

**Certified Reference Material**

**Certificate of Analysis**

**Product ID:** IARM-TiG4-18

ISO  
17034:2016

ISO/IEC  
17025:2017

ISO  
9001:2015

**Product Description:** Titanium Commercially Pure, A70 / R50700

Revision No.: 000  
Revision Date: 03/11/2022

**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**

<b>Al</b> 0.0020 ± 0.0007	<b>C</b> 0.053 ± 0.003	<b>Co</b> 0.0006 ± 0.0005	<b>Cr</b> 0.0017 ± 0.0005
<b>Cu</b> 0.0012 ± 0.0006	<b>Fe</b> 0.164 ± 0.009	<b>H</b> 0.0019 ± 0.0005	<b>Mn</b> 0.0011 ± 0.0002
<b>Mo</b> 0.0007 ± 0.0004	<b>N</b> 0.003 ± 0.001	<b>Nb</b> 0.002 ± 0.001	<b>Ni</b> 0.0023 ± 0.0002
<b>O</b> 0.34 ± 0.02	<b>P</b> 0.0010 ± 0.0004	<b>S</b> 0.0014 ± 0.0009	<b>Sn</b> 0.019 ± 0.001
<b>V</b> 0.0005 ± 0.0003	<b>W</b> 0.0010 ± 0.0008	<b>Zr</b> 0.0005 ± 0.0002	

**Indicative Values listed in ppm**

As (20)	B (10)	Ca (2)	Cl (1)	Hf (20)	Mg (10)	Pb (30)
Pd (<50)	Ru (<50)	Sb (7)	Si (30)	Ta (7)	Ti (99.5%)	Y (7)

**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 calculate 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.

$$1. N_{MIN} = \max(10, \sqrt[3]{N_{PROD}}) \qquad 2. U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

**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-recognized 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.

- LGC Standards - Manchester, NH
- Connecticut Metallurgical, Inc. - East Hartford, CT
- Dirats Laboratories - Westfield, MA
- IMR Test Labs - Lansing, NY
- IMR Test Labs - Louisville, KY
- Laboratory Testing, Inc. - Hatfield, PA
- Northern Analytical Laboratory, Inc. - Londonderry, NH
- NSL Analytical Services - Cleveland, OH
- SGS MSI - Melrose Park, IL
- EAG Laboratories - Liverpool, NY
- Lucid Laboratories - Telangana, India
- National Research Council Canada - Ottawa, Canada
- Scrooby's Laboratory Service - Benoni, South Africa
- Sheffield Analytical Services - Sheffield, UK
- TCR Engineering Services - Maharashtra, India
- TEC Eurolab - Campogalliano MO, 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.

  
Kimberly Halkotis, Global Product Manager

March 11, 2022  
Certification Date



ISO 17034 Accredited: Reference Materials  
Producer, Certificate # 2848.02  
ISO/IEC 17025 Accredited: Chemical  
Testing, Certificate # 2848.01

**Conditions of Sale and Supply:** All CRMs & RMs sold are subject to applicable LGC Standard Terms and Conditions of Sale.

The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

	Al	As	B	C	Ca	Cl	Co	Cr	Cu	Fe	H	Hf	Mg
1	0.000002	0.0012	0.000001	0.0478	0.0001	0.000005	0.0001	0.0006	0.0002	0.1405	0.0013	0.00001	0.00002
2	0.0007	0.0029	0.00001	0.0496	0.0004	0.0002	0.0001	0.0007	0.0003	0.1415	0.0014	0.00002	0.0001
3	0.0012		0.0002	0.0497			0.0001	0.0007	0.0004	0.1430	0.0015	0.0007	0.0009
4	0.0015		0.0005	0.0499			0.0001	0.0008	0.0005	0.1480	0.0015	0.0017	0.0010
5	0.0020		0.0020	0.0500			0.0003	0.0010	0.0006	0.1500	0.0018	0.0080	0.0012
6	0.0021		0.0020	0.0522			0.0004	0.0012	0.0007	0.1558	0.0018	<0.00001	0.0022
7	0.0021		<0.000005	0.0539			0.0010	0.0015	0.0007	0.1564	0.0026	<0.00005	<0.000004
8	0.0021		<0.0002	0.0544			0.0010	0.0018	0.0010	0.1620	0.0026	<0.0001	<0.00005
9	0.0024		<0.0005	0.0549			0.0020	0.0018	0.0010	0.1650	0.0029	<0.0001	<0.0002
10	0.0025		<0.0005	0.0580			<0.0001	0.0020	0.0010	0.1680		<0.0005	<0.0005
11	0.0030		<0.0005	0.0590			<0.0010	0.0020	0.0014	0.1705		<0.0010	<0.0010
12	0.0040		<0.001	0.0590			<0.002	0.0025	0.0022	0.1720		<0.005	<0.002
13	<0.0005		<0.0010				<0.002	0.0030	0.0030	0.1797			<0.002
14	<0.001		<0.002				<0.005	0.0036	0.0039	0.1800			<0.0020
15	<0.002		<0.005					<0.0010	<0.0010	0.1900			<0.005
16	<0.002							<0.002	<0.002	0.1950			
17	<0.005							<0.002	<0.005				
18								<0.005	<0.0100				
19													
20													
Mean	0.0020	0.0021	0.0008	0.0532	0.0002	0.0001	0.0006	0.0017	0.0012	0.1636	0.0019	0.0021	0.0009
STDV	0.0010	0.0012	0.0010	0.0039	0.0002	0.0002	0.0007	0.0009	0.0011	0.0170	0.0006	0.0034	0.0008
<b>Certified</b>	<b>0.0020</b>	<b>(0.002)</b>	<b>(0.001)</b>	<b>0.053</b>	<b>(0.0002)</b>	<b>(0.0001)</b>	<b>0.0006</b>	<b>0.0017</b>	<b>0.0012</b>	<b>0.164</b>	<b>0.0019</b>	<b>(0.002)</b>	<b>(0.001)</b>
U <sub>CRM</sub>	0.0007			0.003			0.0005	0.0005	0.0006	0.009	0.0005		
Methods	I,IM,O,G,X	G	I,IM,G,O	C,G	G	G	IM,I,G,X,O,A	IM,O,I,G,X	IM,O,I,X,G,A	I,IM,X,O,G	F	IM,I,G,X	IM,I,G,X,O,A

	Mn	Mo	N	Nb	Ni	O	P	Pb	Pd	Ru	S	Sb	Si
1	0.0007	0.0001	0.0013	0.0002	0.0016	0.3080	0.0003	0.000004	0.0030	<0.00001	0.00003	0.0004	0.0001
2	0.0008	0.0001	0.0016	0.0003	0.0018	0.3082	0.0006	0.0038	<0.00001	<0.00005	0.0007	0.0010	0.0007
3	0.0009	0.0001	0.0024	0.0004	0.0020	0.3188	0.0010	0.0040	<0.00005	<0.00005	0.0009		0.0009
4	0.0009	0.0001	0.0025	0.0004	0.0020	0.3280	0.0010	0.0053	<0.00005	<0.0001	0.0009		0.0030
5	0.0009	0.0006	0.0030	0.0017	0.0020	0.3410	0.0010	<0.000001	<0.0001	<0.001	0.0009		0.0031
6	0.0009	0.0010	0.0030	0.0019	0.0021	0.3470	0.0010	<0.00005	<0.001	<0.0010	0.0019		0.0040
7	0.0010	0.0010	0.0030	0.0020	0.0021	0.3490	0.0012	<0.0001	<0.0010	<0.0020	0.0030		0.0041
8	0.0010	0.0010	0.0033	0.0020	0.0023	0.3520	0.0020	<0.0001	<0.0020	<0.005	0.0030		0.0050
9	0.0010	0.0010	0.0046	0.0033	0.0023	0.3630	<0.0005	<0.0005	<0.005		<0.0005		0.0067
10	0.0011	0.0012	0.0069	0.0036	0.0025		<0.0005	<0.0010			<0.0010		<0.00001
11	0.0012	0.0019	<0.001	0.0060	0.0025		<0.005	<0.002			<0.0010		<0.002
12	0.0016	<0.00007		<0.00026	0.0027		<0.0050	<0.002					<0.002
13	0.0017	<0.0005		<0.001	0.0027			<0.002					<0.0020
14	<0.0005	<0.0010		<0.0010	0.0027			<0.005					<0.0025
15	<0.001	<0.0010		<0.002	0.0029								<0.0025
16	<0.0010	<0.002		<0.002	0.0032								<0.005
17	<0.002	<0.002		<0.005	<0.002								<0.0050
18	<0.002	<0.005			<0.002								
19	<0.005				<0.005								
20	<0.005												
Mean	0.0011	0.0007	0.0032	0.0020	0.0023	0.3350	0.0010	0.0033	0.0030		0.0014	0.0007	0.0031
STDV	0.0003	0.0006	0.0016	0.0018	0.0004	0.0200	0.0005	0.0023			0.0011	0.0004	0.0022
<b>Certified</b>	<b>0.0011</b>	<b>0.0007</b>	<b>0.003</b>	<b>0.002</b>	<b>0.0023</b>	<b>0.34</b>	<b>0.0010</b>	<b>(0.003)</b>	<b>(&lt;0.005)</b>	<b>(&lt;0.005)</b>	<b>0.0014</b>	<b>(0.0007)</b>	<b>(0.003)</b>
U <sub>CRM</sub>	0.0002	0.0004	0.001	0.001	0.0002	0.02	0.0004				0.0009		
Methods	I,IM,O,X,G,A	I,IM,O,X,G	F,O,G	IM,I,X,G,O	I,IM,O,G,X,A	F	IM,I,G,O,W	IM,I,G,X,O,A	IM,I,G	IM,I,G	C,G,F,O	G	I,IM,O,G,X,W

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GF AA, I = ICP or DCP, IM=ICP-MS, D = DC Arc, O = AES, X = XRF, G = GDAES or GDMS, H = Hollow Cathode AES

The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

	Sn	Ta	Ti	V	W	Y	Zr
1	0.0139	0.0003	99.310	0.0002	0.0001	0.0002	0.0002
2	0.0154	0.0004	99.380	0.0002	0.0003	0.0004	0.0002
3	0.0160	0.0007	99.700	0.0002	0.0004	0.0010	0.0002
4	0.0177	0.0010	99.700	0.0003	0.0006	0.0010	0.0003
5	0.0178	0.0010		0.0003	0.0006	<0.00001	0.0003
6	0.0180	<0.00005		0.0006	0.0010	<0.00005	0.0003
7	0.0180	<0.0001		0.0010	0.0017	<0.0005	0.0004
8	0.0184	<0.0001		0.0010	0.0029	<0.001	0.0004
9	0.0192	<0.001		<0.0005	<0.001	<0.0010	0.0005
10	0.0199	<0.0010		<0.001	<0.0010	<0.005	0.0007
11	0.0200	<0.002		<0.0010	<0.002	<0.0085	0.0008
12	0.0208	<0.002		<0.002	<0.0020		0.0010
13	0.0210	<0.005		<0.002	<0.005		0.0011
14	0.0229			<0.0020			<0.000006
15	0.0230			<0.005			<0.0001
16				<0.005			<0.0010
17							<0.002
18							<0.003
19							<0.005
20							
Mean	0.0188	0.0007	99.523	0.0005	0.0010	0.0007	0.0005
STDV	0.0026	0.0003	0.2069	0.0004	0.0009	0.0004	0.0003
<b>Certified</b>	<b>0.019</b>	<b>(0.0007)</b>	<b>(99.5)</b>	<b>0.0005</b>	<b>0.0010</b>	<b>(0.0007)</b>	<b>0.0005</b>
U <sub>CRM</sub>	0.001			0.0003	0.0008		0.0002
Methods	IM,O,I,X	IM,I,G,X	I,X	I,IM,G,X,O	IM,I,G	I,IM,G	I,IM,O,X,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

The following data was analyzed by GDMS and is intended for informational purposes only

	Ag	Au	Ba	Be	Bi	Br	Cd	Ce	Cs	Dy	Er	Eu	F	Ga
1	<0.000001	<0.00001	<0.0000004	<0.0000002	<0.0000008	0.000003	<0.000009	<0.000002	<0.000001	<0.00001	<0.00001	<0.00001	<0.00005	<0.000002
2	<0.00005	<0.00004	<0.00001	<0.000005	<0.00001	<0.00001	<0.00005	<0.00001	<0.00001					<0.00001

	Gd	Ge	Hg	Ho	I	In	Ir	K	La	Li	Lu	Na	Nd	Os
1	<0.00001	<0.000003	<0.000006	<0.00001	<0.000002	<0.00004	<0.00001	0.00002	<0.000002	<0.0000003	<0.00001	0.00002	<0.00001	<0.00001
2		<0.00005	<0.00005		<0.00001	<0.00005		<0.000001	<0.00001	<0.000005		<0.000003		

	Pr	Pt	Rb	Re	Rh	Sc	Se	Sm	Sr	Tb	Te	Th	Tl	Tm
1	<0.00001	<0.000002	0.00005	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00022	<0.00001	<0.000002	<0.0000001	<0.000001	<0.00001
2		<0.00001	<0.00006			<0.00002	<0.00005				<0.00005	<0.000001	<0.00001	

	U	Yb	Zn
1	<0.0000001	<0.00001	<0.000004
2	<0.000001		<0.00003