-ray Spectrometry methods

MASS CONTENT IN %

		C	Cr	Al	Ti	Mn	Si	Ni	Cu	Mo	V	P	S	Nb	Zr	W
C101	Certified	0.024	21.77	5.06	0.31	0.198	0.32	0.34	0.055	0.026	0.023	0.013	<i>0.006</i>	<i>0.011</i>	<i>0.003</i>	<i>0.011</i>
	Uncertainty C(95%)	0.004	0.26	0.23	0.02	0.005	0.02	0.04	0.004	0.005	0.003	0.002				
C102	Certified	0.038	24.41	4.98	0.25	0.265	1.27	0.19	0.031	0.022	0.089	0.025	<i>0.006</i>	<i>0.005</i>	<i>0.003</i>	<i>0.020</i>
	Uncertainty C(95%)	0.006	0.21	0.15	0.02	0.011	0.02	0.03	0.007	0.004	0.006	0.004				
C103	Certified	0.064	27.04	5.28	0.29	0.287	0.34	0.21	0.066	0.013	0.035	0.027	<i>0.006</i>	<i>0.002</i>	<i>0.001</i>	<i>0.004</i>
	Uncertainty C(95%)	0.006	0.21	0.15	0.02	0.011	0.02	0.03	0.007	0.004	0.006	0.004				
C104	Certified	0.055	29.77	6.58	0.76	0.838	0.78	0.51	0.199	0.18	0.22	0.035	0.019	0.52	0.28	<i>0.008</i>
	Uncertainty C(95%)	0.003	0.25	0.20	0.04	0.040	0.03	0.08	0.013	0.02	0.02	0.004	0.003	0.04	0.04	

Italics – indicative values

SPECIFICATION

Reference materials in the form of cylinders in diameter of 38 mm (C101-C103) and in diameter of 36 mm (C104), height 18 mm, are made of rolled and forged steel (C101 - C103) and of cast steel of vacuum induction melting (C104).

The homogeneity was evaluated according to ISO Guide 35:2017 by OES. The characterisation of RMs achieved by means inter-laboratory experiment

NOTE:

Antimony content in RM C104 is about 1%

Central zone RM C104 in diameter about 8 mm is porous and not recommended for analysis

CRM VALIDITY

Reference material will remain stable provided that it is not subjected to excessive heat, for example during preparation of the working surface

SAFETY

The reference material and packing does not contain explosives, radioactive substances and substances which might influence health and the environment

PARTICIPATING LABORATORIES

Element Materials Technology, USA
 ENVIFORM a.s., Czech Republic
 Institute for Ferrous Metallurgy (IMZ), Poland
 Lithea sro., Czech Republic
 Metal and Quality PJSC, Ukraine
 Slévárna, a.s., Czech Republic
 TCR Engineering Services PVT, Ltd., India
 Vítkovice Testing Center s.r.o., Czech Republic

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MEAN VALUES OF LABORATORIES

C101	C	Cr	Al	Ti	Mn	Si	Ni	Cu	Mo	V	P	S	Nb	Zr	W
1	0.021	21.22	4.80	0.270	0.190	0.297	0.290	0.048	0.019	0.020	0.0119	0.0023	0.002	0.0020	0.0107
2	0.023	21.33	4.84	0.280	0.199	0.310	0.295	0.050	0.020	0.020	0.0128	0.0040	0.002	0.0027	0.0116
3	0.023	21.60	5.01	0.297	0.200	0.329	0.324	0.052	0.021	0.021	0.0130	0.0072	0.010	0.0031	
4	0.028	21.70	5.05	0.300	0.200	0.330	0.330	0.056	0.028	0.025	0.0160	0.0078	0.011	0.0036	
5		21.79	5.26	0.307	0.201	0.331	0.370	0.057	0.030	0.026		0.0080	0.013	0.0051	
6		21.83	5.40	0.311			0.375	0.059	0.030	0.026			0.018		
7		22.10		0.320			0.400	0.060	0.034				0.020		
8		22.15		0.360											
9		22.19													
M(M)	0.024	21.77	5.06	0.306	0.198	0.319	0.341	0.055	0.026	0.023	0.0134	0.0059	0.011	0.0033	0.0112
s(M)	0.003	0.35	0.23	0.027	0.005	0.015	0.042	0.005	0.006	0.003	0.0018	0.0026	0.007	0.0012	0.0006
C102	C	Cr	Al	Ti	Mn	Si	Ni	Cu	Mo	V	P	S	Nb	Zr	W
1	0.035	24.06	4.80	0.240	0.250	1.220	0.140	0.020	0.014	0.070	0.0170	0.0024	0.002	0.0020	0.0198
2	0.035	24.20	4.84	0.240	0.257	1.239	0.151	0.027	0.014	0.084	0.0200	0.0040	0.002	0.0028	0.0208
3	0.041	24.21	4.95	0.247	0.260	1.254	0.160	0.030	0.020	0.090	0.0215	0.0065	0.006	0.0029	
4	0.043	24.33	5.00	0.254	0.271	1.270	0.197	0.030	0.021	0.093	0.0270	0.0073	0.006	0.0041	
5		24.47	5.01	0.261	0.272	1.320	0.208	0.032	0.024	0.096	0.0290	0.0080	0.007	0.0051	
6		24.50	5.30	0.273	0.280	1.325	0.220	0.036	0.029	0.103	0.0290	<0.001	0.009		
7		24.53					0.230	0.040	0.030		0.0295				
8		24.66													
9		24.75													
M(M)	0.038	24.41	4.98	0.252	0.265	1.271	0.187	0.031	0.022	0.089	0.0247	0.0056	0.005	0.0034	0.0203
s(M)	0.004	0.23	0.18	0.013	0.011	0.043	0.036	0.006	0.006	0.011	0.0051	0.0024	0.003	0.0012	0.0007
C103	C	Cr	Al	Ti	Mn	Si	Ni	Cu	Mo	V	P	S	Nb	Zr	W
1	0.060	26.59	5.10	0.261	0.268	0.290	0.163	0.056	0.007	0.030	0.0230	0.0022	0.0001	0.0010	0.0031
2	0.062	26.82	5.18	0.270	0.280	0.330	0.170	0.060	0.010	0.032	0.0264	0.0040	0.001	0.0010	0.0052
3	0.065	26.94	5.36	0.273	0.290	0.330	0.181	0.060	0.010	0.032	0.0290	0.0080	0.003	0.0010	
4	0.070	26.97	5.38	0.274	0.292	0.335	0.223	0.062	0.011	0.034	0.0300	0.0083	0.003	0.0019	
5		27.00	5.38	0.296	0.292	0.348	0.234	0.065	0.017	0.034		0.0090	0.004		
6		27.08		0.300	0.300	0.357	0.240	0.071	0.018	0.046					
7		27.10		0.325		0.360	0.260	0.075	0.020						
8		27.23						0.078							
9		27.62													
M(M)	0.064	27.04	5.28	0.286	0.287	0.336	0.210	0.066	0.013	0.035	0.0271	0.0063	0.002	0.0012	0.0042
s(M)	0.004	0.28	0.13	0.022	0.011	0.024	0.038	0.008	0.005	0.006	0.0031	0.0030	0.002	0.0005	0.0015
C104	C	Cr	Al	Ti	Mn	Si	Ni	Cu	Mo	V	P	S	Nb	Zr	W
1	0.054	29.48	6.33	0.691	0.800	0.720	0.396	0.175	0.150	0.200	0.0300	0.0140	0.456	0.2500	0.0070
2	0.054	29.67	6.40	0.700	0.800	0.757	0.430	0.190	0.150	0.202	0.0341	0.0159	0.470	0.2610	0.0097
3	0.055	29.75	6.51	0.728	0.813	0.780	0.463	0.195	0.170	0.204	0.0358	0.0171	0.511	0.2623	
4	0.059	29.95	6.73	0.750	0.842	0.781	0.536	0.200	0.170	0.205	0.0370	0.0200	0.513	0.3000	
5		30.02	6.74	0.755	0.880	0.800	0.540	0.204	0.180	0.237	0.0400	0.0211	0.541	0.3330	
6			6.80	0.799	0.892	0.800	0.551	0.210	0.200	0.250		0.0230	0.543		
7				0.817		0.809	0.660	0.219	0.202				0.590		
8				0.824				0.218							
M(M)	0.055	29.77	6.58	0.758	0.838	0.778	0.511	0.199	0.180	0.216	0.0354	0.0185	0.518	0.2813	0.0084
s(M)	0.002	0.22	0.20	0.051	0.040	0.031	0.089	0.014	0.025	0.022	0.0037	0.0034	0.046	0.0346	0.0019

Uncertainty C(95%) estimated as the half-width confidence interval of Student's t-distribution. when n is the number of laboratory means

$$C(95\%) = \frac{t \cdot s(M)}{\sqrt{n}}$$

M(M) - Mean of intralaboratory means

s(M) - Standard deviation of the mean values of laboratories

THE METHODS USED

C - HFIR, OES-GDS

Cr - Titrimetric, ICP-OES, Spark OES, OES-GDS, XRF

Al - ICP-OES, AAS, Spark OES

Ti - ICP-OES, AAS, Spark OES, OES-GDS, XRF

Mn - ICP-OES, AAS, Spark OES, OES-GDS

Si - Gravimetric, ICP-OES, Spark OES, OES-GDS

Ni - ICP-OES, AAS, Spark OES, XRF

Cu - ICP-OES, AAS, Spark OES, OES-GDS, XRF

Mo - ICP-OES, AAS, Spark OES, OES-GDS, XRF

V - ICP-OES, AAS, Spark OES, OES-GDS, XRF

P - ICP-OES, Spark OES, OES-GDS

S - HFIR, Spark OES, OES-GDS

Nb - ICP-OES, Spark OES, OES-GDS, XRF

Zr - ICP-OES, Spark OES

W - ICP-OES