ARMI | MBH

Certified Reference Material | Certificate of Analysis

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

Product ID: IARM-NIRENE41-21

Revision No.: 000
Revision Date: 09/26/2023

Product Description: Nickel Alloy, Nickel Chromium, Rene 41 / N07041

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	1.58	±0.04	B	0.0067	±0.0009	C	0.081	±0.002	Co	11.1	± 0.1
Cr	18.98	±0.09	Cu	0.0025	±0.0009	Fe	2.92	±0.06	Mg	0.0019	± 0.0005
Mn	0.013	±0.001	Mo	9.61	±0.09	N	0.0046	±0.0003	Nb	0.022	± 0.002
Ni	52.6	±0.2	O	0.0007	±0.0004	Si	0.028	±0.005	Ti	3.10	± 0.02
V	0.012	±0.003	W	0.006	±0.002	Zr	0.0028	±0.0007			

Indicative Values listed in ppm

As	12	P	35	S	2	Sn	12	Ta	39

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.

- Anderson Laboratories, Inc.- Greendale, WI
- Applied Technical Services - Marietta, GA
- Dirats Laboratories - Westfield, MA
- EAG Laboratories - Liverpool, NY
- Elemental Analysis Inc. - Lexington, KY
- IMR Test Labs - Lansing, NY
- Instytut Metalurgii Zelaza - Gliwice, Poland
- Laboratory Testing, Inc. - Hatfield, PA
- LGC Standards - Manchester, NH
- NSL Analytical Services - Cleveland, OH
- SGS MSi - Melrose Park, IL
- Sheffield Assay Office - Sheffield, England
- TEC Eurolab - Campogalliano, Italy

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

September 26, 2023
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	1.443	0.0003	0.0052	0.0752	10.79	18.64	0.0011	2.770	0.0012	0.0098	9.256	0.0040	0.0160
2	1.455	0.0008	0.0058	0.0777	10.96	18.76	0.0016	2.826	0.0012	0.0108	9.443	0.0040	0.0200
3	1.550	0.0024	0.0058	0.0780	10.97	18.79	0.0023	2.850	0.0016	0.0112	9.461	0.0041	0.0206
4	1.555	<.0001	0.0059	0.0780	10.97	18.87	0.0023	2.851	0.0017	0.0115	9.525	0.0042	0.0210
5	1.563	<0.005	0.0061	0.0810	11.00	18.93	0.0024	2.857	0.0017	0.0117	9.539	0.0047	0.0216
6	1.567	<0.005	0.0061	0.0819	11.02	18.93	0.0024	2.860	0.0021	0.0130	9.560	0.0047	0.0217
7	1.568	<0.0050	0.0064	0.0825	11.04	18.98	0.0034	2.877	0.0024	0.0130	9.566	0.0047	0.0220
8	1.570		0.0071	0.0826	11.05	18.99	0.0048	2.881	0.0030	0.0130	9.590	0.0050	0.0230
9	1.580		0.0077	0.0833	11.06	18.99	<.002	2.884	<0.005	0.0135	9.610	0.0050	0.0236
10	1.580		0.0090	0.0834	11.10	18.99	<0.0010	2.900	<0.005	0.0147	9.659	0.0052	0.0243
11	1.590		0.0090	0.0836	11.14	19.11	<0.005	2.910		0.0156	9.668		0.0255
12	1.599				11.21	19.12	<0.005	2.915		0.0160	9.756		0.0261
13	1.618				11.55	19.17		2.927		0.0175	9.825		
14	1.668				11.62	19.18		3.056		<0.005	9.833		
15	1.686					19.22		3.136		<0.005	9.881		
16	1.744							3.191					
Avg	1.583	0.0012	0.0067	0.0807	11.11	18.98	0.0025	2.918	0.0019	0.0132	9.611	0.0046	0.0221
SD	0.075	0.0011	0.0013	0.0029	0.23	0.17	0.0011	0.113	0.0006	0.0023	0.167	0.0005	0.0027
Certified	**1.58**	**(0.0012)**	**0.0067**	**0.081**	**11.1**	**18.98**	**0.0025**	**2.92**	**0.0019**	**0.013**	**9.61**	**0.0046**	**0.022**
Uncertainty	0.04		0.0009	0.002	0.1	0.09	0.0009	0.06	0.0005	0.001	0.09	0.0003	0.002
Methods	I,X,O	IM,I	I,IM	C	I,X,O	I,X,O	I,IM,O	I,X,O	IM,I	I,IM,X	I,X,O	F	I,IM,X,O

	Ni	O	P	S	Si	Sn	Ta	Ti	V	W	Zr
1	52.16	0.0003	0.0022	0.0001	0.0202	0.0001	0.0021	3.037	0.0044	0.0024	0.0023
2	52.38	0.0004	0.0030	0.0001	0.0212	0.0001	0.0034	3.056	0.0045	0.0031	0.0023
3	52.58	0.0004	0.0030	0.0002	0.0245	0.0001	0.0050	3.070	0.0087	0.0032	0.0025
4	52.63	0.0007	0.0034	0.0003	0.0250	0.0020	0.0051	3.070	0.0091	0.0053	0.0025
5	52.67	0.0008	0.0045	0.0003	0.0266	0.0037	<.0005	3.074	0.0095	0.0065	0.0025
6	52.72	0.0012	0.0046	<.0005	0.0291	<.0002	<0.0010	3.075	0.0100	0.0069	0.0033
7	52.91	0.0013	<0.005	<.0010	0.0312	<.0010	<0.005	3.086	0.0104	0.0073	0.0042
8	52.96	<.0005	<0.005	<0.0001	0.0347	<0.0010	<0.005	3.097	0.0110	0.0090	<0.005
9		<0.0005	<0.0050	<0.0003	0.0399	<0.0010	<0.5	3.106	0.0130	0.0090	<0.005
10				<0.0010	<0.005	<0.005		3.109	0.0130	0.0091	<0.01
11					<0.005	<0.005		3.111	0.0130	<0.005	
12						<0.01		3.120	0.0135	<0.005	
13								3.125	0.0180	<0.01	
14								3.159	0.0200		
15								3.162	0.0251		
16								3.168	<0.01		
Avg	52.63	0.0007	0.0035	0.0002	0.0280	0.0012	0.0039	3.102	0.0122	0.0062	0.0028
SD	0.26	0.0004	0.0009	0.0001	0.0064	0.0016	0.0014	0.038	0.0055	0.0026	0.0007
Certified	**52.6**	**0.0007**	**(0.0035)**	**(0.0002)**	**0.028**	**(0.0012)**	**(0.0039)**	**3.10**	**0.012**	**0.006**	**0.0028**
Uncertainty	0.2	0.0004			0.005			0.02	0.003	0.002	0.0007
Methods	I,X,O	F	I,IM	C	I,IM	I,IM	I,IM	I,X,O	I,IM,X,O	I,IM	IM,I

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