Brammer Standard Company, Inc.

Certificate of Analysis

BS T-4A

Certified Reference Material[1] for Grade 4 Commercially Pure Titanium

(UNS Number R50700, ASTM B348(4))

	Certified Value[2]	Estimate of Uncertainty[3]	Information Values[4]	
		Analysis listed as percent by weight		
Al	**0.040**	0.003	Cu	0.001
Cr	**0.026**	0.0015	H	0.0027
Fe	**0.19**[5]	0.012	O	0.37
Mn	**0.003**	0.0005	P	0.001
Mo	**0.0006**	0.0002	S	0.0004
Ni	**0.014**	0.001	V	0.001
Si	**0.011**	0.001		
Sn	**0.005**	0.0015		
W	**<0.002**			
Zr	**<0.002**			
C	**0.014**[5]	0.003		
N	**0.005**	0.001		

[1] Brammer Standard Company, Inc., is accredited by A2LA (Certificate Number 656.02) to ISO Guide 34 as a Reference Material Producer to produce Certified Reference Materials.

[2] The certified value listed is the present best estimate of the true value based on the results of an interlaboratory testing program.

[3] The uncertainties listed are based on value judgments of the material inhomogeneity and the 95% confidence interval. The half-width confidence interval C(95%) is shown on page 2.

[4] Information values are not certified and are provided for information only.

[5] The original values certified on December 14, 2001 for Fe at 0.18% and C at 0.015% were revised on January 22, 2002 to Fe at 0.19% and C at 0.014% after an additional laboratory reported their results.

See the following pages for more information.

Certificate Number RevT4A-012202p1

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895
Telephone (281) 440-9396 Fax (281) 440-4432 brammerstandard.com

BS T4A **Data listed as mass fraction expressed as percent.** **RevT4A-012202p2**

Analysis	* Al	* Cr	* Fe	* Mn	* Mo	* Ni	* Si	* Sn	* W
1	AES 0.0367	AIC 0.0245	AIC 0.172	AIC 0.0025	AIC 0.0005	AIC 0.013	AIC 0.008	AIC 0.003	AIC <0.001
2	AGM 0.0380	AIC 0.0248	AIC 0.174	AIC 0.003	AIC 0.00051	AIC 0.013	AIC 0.010	AIC 0.003	AIC <0.001
3	AIC 0.0387	AIC 0.025	AIC 0.179	AIX 0.003	AGM 0.00055	AIC 0.0135	AGM 0.01	AGM 0.0037	AIC <0.001
4	XRF 0.039	AIC 0.0256	AIC 0.181	AIC 0.0030	AIC 0.0007	AIC 0.0136	XRF 0.010	XRF 0.004	AIC <0.0010
5	AIC 0.0400	AIC 0.0256	AIC 0.1820	AIC 0.0030		AGM 0.014	AIC 0.0102	AIC 0.0040	AIC <0.002
6	AIC 0.041	AIC 0.0260	AIC 0.189	AIC 0.0031		AIC 0.0145	AES 0.0102	AES 0.0049	AGM 0.000090
7	AIC 0.0414	XRF 0.026	AGB 0.195	AIC 0.0032		AIC 0.0147	AIC 0.011	AIC 0.0055	AIC 0.0009
8	AIC 0.043	AIC 0.026	AES 0.197	AGM 0.0033		AIC 0.0150	AIC 0.0120	AIC 0.006	
9	AIC 0.043	AES 0.027	XRF 0.204	AIC 0.0035		XRF 0.015	AGM 0.0148	AGM 0.0068	
10		AGM 0.0280	AIX 0.204	AES 0.0035		AES 0.0154			
11		AIX 0.028				AIX 0.016			
Average	0.0401	0.0260	0.1877	0.0031	0.00057	0.0143	0.0106	0.0045	
Std Dev	0.0022	0.0012	0.0118	0.0003	0.00009	0.0010	0.0017	0.0013	
Certified	0.040	0.026	0.19	0.003	0.0006	0.014	0.011	0.005	<0.002
t	2.306	2.22281	2.2622	2.2622	3.1824	2.2281	2.306	2.306	
C(95%)	0.0017	0.0008	0.0071	0.0002	0.00015	0.0007	0.0013	0.0010	

Analysis	* Zr	* C	* N	* Cu	* H	* O	* P	* S	* V
1	AIC <0.0008	C 0.012	FU 0.0038	AIC 0.0005	FU 0.0026	FU 0.347	AGM 0.0011	AGM 0.00015	AIC 0.0006
2	AIC <0.0008	C 0.013	FU 0.0043	AIC 0.0007	FU 0.0026	FU 0.355	AES 0.0016	AGM 0.00035	AIC 0.0006
3	AIC <0.002	C 0.013	FU 0.0046	AGM 0.00090	FU 0.0029	FU 0.357		C 0.0004	AGM 0.00090
4	AIC 0.0001	C 0.0136	FU 0.0047	AIC 0.001		FU 0.376		C 0.0005	AIC 0.0017
5	AGM 0.00051	AES 0.0140	FU 0.005	AES 0.001		FU 0.3950			AIC 0.0020
6	AIC 0.0008	C 0.0150	AGM 0.0055	AGM 0.0012					
7		C 0.0162	FU 0.006	AIX 0.002					
8		C 0.0168		AIC 0.0021					
9				AIC 0.0021					
10				AIC 0.0025					
Average		0.0143	0.0048	0.0014	0.00270	0.3660	0.0014	0.00035	0.0012
Std Dev		0.0017	0.0007	0.0007	0.00017	0.0194	0.0004	0.00015	0.0007
Certified	<0.002	0.014	0.005	(0.001)	(0.0027)	(0.37)	(0.001)	(0.0004)	(0.001)
t		2.3646	2.4469	2.262	4.3027	2.7764	12.706	3.1824	2.7764
C(95%)		0.0014	0.0005	0.0005	0.0004	0.0241	0.0032	0.00024	0.0008

Data in parentheses are not certified but are provided for information only.

C(95%) = (t x sd)/√n The half-width confidence interval, where t is the appropriate Student's t value, sd is the interlaboratory standard deviation, and n is the number of acceptable mean values. For further information regarding the confidence interval for the certified value see ISO Guide 35:1989 section 4.

*** Methods of Analysis**

Code	Method
AES	AES - Spark Source Optical Emission Spectrometry AES = Atomic Emission Spectrometry
AIX	Average of Inductively Coupled Plasma Spectrometry and X-Ray Fluorescence Spectrometry
AIC	AES - ICP -Inductively Coupled Plasma Spectrometry
AGM	AES - Glow Discharge Mass Spectrometry
C	Combustion-Infrared Absorption (ASTM E 1019) traceable to CRMs
FU	Inert gas Fusion Method (ASTM E 1019) traceable to CRMs
XRF	X-Ray Fluorescence Spectrometry

Co-operating Laboratories: The co-operating laboratories were:

Laboratory	Laboratory contact
AK Steel Research, Middletown, Ohio	Howard P. Vail
Allegheny Ludlum, Technical Center, Brackenridge, Pennsylvania	Shawn D. Cooper
Allvac, Monroe, North Carolina	Patrick M. Cole
Brammer Standard Co., Inc., Houston, Texas	Richard P. Beaumont
J. Dirats and Co., Inc., Westfield, Massachusetts	Eric E. Dirats
LECO Corporation, St. Joseph, Michigan	Dennis A. Lawrenz
Northern Analytical Laboratory Inc., Merrimack, New Hampshire	Richard J. Guidoboni
Shiva Analyticals (India) Ltd., Hoskote, Bangalore, India	Dr. T. V. Ramakrishna
Titanium Matels Corporation, Morgantown, Pennsylvania	Larry E. Creasy
VHG Laboratories, Inc., Manchester, New Hampshire	Julie M. McIntosh

Certification Process: The requirements of ISO Guide 31, ISO Guide 34, ISO Guide 35, and ASTM Standard Guides E 1724 and E 1831 were followed for the preparation of this reference material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

Analysis: Chemical analyses were made on chips prepared by a lathe from the certified portion of the discs. No standardized sampling procedures are available for titanium, but the principles of ASTM Practice 1806 were used to obtain representative test samples. The laboratories participating in the testing normally followed the requirements of ISO Guide 25 and/or ISO Standard 17025. Individual values listed on page 2 are the average of each analyst's results. Methods of analysis are listed on page 2.

Outliers: Some outlying data was excluded from the data listed on page 2 due to technical assessment of the co-operating laboratories and statistical evaluation.

Traceability: The following Certified Reference Materials were used to validate the analytical data listed on page 2:
SRM 125b, 131e, 173a, 173b, 348a, 651; CE 031.

Homogeneity: This Certified Reference Material was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by optical emission spectrometry and found to be compatible with the following Reference Materials: BS T2 and T4.

Validity statement: ISO Guide 31 states that the certificate of analysis should contain an expiration date for all materials where instability has been demonstrated or is considered possible, after which the certified value is no longer guaranteed by the certifying body. Whereas this material is in a solid form and stable, no expiration date is specified.

Source: This material was supplied by President Titanium, Hanson, Massachusetts.

Form: This Certified Reference Material is in the form of a disc, approximately 38 mm in diameter and 12 mm thick.

Use: This Certified Reference Material is intended for use in optical emission and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Reference Materials.

Certified area: The entire depth of the disc may be used.

> **Caution:** As with any bar material, avoid optical emission spectrometric burns in the center of the disc (5 mm radius), as some segregation may be present.

Sample Preparation: For best analytical results, use the same method for preparing the analytical surface on all reference materials as you use for production specimens. Avoid overheating the disc during surface preparation.

Certificate Number: The unique identification number for this certificate of analysis is RevT4A-012202-px, where x indicates the page number. Refer to future Brammer Standard Company catalogs for information on any revisions to this or other Brammer Standard reference materials. You may also obtain information on revisions of certificates from the internet at brammerstandard.com.

Safety Notice: A Material Safety Data Sheet (MSDS) is not required for this material. This material will not release or otherwise result in exposure to a hazardous chemical under normal conditions of use. Inquiries concerning this Reference Material should be directed to:

Brammer Standard Co., Inc. Phone: (281) 440-9396 web brammerstandard.com
14603 Benfer Road
Houston, Texas 77069-2895 USA Fax: (281) 440-4432 e-mail bramstan@netropolis.net

Certified by: _____ on January 22, 2002.
G. R. Brammer

Brammer Standard Company, Inc., is accredited to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials by A2LA (Certificate Number 656.02) The scope of accreditation is listed on the website: www.brammerstandard.com

By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9002:1994 by National Quality Assurance, U.S.A.

Brammer Standard Company's Chemical Laboratory is accredited to ISO Guide 25 by A2LA. (Certificate Number 656.01)

References:

ASTM documents available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Telephone: 610-832-9500 Fax: 610-832-9555 e-mail: service@astm.org Website: www.astm.org

B 348 - 98 Standard Specification for Titanium and Titanium Alloy Bars and Billets

DS-56G (SAE HS-1086 Jan99) Metals & Alloys in the Unified Numbering System, 8th Edition

E 826 - 85 (Reapproved 1996) Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

E 1019 - 2000 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys

E 1724 - 95 Standard Guide for Testing and Certification of Metal and Metal-Related Reference Materials

E 1806 - 96 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

E 1831 - 96 Standard Guide for Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores, and Related Materials.

ISO Guides available from Global Engineering - www.global.ihs.com

ISO Standard 17025 (First edition, 1999), General requirements for the competence of calibration and testing laboratories.

ISO Guide 25 (Third edition, 1990), General requirements for the competence of calibration and testing laboratories.

ISO Guide 30 (Second edition, 1991), Terms and definitions used in connection with reference materials.

ISO Guide 31 (Second edition, 2000), Reference materials -Contents of certificates and labels.

ISO Guide 33 (Second edition, 2000), Uses of certified reference materials.

ISO Guide 34 (Second edition, 2000), General requirements for the competence of reference material producers.

ISO Guide 35 (Second edition, 1989), Certification of reference materials - General and statistical principles.

Other useful documents available from NIST, U.S. Department of Commerce, Gaithersburg, MD 20899.

NIST Special Publication 260-100, Handbook for SRM Users

NIST Special Publication 829, Use of NIST Standard Reference Materials for Decisions on Performance of Analytical Chemical Methods and Laboratories