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Certified Reference Material — Certificate of Analysis

ISO 17034:2016 | ISO/IEC 17025:2017 | ISO 9001:2015

Product ID: IARM-FE422-22

Revision No.: 000
Revision Date: 01/23/2023

Product Description: Martensitic, AISI 422 / S42200

Description and Intended Use: This **Certified Reference Material** is covered under the scope of accreditation to **ISO 17034** by LGC Standards - Manchester, NH. As an ISO 17034 certified reference material, appropriate use of this material will fulfill the certified reference material and traceability requirements for use in **ISO 17025** accredited laboratories. This CRM may come in the form of a solid disk, or chips. The intended use of this CRM may include, but is not limited to, the calibration of instruments and the validation of analytical methods.

Certified Values listed in wt.% with associated uncertainties

Al	**0.0024**	± 0.0005	**Cr**	**12.22**	± 0.07	**Ni**	**0.616**	± 0.009	**Sn**	**0.0035**	± 0.0005
As	**0.0039**	± 0.0004	**Cu**	**0.126**	± 0.003	**O**	**0.0073**	± 0.0004	**Ti**	**0.0017**	± 0.0006
B	**0.0006**	± 0.0002	**Mn**	**0.687**	± 0.007	**P**	**0.021**	± 0.001	**V**	**0.210**	± 0.004
C	**0.239**	± 0.006	**Mo**	**0.97**	± 0.01	**S**	**0.0095**	± 0.0004	**W**	**1.03**	± 0.01
Ca	**0.0029**	± 0.0003	**N**	**0.050**	± 0.002	**Sb**	**0.0009**	± 0.0004			
Co	**0.022**	± 0.001	**Nb**	**0.013**	± 0.001	**Si**	**0.44**	± 0.01			

Indicative Values listed in ppm

Fe	Bal	Pb	0.0017	Zr	0.0017

Homogeneity and Uncertainty: "Uncertainty" values, as reported adjacent to certified concentration values, are based on a 95% Confidence Interval. These estimated uncertainties include the combined effects of method imprecision, material inhomogeneity, and any bias between methods. Homogeneity data from experimental XRF results are reflected in both the overall statistics and certified data. Homogeneity samples are selected by a systematic sampling procedure. The number of samples may be determined by equation 1, where N_{prod} is the number of units produced and N_{min} is the number of samples used for homogeneity testing. These samples are arranged in a simple randomized design such that each sample is analyzed multiple times by XRF. Homogeneity may also be determined within sample using an applied version of ASTM E826. A single factor ANOVA is used to calculated uncertainty due to inhomogeneity (U_{hom}). Uncertainty of the material is calculated by equation 2, where $H=U_{hom}$, S= Standard deviation, t= t-value at 95% CI, and n= number of observations.

$$1.\ N_{MIN} = \max\left(10, \sqrt[3]{N_{PROD}}\right) \qquad 2.\ U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

Certification Laboratories: Much of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to ISO 17025. It is an implicit requirement for this accreditation that analytical work should be performed with due traceability, via an unbroken chain of comparisons, each with stated uncertainty, to primary standards such as the mole, or to nationally- or internationally-recognised reference materials. Of the individual results herein, some have traceability (to the mole) via primary analytical methods. Some are traceable to substances of known stoichiometry. Most have traceability via commercial solutions. Furthermore, some results have additional traceability to NIST standards, as part of the analytical calibration or process control.

- Applied Technical Services - Marietta, GA
- Avon Specialty Metals Ltd - Gloucester, England
- Dirats Laboratories - Westfield, MA
- EAG Laboratories - Liverpool, NY
- IMR Test Labs - Lansing, NY
- Laboratory Testing, Inc. - Hatfield, PA
- LGC Standards - Manchester, NH
- Lithea S.R.O. - Brno, Czech Republic
- Lucid Laboratories - Hyderabad, India
- New Hampshire Materials Laboratory Inc - Somersworth, NH
- NSL Analytical Services - Cleveland, OH
- Scrooby's Laboratory Service Pty Ltd - Benoni, South Africa
- SGS MSi - Melrose Park, IL
- Sheffield Assay Office - Sheffield, England

Instructions for Use: The test surface is on the opposite side of the labeled surface, which includes the material identification. The entire thickness of the unit is certified. However, the user is cautioned not to measure disks less than 2 mm thick when using X-ray fluorescence spectrometry. Each packaged disk has been prepared by finishing the test surface using a lathe. The user must determine the correct surface preparation procedure for each analytical technique. The user is cautioned to use care when either resurfacing the disk or performing additional polishing, as these processes may contaminate the surface. The minimum sample size for chips should be individually evaluated based on the analytical technique used; this would typically be greater than 0.1 grams. The material should be stored in a cool, dry location when not in use.
Chips are not recommended for gas analysis.

Period of Validity: The certification of this material is valid indefinitely, within the uncertainty specified, provided the material is handled and stored in accordance with the instructions stated on this certificate. The certification is nullified if the material is damaged, contaminated, otherwise modified, or used in a manner for which it was not intended.

Chuck Goudreau, Certifying Officer

23 January 2023
Certification Date

ISO 17034 Accredited: Reference Materials Producer, Certificate # 2848.02
ISO/IEC 17025 Accredited: Chemical Testing, Certificate # 2848.01

The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

	Al	As	B	C	Ca	Co	Cr	Cu	Fe	Mn	Mo	N	Nb
1	0.0011	0.0030	0.0002	0.2100	0.0020	0.0150	11.92	0.1142	83.07	0.6570	0.9300	0.0475	0.0082
2	0.0014	0.0030	0.0002	0.2186	0.0023	0.0173	11.94	0.1190	83.10	0.6627	0.9383	0.0476	0.0100
3	0.0020	0.0031	0.0002	0.2249	0.0025	0.0180	12.00	0.1196	83.40	0.6630	0.9460	0.0480	0.0100
4	0.0021	0.0035	0.0005	0.2290	0.0027	0.0193	12.03	0.1200	83.68	0.6683	0.9490	0.0488	0.0100
5	0.0021	0.0037	0.0006	0.2330	0.0028	0.0195	12.06	0.1210	83.78	0.6760	0.9590	0.0490	0.0102
6	0.0021	0.0038	0.0007	0.2374	0.0028	0.0200	12.16	0.1214		0.6797	0.9600	0.0492	0.0106
7	0.0022	0.0038	0.0007	0.2380	0.0030	0.0218	12.17	0.1240		0.6819	0.9634	0.0502	0.0113
8	0.0024	0.0040	0.0007	0.2390	0.0030	0.0220	12.19	0.1249		0.6826	0.9684	0.0530	0.0116
9	0.0024	0.0040	0.0008	0.2400	0.0030	0.0220	12.21	0.1250		0.6850	0.9692	0.0532	0.0121
10	0.0025	0.0042	0.0008	0.2400	0.0033	0.0220	12.25	0.1252		0.6860	0.9712		0.0130
11	0.0026	0.0042	0.0009	0.2401	0.0034	0.0220	12.26	0.1265		0.6877	0.9725		0.0130
12	0.0030	0.0049	0.0009	0.2402	0.0035	0.0220	12.27	0.1269		0.6900	0.9730		0.0134
13	0.0037	0.0050	<0.0005	0.2407	0.0038	0.0220	12.27	0.1270		0.6900	0.9764		0.0144
14	0.0047	<0.002	<0.001	0.2420	<0.0050	0.0222	12.29	0.1270		0.6914	0.9800		0.0150
15	<0.0005	<0.0050	<0.001	0.2449		0.0223	12.31	0.1290		0.6948	0.9830		0.0151
16	<0.0010	<0.01	<0.0010	0.2463		0.0227	12.34	0.1300		0.6960	0.9895		0.0160
17	<0.005	<0.01	<0.005	0.2520		0.0232	12.36	0.1302		0.6961	1.0021		0.0168
18				0.2530		0.0240	12.38	0.1330		0.6967	1.0040		0.0170
19				0.2680		0.0244	12.38	0.1370		0.6980	1.0040		<0.01
20						0.0260	12.46	0.1380		0.7000	1.0071		
21						0.0290	12.47			0.7080	1.0190		
22						<0.01				0.7140			
23													
Mean	0.0024	0.0039	0.0006	0.2388	0.0029	0.0217	12.22	0.1259	83.41	0.6866	0.9745	0.0496	0.0126
STDV	0.0009	0.0006	0.0003	0.0127	0.0005	0.0030	0.16	0.0060	0.32	0.0146	0.0238	0.0022	0.0026
Certified	0.0024	0.0039	0.0006	0.239	0.0029	0.022	12.22	0.126	(83.41)	0.687	0.97	0.050	0.013
U_{CRM}	0.0005	0.0004	0.0002	0.006	0.0003	0.001	0.07	0.003		0.007	0.01	0.002	0.001
Methods	I,IM,O,G,X	I,IM,O,G	I,G,IM,O	C,O,G	O,I,G,IM,X	I,IM,O,G,X	I,O,G,X	I,O,IM,X	I,O,IM,X	I,O,G,X	I,O,G,X	F,O	I,IM,O,G,X

	Ni	O	P	Pb	S	Sb	Si	Sn	Ti	V	W	Zr
1	0.5700	0.0069	0.0130	0.0003	0.0081	0.0004	0.3980	0.0020	0.0003	0.1938	0.981	0.0001
2	0.5740	0.0070	0.0170	0.0003	0.0085	0.0006	0.4015	0.0024	0.0003	0.1970	0.986	0.0002
3	0.5890	0.0072	0.0180	0.0005	0.0087	0.0007	0.4040	0.0030	0.0010	0.1970	0.996	0.0016
4	0.6049	0.0074	0.0190	0.0012	0.0090	0.0011	0.4049	0.0031	0.0010	0.2000	1.003	0.0017
5	0.6062	0.0075	0.0190	0.0017	0.0092	0.0013	0.4080	0.0032	0.0012	0.2010	1.009	0.0020
6	0.6062	0.0078	0.0193	0.0027	0.0092	0.0013	0.4117	0.0034	0.0015	0.2033	1.012	0.0020
7	0.6070		0.0194	0.0050	0.0093	<0.0010	0.4126	0.0034	0.0018	0.2037	1.018	0.0022
8	0.6100		0.0200	<0.00005	0.0094	<0.0010	0.4178	0.0036	0.0019	0.2041	1.020	0.0036
9	0.6120		0.0207	<0.0001	0.0098	<0.002	0.4320	0.0037	0.0021	0.2050	1.022	<0.00005
10	0.6127		0.0210	<0.0003	0.0100	<0.002	0.4350	0.0039	0.0021	0.2080	1.032	<0.0005
11	0.6140		0.0216	<0.0005	0.0100	<0.002	0.4387	0.0041	0.0026	0.2086	1.038	<0.0010
12	0.6177		0.0220	<0.0010	0.0100	<0.0020	0.4405	0.0041	0.0030	0.2091	1.040	<0.002
13	0.6186		0.0221	<0.002	0.0100		0.4453	0.0042	0.0033	0.2110	1.040	<0.002
14	0.6190		0.0223	<0.002	0.0100		0.4456	0.0054	<0.0005	0.2142	1.040	<0.002
15	0.6190		0.0223	<0.002	0.0102		0.4480	<0.005	<0.0010	0.2148	1.044	<0.005
16	0.6248		0.0225	<0.005	0.0103		0.4500	<0.01	<0.002	0.2161	1.048	<0.01
17	0.6280		0.0229		0.0103		0.4500	<0.01	<0.002	0.2163	1.048	<0.01
18	0.6290		0.0230				0.4550		<0.002	0.2170	1.070	
19	0.6340		0.0230				0.4570		<0.005	0.2190	1.077	
20	0.6355		0.0230				0.4591		<0.005	0.2200	1.079	
21	0.6370		0.0239				0.4631		<0.01	0.2220	1.100	
22	0.6400		0.0260				0.4690			0.2300		
23	0.6653		0.0276				0.4800					
Mean	0.6163	0.0073	0.0212	0.0017	0.0095	0.0009	0.4359	0.0035	0.0017	0.2096	1.033	0.0017
STDV	0.0209	0.0003	0.0030	0.0017	0.0007	0.0004	0.0241	0.0008	0.0009	0.0093	0.031	0.0011
Certified	0.616	0.0073	0.021	(0.0017)	0.0095	0.0009	0.44	0.0035	0.0017	0.210	1.03	(0.0017)
U_{CRM}	0.009	0.0004	0.001		0.0004	0.0004	0.01	0.0005	0.0006	0.004	0.01	
Methods	I,O,G,X	F	I,O,G,IM,X	I,O,G,IM,X	C,O,X,I	IM,I,O,X	I,O,G,IM,X	I,IM,G,O,X	I,IM,O,G,X	I,O,G,IM,X	I,O,G,X	IM,O,I,G,X

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP or DCP, IM=ICP-MS, D = DC Arc, O = AES, X = XRF, G = GDAES or GDMS, H = Hollow Cathode AES