ARMI | MBH ANALYTICAL LTD

Certified Reference Material   Certificate of Analysis

Product ID: IARM-FE409-20

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

Product Description: Stainless Steel, AISI 409 / S40900

Revision No.: 000
Revision Date: 03/22/2022

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	0.017 ± 0.001	**As**	0.0026 ± 0.0003	**C**	0.010 ± 0.001	**Co**	0.019 ± 0.001
Cr	11.28 ± 0.07	**Cu**	0.0655 ± 0.0008	**Mn**	0.387 ± 0.006	**Mo**	0.011 ± 0.001
N	0.010 ± 0.002	**Nb**	0.0041 ± 0.0006	**Ni**	0.110 ± 0.003	**P**	0.021 ± 0.001
S	0.0007 ± 0.0004	**Sb**	0.0011 ± 0.0005	**Si**	0.52 ± 0.01	**Sn**	0.0053 ± 0.0004
Ti	0.141 ± 0.006	**V**	0.075 ± 0.002	**W**	0.0036 ± 0.0009	**Zn**	0.010 ± 0.003

Indicative Values listed in ppm

B (3)	Fe (87.4%)	Mg (100)	Pb (10)	Zr (21)

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.

- LGC Standards - Manchester, NH
- Connecticut Metallurgical, Inc. - East Hartford, CT
- Dirats Laboratories - Westfield, MA
- IMR Test Labs - Lansing, NY
- Applied Technical Services - Marietta, GA
- Luvak Inc. - Boylston, MA
- Instytut Metalurgii Żelaza - Gliwice, Poland
- NSL Analytical Services - Cleveland, OH
- SGS MSi - Melrose Park, IL
- EAG Laboratories - Liverpool, NY
- New Hampshire Materials Laboratory - Somersworth, NH
- Scrooby's Laboratory Service - Benoni, South Africa
- Raghavendra Spectro Metallurgical Laboratory - Bengaluru, India
- IMR Test Labs - Louisville, KY

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.

Kimberly Halkiotis, Global Product Manager

March 22, 2022
Certification Date

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

	Al	As	B	C	Co	Cr	Cu	Fe	Mg	Mn	Mo	N	Nb
1	0.0124	0.0021	0.0001	0.0043	0.0150	11.000	0.0620	87.050	0.0005	0.3550	0.0070	0.0080	0.0029
2	0.0141	0.0021	0.0004	0.0059	0.0167	11.010	0.0640	87.240	0.0007	0.3690	0.0070	0.0085	0.0033
3	0.0146	0.0024		0.0080	0.0170	11.070	0.0643	87.380	0.0025	0.3700	0.0090	0.0089	0.0033
4	0.0150	0.0027		0.0090	0.0170	11.140	0.0648	87.540	0.0028	0.3720	0.0093	0.0090	0.0035
5	0.0158	0.0028		0.0090	0.0172	11.149	0.0648	87.600	0.0390	0.3750	0.0093	0.0090	0.0037
6	0.0164	0.0029		0.0090	0.0185	11.166	0.0650		<0.0005	0.3820	0.0100	0.0090	0.0040
7	0.0172	0.0030		0.0091	0.0190	11.210	0.0650		<0.001	0.3846	0.0100	0.0115	0.0040
8	0.0174	0.0030		0.0100	0.0190	11.218	0.0652		<0.0010	0.3847	0.0100	0.0137	0.0040
9	0.0180	<0.002		0.0105	0.0191	11.267	0.0653		<0.0010	0.3856	0.0100		0.0042
10	0.0180	<0.002		0.0106	0.0194	11.310	0.0653		<0.005	0.3860	0.0100		0.0045
11	0.0180	<0.005		0.0115	0.0196	11.310	0.0658			0.3870	0.0105		0.0055
12	0.0183	<0.0050		0.0115	0.0210	11.350	0.0660			0.3890	0.0108		0.0060
13	0.0185			0.0120	0.0212	11.350	0.0660			0.3900	0.0114		<0.002
14	0.0190			0.0120	0.0215	11.350	0.0660			0.3910	0.0120		<0.005
15	0.0196			0.0140	0.0215	11.370	0.0661			0.3910	0.0126		<0.01
16	0.0200			0.0150	0.0220	11.390	0.0666			0.3944	0.0138		<0.01
17	0.0200				0.0221	11.410	0.0670			0.3960	0.0138		
18	0.0205					11.414	0.0694			0.3970	0.0138		
19						11.433				0.3980	0.0150		
20						11.460				0.4000			
21						11.490				0.4090			
22										0.4187			
23													
Mean	0.0174	0.0026	0.0003	0.0101	0.0192	11.279	0.0655	87.362	0.0091	0.3875	0.0108	0.0097	0.0041
STDV	0.0023	0.0004	0.0002	0.0027	0.0021	0.1459	0.0015	0.2241	0.0167	0.0140	0.0022	0.0019	0.0009
Certified	**0.017**	**0.0026**	**(0.0003)**	**0.010**	**0.019**	**11.28**	**0.0655**	**(87.4)**	**(0.01)**	**0.387**	**0.011**	**0.010**	**0.0041**
U$_{CRM}$	0.001	0.0003		0.001	0.001	0.07	0.0008			0.006	0.001	0.002	0.0006
Methods	I,IM,O,X,G	I,IM,X	IM,I	C,O,G	I,IM,O,X	I,O,X,G	I,IM,O,X	I,O,X	I,IM,X	I,O,X,G,IM	I,IM,O,X,G	F,O	I,IM,O,X,G

	Ni	P	Pb	S	Sb	Si	Sn	Ti	V	W	Zn	Zr
1	0.0980	0.0180	0.0001	0.0002	0.0007	0.4690	0.0041	0.1120	0.0660	0.0009	0.0053	0.0016
2	0.1000	0.0182	0.0002	0.0002	0.0008	0.4840	0.0046	0.1180	0.0670	0.0014	0.0077	0.0023
3	0.1000	0.0190	0.0002	0.0003	0.0009	0.4930	0.0048	0.1185	0.0700	0.0030	0.0087	0.0023
4	0.1040	0.0190	0.0010	0.0006	0.0010	0.4960	0.0048	0.1230	0.0710	0.0033	0.0099	<0.0001
5	0.1040	0.0193	0.0021	0.0006	0.0017	0.5020	0.0050	0.1260	0.0719	0.0037	0.0104	<0.0010
6	0.1060	0.0194	<0.001	0.0008	0.0018	0.5023	0.0051	0.1300	0.0730	0.0040	0.0120	<0.002
7	0.1060	0.0196	<0.0010	0.0008	<0.001	0.5070	0.0052	0.1360	0.0739	0.0042	0.0120	
8	0.1060	0.0200	<0.0010	0.0012	<0.005	0.5080	0.0054	0.1363	0.0750	0.0042	0.0168	
9	0.1070	0.0200	<0.002	0.0016		0.5121	0.0056	0.1380	0.0752	0.0050	<0.001	
10	0.1090	0.0201	<0.002	<0.0005		0.5123	0.0056	0.1384	0.0754	0.0050	<0.005	
11	0.1090	0.0208	<0.002	<0.001		0.5134	0.0058	0.1414	0.0755	0.0050		
12	0.1115	0.0217	<0.005	<0.001		0.5168	0.0060	0.1430	0.0760	<0.0010		
13	0.1116	0.0220		<0.0010		0.5184	0.0060	0.1430	0.0770	<0.0010		
14	0.1125	0.0220		<0.002		0.5200	0.0063	0.1430	0.0770	<0.005		
15	0.1146	0.0230		<0.002		0.5200	<0.005	0.1450	0.0770	<0.01		
16	0.1152	0.0235		<0.002		0.5300	<0.01	0.1456	0.0773			
17	0.1170	0.0240				0.5320		0.1500	0.0780			
18	0.1180	0.0240				0.5320		0.1500	0.0790			
19	0.1200	0.0240				0.5380		0.1540	0.0790			
20	0.1200	0.0270				0.5410		0.1540	0.0794			
21	0.1210					0.5420		0.1580	0.0799			
22						0.5720		0.1640				
23								0.1667				
Mean	0.1100	0.0212	0.0007	0.0007	0.0011	0.5164	0.0053	0.1406	0.0749	0.0036	0.0104	0.0021
STDV	0.0070	0.0024	0.0009	0.0005	0.0005	0.0222	0.0006	0.0145	0.0039	0.0014	0.0034	0.0004
Certified	**0.110**	**0.021**	**(0.001)**	**0.0007**	**0.0011**	**0.52**	**0.0053**	**0.141**	**0.075**	**0.0036**	**0.010**	**(0.0021)**
U$_{CRM}$	0.003	0.001		0.0004	0.0005	0.01	0.0004	0.006	0.002	0.0009	0.003	
Methods	I,O,X,IM	I,O,X,G,IM	I,IM,O,X	C,O,G,I,X	I,IM	I,O,X,G	I,IM,O,X	I,IM,O,X,G	I,IM,O,X,G	I,IM,O,X	I,IM,X	I,IM

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

LGC