

Analytical Reference Materials International

Certificate of Analysis Certified Reference Material



Grade: **Ti-6Al-6V-2Sn / UNS R56620**

Part Number (Q.A. NO.): **IARM 178B**

Certificate Date: **04/08/2004**

Certificate No.: **178B-04082004-IARM-F**

Revision Date: **04/14/2008**

Interpretation of Data

1. Certified values listed below 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. 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.
3. The "Inter-laboratory Analysis Program" (ILAP) utilized in the establishment of the data are an ongoing program with permanent membership. Certain elements may be selected by a consensus of the members for more extensive testing. Therefore the data in **brackets []** indicates **further testing is in process**.
4. The **"±Estimated Uncertainty"** is enclosed by a **parentheses ()** below the individual **element's concentration** and is based on a Confidence Interval at 95%. Included in this estimated uncertainty, are the combined effects of method imprecision, material inhomogeneity, and any bias between methods.

Important: A "User Registration Card" accompanies all shipments. This card should be completed immediately upon receipt of materials with the appropriate user information. This is the only way in which ARMI can guarantee customer updates or possible data modifications!

<u>Aluminum</u> 5.58 (0.03)	<u>Carbon</u> 0.030 (0.001)	<u>Chromium</u> 0.015 (0.001)	<u>Copper</u> 0.51 (0.01)	<u>Iron</u> 0.56 (0.01)	<u>Hydrogen</u> 0.0028 (0.0002)	<u>Manganese</u> 0.003 (0.001)
<u>Molybdenum</u> 0.008 (0.001)	<u>Nitrogen</u> 0.008 (0.0005)	<u>Niobium</u>	<u>Nickel</u> 0.017 (0.001)	<u>Oxygen</u> 0.157 (0.004)	<u>Phosphorus</u>	<u>Sulfur</u> (0.001)
<u>Silicon</u> 0.025 (0.002)	<u>Tin</u> 2.00 (0.02)	<u>Vanadium</u> 5.56 (0.03)	<u>Tungsten</u>	<u>Yttrium</u>	<u>Ytterbium</u>	<u>Zirconium</u> 0.004 (0.001)

The laboratories participating in the "Inter-Laboratory Analysis Program" (ILAP) and certification of this material are as follows:

Alcoa - Howmet Research Center - Whitehall, MI
ATI Allvac - Monroe, NC
IMR Test Labs - Lansing, NY
NSL Analytical Services - Cleveland, OH
Timet - North American Operations - Henderson, NV
Timet - UK Limited - Witton, Birmingham, UK

Anderson Laboratories, Inc. - Greendale, WI
Bodycote Testing - Portland, OR
Laboratory Testing, Inc. - Hatfield, PA
Special Metals IncoTest - Hereford, UK
Timet - North American Operations - Morgantown, PA
Wah Chang - Albany, OR

Traceability: All members of the "Inter-Laboratory Analysis Program" (ILAP) listed above validate test methods and instrument performance utilizing SRMs produced by the National Institute of Standards and Technology, (NIST) as well as other CRMs and RMs produced by recognized Certifying Bodies from around the world. The specific SRMs, CRMs and RMs applicable to the material covered by this certificate are: NIST 654B, 173, 15H, 352C, 344, NCS NS57004, NIST 648, 654B, NIST 647, 648, IARM 174A, 175B, ALPHA AR651, LECO 501-320, In House 1051, 1062, 1068, 1072, 31059, BCS 351, 454/1, 462/1, LECO 501-664, 501-530, 502-024, 502-154, Eltra 91200-1, NIST 173B, BCS 237/2, 357, 451/1, LECO 502-154, 501-320, IARM 178A, BS T81, LECO 501-506, 501-664, NIST 173A, 174, 648, 653, IARM 178A, NIST 650, 651, 652, 3107, 3112A, 3113, 3167A, 3169, IARM 175A, 178A, LECO 502-154, BN 3840, LECO 501-505, 502-154, 502-201, NIST 15H, LECO 501-300, 501-678, ZR CK66C, CK204J, NIST 641, 642, 644, 646, 654B, 1128, 1133, IARM 178A, BS T-2, T-4, T-7, T-13, T-14, T-15, T-19, T-22, T-24, TX-21.

A specific line of traceability is established to NIST and other Certifying Bodies for those elements that are noted as "Certified Values" on the Certificates of Analyses referenced above.

See Reverse Side for Statistical Data and Additional Information Regarding this Material.

The following data and accompanying statements represent all pertinent information reported in the ILAP as it applies to the chemical characterization of this material as of 04/14/2008.

178B	Al	C	Cr	Co	Cu	Fe	H	Mn	Mo	Ni	N	O	Pd	P	Si
1	5.627	0.030	0.0152	0.0015	0.530	0.580	0.0030	0.0029	0.010	0.020	0.0080	0.1572	<0.003	<0.002	0.020
2	5.548	0.0319	0.014	0.0013	0.518	0.570	0.00276	0.002	0.0087	0.0172	0.0072	0.1597	<0.010	0.0006	0.0260
3	5.517	0.0292	0.0157	0.0024	0.513	0.573	0.0033	0.0034	0.0089	0.0180	0.0074	0.155	<0.0001	0.0010	0.0200
4	5.517	0.0323	0.012	0.0014	0.494	0.545	0.0030	0.002	0.0092	0.0160	0.0070	0.1646	<0.001	<0.005	0.031
5	5.565	0.0309	0.0155		0.4989	0.5549	0.0027	0.0034	0.0049	0.0149	0.0077	0.160	0.003	0.001	0.0232
6	5.59	0.0289	0.0180		0.505	0.565	0.002473	0.002	0.0065	0.015	0.00715	0.1506	<0.001	<0.0020	0.024
7	5.61	0.030167	0.012		0.485	0.57	0.00250	0.0012	0.006	0.0166	0.008273	0.1626	<0.01		0.023
8	5.65	0.0323	0.0121		0.485	0.56865	0.0034	0.0032	0.0066	0.0171	0.0073	0.157	<0.005		0.0229
9	5.60	0.0272	0.018		0.490	0.56	0.0027		0.0075	0.016667	0.009	0.1503			0.022
10	5.60	0.028	0.015		0.512	0.577	0.00265		0.0121	0.0197	0.0086				0.025
11	5.590	0.0304	0.01380		0.526	0.554			0.008	0.017					0.0237
12	5.51				0.494	0.5430			0.0082	0.01570					0.0251
13					0.522	0.573			0.0109	0.0200					0.0320
14															0.0266
Mean	5.5765	0.0301	0.0147	0.0017	0.5056	0.5641	0.0028	0.0025	0.0083	0.0172	0.0078	0.1574	0.0030	0.0009	0.0246
STDV.	0.0453	0.0017	0.0022	0.0005	0.0156	0.0118	0.0003	0.0008	0.0020	0.0018	0.0007	0.0049		0.0002	0.0035
Certified	5.58	0.030	0.015	(0.001)	0.51	0.56	0.0028	0.003	0.008	0.017	0.008	0.157	0.0028		0.025
95% C.I.	0.03	0.001	0.001		0.01	0.01	0.0002	0.001	0.001	0.001	0.0005	0.004			0.002
Methods	X,I,O	C	X,I	I	X,I,O	X,I,O	F,O	X,I,O	X,I,O	X,I,O	F	F			X,I,O

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

178B	S	Sn	Ti	V	Y	Zr	B	Mg	Nb	Ru	Ta	W	Yb	Pb	Sb
1	0.0022	2.05	85.397	5.51	<0.0010	0.0036	<0.0010	<0.008	<0.003	<0.010	<0.0001	0.0178			
2	0.0017	1.967	85.68	5.57	<0.005	0.0048	0.0006	0.0006	<0.002	0.0050	0.10	<0.002			
3	0.0006	1.981	85.54	5.474	<0.0004	0.0042	<0.0001	<0.0010	0.0272	<0.001	<0.001	<0.001			
4	0.0004	1.976	86.766	5.525	<0.0001	0.0053	0.0004	0.004	0.001	<0.01	0.0019	<0.01			
5		1.979	86.392	5.537	0.0002	0.0036	<0.001	<0.001	0.0055	0.0010	<0.01	<0.0050			
6		2.000	85.830	5.55	<0.0010	0.003	0.0012	<0.02	0.0075	<0.005					
7		1.96		5.62	0.0001	0.0049	0.0002	<0.01	<0.001						
8		1.994		5.58	<0.001	0.004	<0.0005		0.005						
9		1.97		5.601	<0.01	0.0060	<0.0005		<0.001						
10		2.01		5.63	<0.0001	0.0042			<0.0010						
11		2.023		5.580	<0.001	0.0044			<0.0100						
12		2.03		5.59	<0.0005	0.0033			<0.0500						
13		2.005													
Mean	0.0012	1.9958	85.9342	5.5639	0.0002	0.0043	0.0006	0.0023	0.0092	0.0030	0.0510	0.0178			
STDV.	0.0009	0.0271	0.5331	0.0463	0.0001	0.0009	0.0004	0.0024	0.0103	0.0028	0.0694				
Certified	(0.001)	2.00	(85.9)	5.56		0.004									
95% C.I.		0.02		0.03		0.001									
Methods	C	X,I	X,I,O	X,I,O		X,I,O									

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

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 which provides the information detailed in ISO Guide 31. The only generally accepted certifying body in the United States for primary standards - 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 one or more of whose property values 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, one or more of whose property values are 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): Although ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", it is also a well thought out and logical plan for conducting an inter-laboratory program involving multiple techniques. Therefore, the planning, conducting, analyzing, protocol, and treatment of data resulting from this inter-laboratory program were performed utilizing the guidelines established in ASTM E691-87.

Methods of Analysis: In view of the fact, that the "Inter-Laboratory Analysis Program" entails a wide variety of materials, no single analytical method would provide optimum data results. Therefore, the methods utilized were a combination of ASTM Standard Methods for classical wet chemistry, ICP, AA, Optical Emission, and X-Ray spectrometric methods. The determinations for Carbon, Sulfur, Nitrogen, and Oxygen are the result of combustion instrument procedures.

Selection of Materials: A "batch" or "series" is defined as a single bar of one continuous length and heat. The majority of materials are in wrought condition; other methods of manufacture are utilized as a less desirable resort. ILAP samples are taken by removing a section, a minimum of, every one-twelfth of total length from the entire bar. A portion of the section is converted to chips and 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. Each member of the ILAP is furnished a sample pack from a specific location on the batch bar. This systematic sampling procedure results in the homogeneity being reflected as a product of the overall statistics and certified data. This method of homogeneity testing is in accordance with ISO Guide 34, regarding the systematic selection and testing of a representative number of units for the assessment of homogeneity.

Certified by: 
 William D. Britt, President & General Manager
 Analytical Reference Materials International Corporation

Certificate No.: 178B-04082004-ARM-F
 Certificate Date: 04/08/2004
 Revision Date/No.: 04/14/2008