LGC ARMI

Certificate of Analysis
IARM 271B
Titanium Alloy 5-2.5 / UNS R54520
Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Al	**5.21** $\pm$ 0.02	**B**	**0.0012** $\pm$ 0.0006	**C**	**0.0128** $\pm$ 0.0007	**Cr**	**0.010** $\pm$ 0.001
Cu	**0.0068** $\pm$ 0.0006	**Fe**	**0.196** $\pm$ 0.003	**H**	**0.0139** $\pm$ 0.0006	**Mn**	**0.0036** $\pm$ 0.0001
Mo	**0.0063** $\pm$ 0.0005	**N**	**0.013** $\pm$ 0.001	**Nb**	**0.005** $\pm$ 0.002	**Ni**	**0.0089** $\pm$ 0.0007
O	**0.155** $\pm$ 0.005	**Si**	**0.010** $\pm$ 0.002	**Sn**	**2.52** $\pm$ 0.02	**V**	**0.057** $\pm$ 0.001
Zr	**0.059** $\pm$ 0.002						

Indicative Values listed in ppm

Co (10)	Mg (10)	P (11)	Pd (11)	Ru (30)	S (10)	Ta (104)
Ti (91.9%)	W (21)	Y (1.8)				

Description and Intended Use

This CRM may come in the form of a solid disc 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.

Interpretation of Data

1. Certified values listed reflect analysis results submitted by qualified analytical laboratories using a combination of methods and instrumentation that emulate actual methods and instrumental techniques currently utilized in the analytical community, and are reported as wt% unless otherwise noted.
2. This material was tested using both the solid disks and chips prepared from individual sections of bar. The certified values are considered representative of the overall average composition of the material.
3. Any data reported and enclosed by a parentheses ( ) is a "best estimate" and is not certified. This data could not be quantified sufficiently for certification. It was, however, reported by enough laboratories to be considered as potentially present in the matrix of the material being examined.
4. "Provisional Certificate of Analysis" reports values that support a fully certified reference material; it also indicates that values may be in a continued process of statistical evaluation and are subject to change.
5. Chips are not certified for Oxygen analysis.

The following data and accompanying statements represent all pertinent information reported in the ILAP as it applies to the chemical characterization of this material.

	Al	B	C	Co	Cr	Cu	Fe	H	Mg	Mn	Mo	N	Nb	Ni	O	P
1	5.137	0.0001	0.0114	0.0003	0.0069	0.00486	0.189	0.01242	0.0009	0.0034	0.0057	0.0095	0.002	0.007	0.142	0.001
2	5.15	0.0005	0.0121	0.00096	0.007	0.0057	0.1895	0.013	0.0012	0.0035	0.0059	0.01	0.003855	0.008	0.142	0.0012
3	5.19	0.0012	0.0121	0.001	0.0088	0.0067	0.19	0.013	<0.001	0.003565	0.0059	0.0108	0.004	0.0082	0.1452	0.0012
4	5.20	0.0013	0.0122	0.0011	0.009	0.007	0.1906	0.01332	<0.005	0.0036	0.006	0.0111	0.0058	0.0086	0.1465	<0.005
5	5.203	0.0016	0.0123	0.0017	0.0094	0.007	0.196	0.0136	<0.0100	0.0037	0.006	0.0118	0.0061	0.009	0.1542	
6	5.214	0.0017	0.0125	<0.005	0.0097	0.007	0.198	0.0138		0.0037	0.0068	0.012	0.0076	0.009	0.1552	
7	5.2227	0.00185	0.013	<0.005	0.01	0.0072	0.198	0.014		0.0037	0.007	0.0123		0.009	0.1552	
8	5.228		0.013	<0.005	0.0103	0.0073	0.198	0.0143		0.004	0.0073	0.0125		0.0096	0.157	
9	5.2325		0.0135	<0.0050	0.0107	0.0073	0.1995	0.015				0.0141		0.0096	0.1592	
10	5.2339		0.01406	<0.01	0.011	0.0078	0.2007	0.015				0.0144		0.0098	0.1607	
11	5.24918		0.0149		0.0115		0.2007	0.01523				0.01547		0.0105	0.1608	
12	5.259				0.0119		0.2033					0.0156			0.16189	
13	5.26				0.012							0.0169			0.163	
14					0.0127										0.1658	
15																
Mean	5.21	0.0012	0.0128	0.001	0.01	0.0068	0.196	0.0139	0.0010	0.0036	0.0063	0.013	0.005	0.0089	0.155	0.0011
STDV.	0.04	0.0007	0.001	0.0005	0.002	0.0009	0.005	0.0009	0.0002	0.0002	0.0006	0.002	0.002	0.001	0.008	0.0001
Certified	**5.21**	**0.0012**	**0.0128**	**(0.001)**	**0.010**	**0.0068**	**0.196**	**0.0139**	**(0.001)**	**0.0036**	**0.0063**	**0.013**	**0.005**	**0.0089**	**0.155**	**(0.0011)**
95% C.I.	0.02	0.0006	0.0007		0.001		0.003	0.0006		0.0001	0.0005	0.001	0.002	0.0007	0.005	
Methods	X,O,I,G	O,IM,I,G	O,C	X,I,G	X,O,I,G	X,O,I,G	X,O,I,G	O,F	I	X,I,G	X,O,I,G	O,F	X,I,G	X,O,I,G	O,F	O,I

	Pd	Ru	S	Si	Sn	Ta	Ti	V	W	Y	Zr					
1	0.0007	0.00255	0.0003	0.006	2.456	0.00946	91.49	0.054	0.0019	0.0001	0.0527					
2	0.0008	0.0026	0.00052	0.007	2.477	0.01	91.697	0.055	0.0019	0.00019	0.0562					
3	0.0008	0.0037	0.0013	0.008	2.48	0.0104	91.90	0.055	0.00204	0.0002	0.0578					
4	0.001	<0.005	0.00145	0.008	2.52	0.0106	92.64	0.0554	0.0026	0.0002	0.058					
5	0.002	<0.0050	0.0024	0.009	2.5256	0.0115		0.0556	<0.005	0.0002	0.0583					
6	<0.005			0.009	2.527	<0.0100		0.0557	<0.005		0.0596					
7	<0.0050			0.01	2.53			0.056	<0.01		0.061					
8				0.0112	2.53			0.0574	<0.0100		0.0615					
9				0.0113	2.541			0.05778			0.063					
10				0.0113	2.5424			0.059			0.064					
11				0.0132	2.557			0.06								
12				0.0141	2.588			0.06								
13								0.0604								
14																
15																
Mean	0.0011	0.003	0.001	0.01	2.52	0.0104	91.9	0.057	0.0021	0.00018	0.059					
STDV.	0.0005	0.0007	0.0008	0.002	0.04	0.0008	0.5	0.002	0.0003	0.00004	0.003					
Certified	**(0.0011)**	**(0.003)**	**(0.001)**	**0.010**	**2.52**	**(0.0104)**	**(91.9)**	**0.057**	**(0.0021)**	**(0.00018)**	**0.059**					
95% C.I.				0.002	0.02			0.001			0.002					
Methods	X,O,IM,I	X,IM,I	C	X,O,I,G	X,O,I,G	X,I	X,O	X,O,I,G	X,I	X,O,IM,I,G	X,O,I,G					

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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Participating Laboratories

Perryman Company	Houston, PA	LECO Corporation	St. Joseph, MI
ATI Specialty Materials, Monroe	Monroe, NC	Laboratory Testing, Inc.	Hatfield, PA
ATI Richland Operations	Richland, WA	Laboratorio Prove Materiali S. Marco srl	Schio, Italy
ATI Powder Metals	Pittsburgh, PA	Anderson Laboratories, Inc.	Greendale, WI
ATI Specialty Alloys and Components	Albany, OR	Special Metals IncoTest	Hereford, UK
IMR Test Labs	Lansing, NY	Timet - UK Limited	Birmingham, UK

Traceability

Members of the "Inter-Laboratory Analysis Program" (ILAP) validate test methods and instrument performance utilizing SRMs, CRMs, and RMs produced by recognized Certifying Bodies. The specific SRMs, CRMs, and RMs applicable to the material covered by this certificate are:

ALPHA AR637	ALPHA AR641	ALPHA AR642	ALPHA AR648	ALPHA AR649	ALPHA AR650	ALPHA AR651	ALPHA AR881	ALPHA AR891
ALPHA AR892	BCS 351	BCS 357	BCS 451/1	BCS 454/1	BCS 462/1	HTL 608	IARM 175B	IARM 175C
IARM 176B	IARM 177B	IARM 177C	IARM 178A	IARM 178B	IARM 269A	IARM 269B	IARM 271A	IARM 286A
IARM 314A	IH BN3840	IH BN3849	IH D91146B	LECO 501-320	LECO 501-502	LECO 501-644	LECO 501-653	LECO 501-657
LECO 501-675	LECO 501-676	LECO 501-952	LECO 501-995	LECO 501-996	LECO 502-016	LECO 502-154	LECO 502-455	LECO 762-741
MBH 101XTI4	MBH 101XTI5-A	MBH 101XTI6-A	MBH 10XTI3-A	NIST 166C	NIST 173	NIST 173B	NIST 173C	NIST 174
NIST 176	NIST 176B	NIST 2452	NIST 3101A	NIST 3107	NIST 3112A	NIST 3113	NIST 3114	NIST 3117A
NIST 3126A	NIST 3131A	NIST 3132	NIST 3136	NIST 3137	NIST 3138	NIST 3139A	NIST 3150	NIST 3155
NIST 3163	NIST 3165	NIST 3167A	NIST 3168	NIST 3169	NIST 647	NIST 648	NIST 651	NIST 654B
NIST 928	TIV25	VHG 44/03						

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 is also 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.

$$1. \quad N_{min} = \max(10, \sqrt[3]{N_{prod}})$$

$$2. \quad U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

The International Standards Organization (ISO) definitions, expressed in ISO Guide 30–1992 list the following:

Certifying Body: Any technically competent body (organization or firm, public or private) that issues a reference material certificate with the information detailed in ISO Guide 31. The only generally accepted certifying body in the United States for primary standards or Standard Reference Materials (SRM) is the U. S. Department of Commerce, National Institute of Standards & Technology (NIST), Gaithersburg, MD. All other certifying bodies in the United States produce Reference Materials (RM) or Certified Reference Materials (CRM).

Reference Material (RM): Material or substance, with one or more property values that are sufficiently homogeneous and well established, to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Certified Reference Material (CRM): Reference material, accompanied by a certificate, with one or more property values certified by a procedure, which establishes its traceability to an accurate realization of the unit in which the property values are expressed, and for which each certified value is accompanied by an uncertainty at a stated level of confidence.
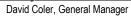
Inter-Laboratory Analysis Program (ILAP): ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", but also outlines a well thought out and logical plan for conducting an inter laboratory program involving multiple analytical techniques. Therefore, the guidelines established in ASTM E691-87 were applied to all aspects of this inter laboratory program, including the protocols for planning, handling, analysis and treatment of resulting data.

Methods of Analysis: The "Inter Laboratory Analysis Program" analyzes a wide variety of materials, and as a result, no single analytical method would provide optimum analytical results. Therefore, a combination of ASTM Standard Methods for classical wet chemistry, ICP, AA, Optical Emission, X-Ray spectrometric, and other accepted methods were used to produce analytical data. Carbon, Sulfur, Nitrogen, and Oxygen results were supplied from combustion and OE instrument procedures.

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

Instructions for Use: The test surface is on the side opposite to the labeled surface, which includes the IARM number. 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 to be used for Oxygen analysis.

Selection of Materials: A "batch" or "series" is defined as a continuous length of bar produced from a single heat. The majority of IARM materials are in wrought condition; other methods of manufacture are utilized if necessary. ILAP samples are removed from equal sections from the total length of the bar. A portion of each section is converted to chips and a thin (pin) disk for analysis by classical wet chemistry, ICP, AA, and combustion procedures, and the balance remains as a thick disk for OES and X-Ray analysis.

David Coler, General Manager

Analytical Reference Materials International