ARMI | MBH
ANALYTICAL LTD

Certified Reference Material

Certificate of Analysis

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

Product ID: MBH-11X 0331.2 M

Product Description: Corrosion Resistant Iron

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	0.137	± 0.005	C	2.62	± 0.06	Co	0.179	± 0.002	Cr	1.54	± 0.03
Cu	6.68	± 0.09	Mn	1.85	± 0.04	Mo	0.067	± 0.003	Nb	0.134	± 0.006
Ni	15.1	± 0.1	P	0.050	± 0.002	Pb	0.019	± 0.002	Si	3.14	± 0.08
Sn	0.0271	± 0.0008	Ti	0.198	± 0.005	V	0.051	± 0.003	W	0.004	± 0.001
Zr	0.0022	± 0.0007								

Indicative Values listed in ppm

As	(30)	B	(<10)	Fe	(69%)	Mg	(20)	N	(<50)	O	(<100)	S	(900)
Zn	(<10)												

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.

- Connecticut Metallurgical, Inc. - East Hartford, CT
- IMR Test Labs - Lansing, NY
- Laboratory Testing, Inc. - Hatfield, PA
- NSL Analytical Services - Cleveland, OH
- SGS MSi - Melrose Park, IL
- Cleveland Cliffs - Middletown, OH
- Applied Technical Services - Marietta, GA
- EAG Laboratories - Liverpool, NY
- Sheffield Assay Office - Sheffield, UK
- Scrooby's Laboratory Service - Rynfield, South Africa
- LGC Standards - Manchester, NH
- Element Materials Technology - Middlesbrough, UK
- New Hampshire Materials Laboratory - Somersworth, NH
- RSML - Bengaluru, India

Instructions for Use: The test surface is on the opposite side of the labeled surface, which includes the material identification. This material is individually chill cast per piece. This manner of casting can cause the formation of inhomogeneous segregates in the upper, engraved portion of the disk. Therefore, the certification information above is not applicable to within 3mm of the engraved surface. 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

<u>February 2, 2022</u>
Certification Date

Conditions of Sale and Supply: All CRMs & RMs sold are subject to applicable LGC Standard Terms and Conditions of Sale.

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

Lab	Al	As	B	C	Co	Cr	Cu	Fe	Mg	Mn	Mo	N	Nb
1	0.1138	0.0011	0.0003	2.435	0.173	1.461	6.353	67.28	0.0001	1.742	0.054	0.005	0.1085
2	0.127	0.0022	0.0005	2.4736	0.1751	1.463	6.393	67.82	0.0003	1.748	0.0569	0.0054	0.118
3	0.13	0.0027	0.0017	2.543	0.1751	1.4639	6.46	68.7833	0.0022	1.7506	0.0624		0.122
4	0.133	0.0044		2.573	0.1767	1.478	6.461	69.95	0.005	1.77	0.0639		0.123
5	0.1337	<0.0005		2.585	0.177	1.483	6.58	70.2	<0.0005	1.795	0.0644		0.1258
6	0.134	<0.001		2.601	0.177	1.484	6.6		<0.001	1.805	0.065		0.127
7	0.134	<0.0010		2.605	0.1786	1.4878	6.6502		<0.001	1.811	0.065		0.127
8	0.1356	<0.002		2.61	0.179	1.491	6.7003		<0.0010	1.8251	0.0653		0.1318
9	0.136	<0.002		2.63	0.179	1.511	6.725		<0.0010	1.853	0.066		0.1349
10	0.137	<0.002		2.6324	0.1798	1.535	6.728		<0.005	1.855	0.0678		0.135
11	0.138	<0.005		2.634	0.18	1.556	6.745		<0.01	1.8603	0.068		0.136
12	0.138	<0.0050		2.65	0.183	1.578	6.7724			1.867	0.069		0.136
13	0.1401	<0.01		2.682	0.183	1.5808	6.7741			1.872	0.069		0.1363
14	0.141			2.8091	0.185	1.585	6.78			1.9045	0.07		0.1382
15	0.1467			2.9		1.59	6.7959			1.914	0.0705		0.1411
16	0.15					1.594	6.828			1.935	0.071		0.144
17	0.15					1.6008	6.873			1.936	0.072		0.144
18	0.1505					1.629	6.977			1.968	0.073		0.15
19						1.644				1.999	0.0735		0.152
20											0.0785		0.158
Mean	0.1371	0.0026	0.0008	2.6242	0.1787	1.5376	6.6776	68.807	0.0019	1.8532	0.0673	0.0052	0.1344
STDV	0.0090	0.0014	0.0008	0.1149	0.0034	0.0612	0.1715	1.2800	0.0023	0.0760	0.0056	0.0003	0.0121
Certified	**0.137**	**(0.003)**	**(<0.001)**	**2.62**	**0.179**	**1.54**	**6.68**	**(69)**	**(0.002)**	**1.85**	**0.067**	**(<0.005)**	**0.134**
U$_{CRM}$	0.005			0.06	0.002	0.03	0.09			0.04	0.003		0.006
Methods	I,O,G,IM,X	I,O,IM,X	IM,O,I	C,G,O,I,X	I,O,IM,X	I,O,G,X	I,O,G,X	I,O,X	I,O,G,IM	I,O,G,X	I,O,G,IM,X	F	I,O,G,IM,X

Lab	Ni	O	P	Pb	S	Si	Sn	Ti	V	W	Zn	Zr
1	14.51	0.0003	0.044	0.015	0.0673	2.78	0.0248	0.181	0.041	0.005	0.001	0.0027
2	14.73	0.0091	0.0462	0.016	0.0761	2.911	0.025	0.1812	0.0444	0.0025	0.0014	0.0007
3	14.79		0.0468	0.017	0.078	2.9283	0.026	0.187	0.0456	0.0028		0.0013
4	14.85		0.0472	0.017	0.078	2.9781	0.0263	0.191	0.0484	0.0033		0.0015
5	14.88		0.0479	0.0172	0.0789	3.051	0.0264	0.1916	0.05	0.0041		0.0016
6	14.917		0.048	0.0179	0.079	3.068	0.0267	0.192	0.05	0.0046		0.002
7	14.937		0.0488	0.018	0.08	3.0704	0.0268	0.1923	0.051	0.0054		0.0027
8	14.9422		0.0488	0.018	0.0831	3.079	0.027	0.193	0.0516	0.0057		0.0034
9	15.013		0.0497	0.0181	0.0851	3.082	0.028	0.195	0.0518	<0.005		0.0035
10	15.02		0.0503	0.0185	0.088	3.088	0.028	0.195	0.0521	<0.01		<0.0010
11	15.059		0.0508	0.0206	0.0995	3.13	0.028	0.195	0.0523			<0.002
12	15.21		0.051	0.0219	0.102	3.169	0.0286	0.202	0.0534			<0.005
13	15.22		0.0533	0.022	0.1052	3.222	0.029	0.202	0.055			<0.01
14	15.26		0.0538	0.0253	0.1104	3.277	0.0293	0.204	0.057			
15	15.32		0.054	0.028	0.112	3.286		0.2056	0.0572			
16	15.3262		0.0551	<0.005	0.119	3.3018		0.206	0.063			
17	15.351				0.1199	3.331		0.2081				
18	15.392				0.12	3.334		0.218				
19	15.42					3.382		0.22				
20						3.4026						
Mean	15.060	0.0047	0.0497	0.0194	0.0934	3.1436	0.0271	0.1979	0.0515	0.0042	0.0012	0.0022
STDV	0.2544	0.0062	0.0031	0.0036	0.0175	0.1711	0.0014	0.0107	0.0053	0.0012	0.0003	0.0010
Certified	**15.1**	**(<0.01)**	**0.050**	**0.019**	**(0.09)**	**3.14**	**0.0271**	**0.198**	**0.051**	**0.004**	**(<0.001)**	**0.0022**
U$_{CRM}$	0.1		0.002	0.002		0.08	0.0008	0.005	0.003	0.001		0.0007
Methods	I,O,G,X	F	I,O,G,IM,X	I,IM,O,X	C,G,O,X,I	I,O,G,X	I,O,IM,X	I,O,G,IM,X	I,O,G,IM,X	I,O,IM,X	I,IM	I,O,IM,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

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