MBH ANALYTICAL LTD

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CERTIFICATE OF ANALYSIS

101X Ti2 (batch A)

Certified Reference Material Information

Type:	TITANIUM 6-2-4-2 (HIPped POWDER)
Form and Size:	Disc 40mm Diameter x 13mm Thickness
Produced by:	Crucible Materials Corp.
Certified and supplied by:	MBH Analytical Ltd.

Assigned Values

Percentage element by weight

Element	Al	Sn	Zr	Mo	Fe	Cr	Ni
Value [1]	**6.02**	**2.05**	**3.97**	**2.08**	**0.053**	**0.0054**	**0.0073**
Uncertainty [2]	0.04	0.03	0.02	0.03	0.002	0.0003	0.0005

Element	Cu	Si	Y	C	O	N	H
Value [1]	**(0.003)**	**0.110**	**0.0002**	**0.016**	**0.143**	**0.0053**	**0.0076**
Uncertainty [2]	-	0.005	0.0001	0.002	0.007	0.0008	0.0003

Note: values given in parentheses are not certified - they are provided for information only

Definitions

[1] The certified values are the present best estimates of the true content for each element. Each value is a panel consensus, based on the averaged results of an interlaboratory testing programme, detailed on page 3.

[2] The uncertainty values are equivalent to the 95% confidence interval derived from the wet analysis results, after assessment of the homogeneity data, as described on page 2.

Certified by:

on 15th August 2008

MBH ANALYTICAL LIMITED _____

C Eveleigh

Method of Preparation

This reference material was produced by atomisation of molten titanium alloy using pressurized argon. The resultant powder was sieved, and then loaded into a steel container which was vacuum outgassed prior to sealing. The sealed container was HIPped, to achieve 100% consolidation.

Sampling

Samples for chemical analysis, and discs for homogeneity checks, were taken from several positions within the batch. At least 10% of all discs were incorporated into the schedule for homogeneity checking.

Homogeneity

The discs were checked for sample and batch uniformity using an optical emission spectrometer. No significant inhomogeneity was found, and spectrometer performance was similar at all positions within the sample.

Chemical Analysis

Analysis was carried out on solid pieces or millings taken from samples representative of the product. It was performed by a panel of laboratories mostly operating within the terms of EN ISO/IEC 17025 - 2000, using documented standard reference methods and validated by appropriate reference materials.

The individual values listed overpage are the average of each analyst's results.

Estimation of Uncertainties

Each element certified has been analysed by several laboratories, and 95% half-width confidence intervals ($C_{(95\%)}$) for the resultant mean values have been derived by the method shown on page 3.

Since the complete batch of material has been found to be homogeneous (for the main application envisaged), these 95% confidence intervals have been used directly as an indicator of uncertainty.

Traceability

Most of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation by a national or internationally-recognized authority. It is part of the 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 primary reference materials.

Usage

Intended use: With optical emission and X-ray fluorescence spectrometers.

Recommended method of use: Titanium and its alloys are generally prepared by linishing, milling, turning or polishing, but note that liquid coolants or solvents should not be used as part of this process. Otherwise, users are recommended to follow the calibration and sample preparation procedures specified by the relevant instrument manufacturer.

Preparation should be the same for reference materials and the samples for test.

A minimum of three consistent replicate analyses is recommended to provide the necessary sample size. Users are advised to check against possible bias between reference materials and production samples due to differences in metallurgical history, and be aware of possible inter-element effects.

Analytical Data

Percentage element by weight

Sample	Al	Sn	Zr	Mo	Fe	Cr	Ni
1	5.88	1.954	3.915	2.02	0.0460	0.0044	0.0058
2	5.926	1.96	3.931	2.02	0.048	0.0045	0.0061
3	5.956	1.985	3.936	2.037	0.049	0.0048	0.0070
4	5.96	2.031	3.939	2.038	0.0495	0.0050	0.0071
5	5.962	2.035	3.942	2.04	0.050	0.0052	0.0072
6	5.983	2.035	3.945	2.050	0.0517	0.0055	0.0073
7	5.985	2.04	3.96	2.060	0.052	0.0055	0.0073
8	6.020	2.052	3.961	2.093	0.052	0.0056	0.0074
9	6.029	2.055	3.978	2.097	0.052	0.0057	0.0075
10	6.048	2.06	3.986	2.098	0.0521	0.0058	0.0077
11	6.065	2.067	4.008	2.12	0.0541	0.0058	0.0082
12	6.072	2.07	4.014	2.12	0.056	0.0060	0.0087
13	6.089	2.074	4.034	2.125	0.0563	0.0060	
14	6.10	2.083		2.137	0.0567	0.0062	
15	6.10	2.095		2.152	0.059		
16	6.10	2.100			0.0597		
17	6.108	2.113					
Mean	**6.023**	**2.048**	**3.965**	**2.080**	**0.0528**	**0.0054**	**0.0073**
Std Dev	0.070	0.046	0.036	0.045	0.0040	0.0006	0.0008
$C_{(95\%)}$	0.036	0.023	0.022	0.025	0.0022	0.0003	0.0005

Sample	Cu	Si	Y	C	O	N	H
1	0.0015	0.100	0.0001	0.012	0.129	0.0036	0.0072
2	0.0017	0.102	0.0001	0.012	0.137	0.0039	0.0074
3	0.0020	0.102	0.0001	0.0141	0.138	0.0048	0.0075
4	0.0022	0.104	0.0002	0.015	0.140	0.0055	0.0077
5	0.0025	0.106	0.0002	0.016	0.140	0.0055	0.0078
6	0.003	0.108	0.0003	0.0161	0.143	0.0055	0.0081
7	0.0033	0.109	0.0004	0.0185	0.150	0.006	
8	0.0036	0.114	<0.0005	0.0189	0.152	0.006	
9	0.004	0.116	<0.0005	0.0191	0.159	0.0068	
10	0.0042	0.119	<0.001				
11	0.0044	0.120	<0.001				
12		0.121					
Mean	**0.0029**	**0.110**	**0.0002**	**0.0157**	**0.143**	**0.0053**	**0.0076**
Std Dev	0.0010	0.008	0.0001	0.0027	0.009	0.0010	0.0003
$C_{(95\%)}$	0.0007	0.005	0.0001	0.0021	0.007	0.0008	0.0003

Note: $C_{(95\%)}$ is the 95% half-width confidence interval derived from the equation:

$$C_{(95\%)} = (t \times SD)/\sqrt{n}$$

where n is the number of available values, t is the Student's t value for n-1 degrees of freedom, and SD is the standard deviation of the test results.

Participating Laboratories

ATI Allvac Ltd	Sheffield, England	UKAS accreditation 0638
IncoTest Ltd	Hereford, England	UKAS accreditation 0281
Bodycote Materials Testing Ltd	Middlesbrough, England	UKAS accreditation 0239
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 0492
Laboratory Testing, Inc	Hatfield, PA, USA	A2LA accreditation 0117
ATI Allvac	Monroe, NC, USA	PRI accreditation 122282
ATI Wah Chang	Albany, OR, USA	PRI accreditation 121162
Genitest, Inc	Montreal, Canada	PRI accreditation 123077
Institute of Iron & Steel Technology	Shanghai, China	CNAL accreditation 0783
Laboratory TUV-Nord	Brno, Czech Republic	CAI accreditation 1060
Sargam Metals Pvt Ltd	Chennai, India	NABL accreditation 0025
Timet Corp	Morgantown, PA, USA	NADCAP 117819
Leco Corp	St Joseph, MI, USA	
Perryman Corp	Coal Center, PA, USA	
Crucible Materials Corp	Pittsburg, PA, USA	

Note: to achieve the above-noted accreditation (eg UKAS, NATA, A2LA, etc), test houses must demonstrate conformity to the general requirements of EN ISO/IEC 17025.

Analytical Methods Used

ELEMENT	RESULT No. & METHOD							
	ICP-AES	*	MS	GD	XRF	FAAS	OTHER	
Aluminium	1-4, 7, 8, 11, 12, 14, 17	6	-	9	10, 13, 15	5	16	volumetric (EDTA)
Tin	1-3, 5, 9-11, 15, 17	16	-	6	4, 8, 12, 13	7, 14		
Zirconium	1, 2, 6, 7, 10, 11, 13	12	9	4	3, 5, 8	-		
Molybdenum	1-3, 5, 9, 10, 13-15		-	-	4, 6, 7, 12	8, 11		
Iron	1-5, 9-11, 13-15	6	-	12	8, 15	7, 16		
Chromium	1, 7-13	6	-	14	3, 4	2, 5		
Nickel	1, 3-10, 12		-		-	2, 11		
Copper	2, 3, 7, 11	4	-		5, 6, 8, 9	1, 10		
Silicon	1, 2, 7, 10, 12	8	-	5	3, 4, 11	-	9	photometric (molybdenum blue)
							6	gravimetric (perchloric acid)
Yttrium	1-3, 5, 6, 9-11		8		4, 7	-		
Carbon	-		-	-	-	-	all	combustion (infra-red detection)
Oxygen	-		-	-	-	-	all	inert gas fusion
Nitrogen	-		-	-	-	-	all	inert gas fusion
Hydrogen	-		-	-	-	-	all	inert gas fusion

Notes

Results in the ICP-AES * column were generated by spark-ablation of the solid sample, using an ICP-AES detection system

Results in the MS column were generated by ICP with detection by mass spectrometry.

Results in the GD column were generated by glow-discharge with AES detection

Notes

This Certified Reference Material has been produced and certified in accordance with the requirements of ISO Guide 34-2000, ISO Guide 31-2000 and ISO Guide 35-1989, taking into account the requirements of the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

This certification is applicable to the whole of the disc.

This material will remain stable provided adequate precautions are taken to protect it from cross-contamination, extremes of temperature and atmospheric moisture. All production records will be retained for a period of 20 years from the date of this certificate. This certification will therefore expire in August 2028, although we reserve the right to make changes as issue revisions, in the intervening period.

The sampling, analysis and certification of this product were supervised by C Eveleigh, PhD, Technical Director, MBH Analytical Ltd.

The material to which this certificate of analysis refers is supplied subject to our general conditions of sale.