

MAC ref. No.: 1-004-1-0001

CAS. No.: 7440-41-7

Purity: 99.500%

Metals Basis

Form: Solid

Supplier: Alfa Aesar

Batch: D09T009

Be

Beryllium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Major Elements

Beryllium assay	99.50%
Beryllium Oxide	<0.010%

Trace Elements

C	0.08	Fe	0.08	Al	0.04	Mg	0.02
Si	0.02	N	0.03	Mn	<0.015	Cr	<0.01
Ni	0.01	Ag	<0.0003	Ca	<0.02	Co	<0.001
Cu	<0.01	Cd	<0.0002	Mo	<0.002	Pb	<0.002
Zn	<0.02	Li	<0.0003	B	<0.0002		

Notes

Beryllium forms a protective oxide layer when exposed to air.



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-005-1-0001

CAS. No.: 7440-42-8

Purity: 99.6%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: K10T028

B

Boron

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

Major Elements

B 99.6%

Trace Elements

C	0.2	N	0.01	O	<0.1	Al	<0.1
Fe	0.1	Mn	<0.1	Si	0.1		



Micro-Analysis Consultants Ltd



CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-005-2-0004

CAS. No.: 10043-11-5

Purity: 99.5%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: A04V013

BN

Boron Nitride

Typical Analysis Result

All data is presented as normalized and values shown in weight % unless otherwise noted.

B	41.87	N	56.43	O	1.62	Si	0.10
Ca	Traces maybe detected						

Analysis

Analysis performed on an embedded, polished and Carbon coated sample of this material by:
Micro-Analysis Consultants Limited, UK.

The results shown are the average values from a total of 19 random area scans, analysed for a mixture of 600k counts per area.

Equipment Used

Tescan Vega 4 SEM equipped with an Oxford Instruments X-Max 20mm EDS detector.
Software: Oxford Instruments Aztec v3.3 SP1.

Operating Conditions

20 keV Accelerating Voltage. Working distance: 15mm. All Elements

Suppliers Batch Analysis Result

Values in ppm unless otherwise stated.

Trace impurities determined by Optical Emission Spectroscopy.

B ₂ O ₃	4.8%	O ₂	4.2%				
Al	15	Au	<1	Be	<1	Ca	330
Cr	31	Cu	<1	Fe	<1	Mn	2
Mg	<1	Mo	<1	Na	26	Ni	<1
Pb	<1	Si	2147	Sn	<1	Ti	<1
V	<1	W	<1	Zn	<1	Zr	<1

Notes

High probe currents or leaving the beam on the sample for extended periods of time may damage the sample and should be avoided.

The material has been formed from a powder using the hot compression method.

Suitable areas need to be selected at high magnification for analysis.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-006-1-0015

CAS. No.: 7440-44-0

Purity: 99.9+%
metals basis

Form: Solid

Supplier: HTW-Germany

Batch: 48066



Glassy Carbon

Material Information

SIGRADUR® G

Glassy carbon SIGRADUR® consists of pure carbon. The raw materials used show an extreme low content of foreign elements. SIGRADUR® G is heated to over 2000°C. At these high temperatures the most foreign elements vaporize and only pure carbon remains. Due to the high purity, glassy carbon is suitable for applications in the chemical analysis, semiconductor technology and ultra-pure materials technology

Glassy carbon shows no memory effects which is advantageous in the ultra-trace analysis.

Specifications

Maximum service temperature (vacuum or inert gas):	°C	3000
Density:	g/cm ³	1.42
Open porosity:	%	0
Permeability coefficient:	cm ² /s	10 ⁻⁹
Vickers hardness:	HV	230
Flexural strength ¹⁾ :	MPa	260
Young's modulus ²⁾ :	Gpa	35
Compressive strength ¹⁾ :	MPa	480
Specific electrical resistance (30°C):	Ωμm	45
Thermal conductivity (30°C):	W/(km)	6.3
Median linear coefficient of expansion (20-200°C):	1/K	2.6.10 ⁻⁶

¹⁾ 4-point-bending-test; specimen geometry: bead-molding, diameter 3mm, length 60 mm

²⁾ Specimen geometry: bead-molding, diameter 7 mm, length 10 mm



MAC ref. No.: 1-011-2-0005

CAS. No.: 7647-14-5

NaCl

Form: Solid

Sodium Chloride

Supplier: Alfa Aesar

Batch: F23X052

Typical Analysis Result

All data is presented as normalized and values shown in weight % unless otherwise noted.

Na	39.27	Cl	60.73
----	-------	----	-------

Analysis

Analysis performed on an embedded, polished and Carbon coated sample of this material by:
Micro-Analysis Consultants Limited, UK.

The results shown are the average values from a total of 11 random area scans, analysed for a mixture of 20 second live time and 500k counts per area.

Equipment Used

Tescan Vega 4 SEM equipped with an Oxford Instruments X-Max 20mm EDS detector.

Software: Oxford Instruments Aztec v3.3 SP1.

Operating Conditions

20 keV Accelerating Voltage. Working distance: 15mm. All Elements

Suppliers Batch Analysis Result

This material is certified to be suitable for IR and FTIR spectroscopy.

The crystal boules from which these random cuttings were cleaved were grown from ACS grade NaCl.

Samples of each of the crystal boules from which we cleaved these random cuttings were tested by transmission at a peak/band detection limit below the factory detection setting of 2.0 on a Perkin Elmer Paragon 1000 with DTGS detector and no peaks were detected except CO₂ and H₂O.

The material is suitable for transmission testing using the NaCl pellet technique and for diffuse reflectance spectroscopy.

Notes

Hygroscopic Material

High probe currents or leaving the beam on the sample for extended periods of time may damage the sample and should be avoided.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-011-3-0025

Dana Class: 76.01.03.01

Strunz Class: 09.FA.35

Albite

Form: Solid



Supplier: Alfa Aesar

Batch: Southern Ontario, CANADA

Typical Analysis Result

All data is presented as un-normalised and values shown in weight % unless otherwise noted.

O	50.12	Na	9.30	Al	9.46
Si	31.47	K	0.15	Ca	0.08

Total = 100.58%

Analysis

Analysis performed on an embedded, polished and Carbon coated sample of this material by the University of Plymouth, UK.

Equipment Used

JEOL 7001F FEG-SEM equipped with an Oxford Instruments Wave WDS detector.

Software: Oxford Instruments Aztec v6.0.

Operating Conditions

20 keV Accelerating Voltage with a probe current of 5.9 ± 0.1 nA. Working distance: 10mm



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-012-2-0001

CAS. No.: 1309-48-4

Purity: 99.83%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: J12F31



Magnesium Oxide

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

(C) = calculated from the formula assuming total MgO = 99.83%

Major Elements

O	39.62(C)	Mg	60.21(C)
----------	----------	-----------	----------

Trace Elements

Si	0.003	Ca	0.15	Fe	0.01	Cu	0.004
-----------	-------	-----------	------	-----------	------	-----------	-------

X-ray Diffraction Analysis

MgO matches PDF#4-829, Cubic

Hygroscopic Material

CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-013-2-0001

CAS. No.: 1344-28-1

Purity: 99.80%
metals basis

Form: Solid

Supplier: Testbourne

Batch: 36498-HE-1



Aluminium Oxide

Suppliers Batch Analysis Result

All data is presented as normalised and values shown in weight % unless otherwise noted.

(C) = calculated from the formula assuming total $\text{Al}_2\text{O}_3 = 99.8\%$

Major Elements

O	46.98(C)	Mg	52.82(C)
----------	----------	-----------	----------

Trace Elements

Analytical method used: Spectrographic Analysis

B	<0.01	Mg	0.02	Si	0.1	Ca	<0.001
Fe	0.02	Ga	<0.01				

X-ray Diffraction Analysis

Major Al_2O_3 matches PDF#10-173, Trigonal

Notes

Analysis should be conducted at high magnification avoiding the pits in the material surface.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-014-1-0001
CAS. No.: 7440-21-3
Purity: 99.999%

Si

Form: Solid

Silicon

Supplier: Advent
Batch: Gi12782

Certificate of Conformity

We hereby certify that the material listed above have been tested and inspected, and found to confirm in all aspects to the specification listed in the web catalogue

Specification

Single crystal silicon wafer, 99.999% purity
Orientation: 1-0-0
N Type, doped with Phosphorous.
Resistance: 10-50Ω/cm



Micro-Analysis Consultants Ltd

CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-014-2-0001

CAS. No.: 12033-89-5

Purity: 99.99%
metals basis

Form: Solid

Supplier: Testbourne

Batch: S60-04-14173



Silicon Nitride

Typical Analysis Result

All data is presented as normalized and values shown in weight % unless otherwise noted.

N	38.78	Al	0.14	Si	61.08
---	-------	----	------	----	-------

Analysis

Analysis performed on an embedded, polished and Carbon coated sample of this material by:
Micro-Analysis Consultants Limited, UK.

The results shown are the average values from a total of 11 random area scans, analysed for a mixture of 600k counts per area.

Equipment Used

Tescan Vega 4 SEM equipped with an Oxford Instruments X-Max 20mm EDS detector.

Software: Oxford Instruments Aztec v3.3 SP1.

Operating Conditions

20 keV Accelerating Voltage. Working distance: 15mm. All Elements

Suppliers Batch Trace Analysis Result

This analysis certifies that your product was manufactured using materials with the following impurities

Fe	0.003	Ca	0.0004	Mg	0.001	Ni	0.001
Cr	0.001	Mn	0.0005				

Notes

High probe currents or leaving the beam on the sample for extended periods of time may damage the sample and should be avoided.

The material has been formed from a powder using the hot compression method.

Suitable areas need to be selected at high magnification for analysis.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-014-2-0005
CAS. No.: 409-21-2
Purity: 99.9%
metals basis
Form: Solid
Supplier: Testbourne
Batch: S59-04-14173

SiC

Silicon Carbide

Suppliers Batch Analysis Result

All data is presented as normalised and values shown in weight % unless otherwise noted.
(C) = calculated from the formula assuming total SiC = 99.9%

Major Elements

C	29.92(C)	Si	69.98(C)
---	----------	----	----------

Trace Elements

Cu	0.002	Al	0.003	Fe	0.003	Zr	0.005
Pb	0.003						



MAC ref. No.: 1-014-2-0039

CAS. No.: 7631-86-9

Purity: 99.999%
metals basis

Form: Solid

Supplier: Testbourne Ltd

Batch: LOT000910



Silicon (IV) Oxide

Suppliers Batch Analysis Result

All data is presented as normalised and values shown in weight % unless otherwise noted.

(C) = calculated from the formula assuming total $\text{SiO}_2 = 99.999\%$

Major Elements

O	53.26(C)	Si	46.74(C)
----------	----------	-----------	----------

Trace Elements

Metallic elements determined using ICP-OES

Li	1 ppm	Na	1 ppm	Al	6 ppm	K	0.3 ppm
Ca	0.5 ppm	Fe	0.2 ppm				



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-019-2-0004

CAS. No.: 03/02/7758

KBr

Form: Solid

Potassium Bromide

Supplier: MAC

Batch: 1-019-2-0004

Typical Analysis Result

All data is presented as normalized and values shown in weight % unless otherwise noted.

K	32.50	Br	67.5
---	-------	----	------

Analysis

Analysis performed on an embedded, polished and Carbon coated sample of this material by:
Micro-Analysis Consultants Limited, UK.

The results shown are the average values from a total of 11 random area scans, analysed for a mixture of 20 second live time and 500k counts per area.

Equipment Used

Tescan Vega 4 SEM equipped with an Oxford Instruments X-Max 20mm EDS detector.

Software: Oxford Instruments Aztec v3.3 SP1.

Operating Conditions

20 keV Accelerating Voltage. Working distance: 15mm. All Elements

Notes

Hygroscopic Material



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-019-3-0001

Dana Class: 76.01.01.01

Strunz Class: 09.FA.30

Orthoclase

Form: Solid



Supplier: Sagewood

Batch: Gothic County, Colorado, USA

Typical Analysis Result

All data is presented as un-normalised and values shown in weight % unless otherwise noted.

O	46.32	Na	2.50	Al	11.55
Si	29.30	K	9.58	Ba	0.88

Total = 100.13%

Analysis

Analysis performed on an embedded, polished and Carbon coated sample of this material by the University of Plymouth, UK.

Equipment Used

JEOL 7001F FEG-SEM equipped with an Oxford Instruments Wave WDS detector.

Software: Oxford Instruments Aztec v6.0.

Operating Conditions

20 keV Accelerating Voltage with a probe current of 5.9 ± 0.1 nA. Working distance: 10mm

Notes

This Mineral may contain some darker and lighter phases visible in BSE.

These phases should be avoided during analysis.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-020-2-0008

CAS. No.: 7789-75-5

Purity: 99.9%

Typical

Form: Solid

Supplier: Alfa Aesar

Batch: F16W019



Calcium Fluoride

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

(C) = calculated from the formula assuming total $\text{CaF}_2 = 99.9\%$

Major Elements

F	48.62(C)	Ca	51.28(C)
----------	----------	-----------	----------

Trace Elements

Values given in ppm unless otherwise noted.

Al	7.6	Ba	9.4	Cd	0.5	Co	0.5
Cu	1.6	Fe	11.2	K	3	Mg	7
Mn	0.5	Na	5	Ni	0.5	Pb	0.5
Sn	17	Sr	12	Ti	6.2		

Notes

Suitable areas need to be selected at high magnification for analysis.



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-020-3-0017
CAS No.: 65.02.01.01a
Purity: 09.DG.05

Wollastonite

Form: Solid



Supplier: Midland Mineral

Locality: Meldon Quarry, Oakhampton, Devon, UK

Typical Analysis Summary

All data is presented as normalized in weight %

(s) = calculated by stoichiometry

O(s)	41.26	Mg	0.18	Si	24.13
Ca	33.57	Mn	0.50	Fe	0.36

Oxide (wt%)

Total Fe recorded as FeO

MgO	0.30	SiO₂	51.63	CaO	46.97
MnO	0.64	FeO	0.47		

Notes

This mineral may contain some phased areas or inclusions which should be avoided during analysis



Micro-Analysis Consultants Ltd

Material Batch Sample Test Result

MAC ref. No.: 1-020-3-0017 Wollastonite

Element (wt%)

	O(s)	Mg	Si	Ca	Mn	Fe
Area 1	41.14	0.08	23.90	34.22	0.50	0.17
Area 2	41.24	0.00	24.12	33.99	0.52	0.13
Area 3	41.28	0.05	24.18	33.84	0.47	0.19
Area 4	41.23	0.31	24.08	33.19	0.65	0.54
Area 5	41.29	0.31	24.15	33.30	0.48	0.47
Area 6	41.18	0.06	23.98	34.12	0.56	0.10
Area 7	41.28	0.00	24.18	34.01	0.38	0.15
Area 8	41.34	0.03	24.33	33.51	0.61	0.18
Area 9	41.30	0.00	24.24	33.82	0.35	0.29
Area 10	41.29	0.59	24.11	32.71	0.43	0.87
Area 11	41.32	0.54	24.19	32.56	0.51	0.87

Average **41.26** **0.18** **24.13** **33.57** **0.50** **0.36**

Std dev. 0.06 0.22 0.12 0.57 0.09 0.29

(s) = calculated by stoichiometry

Oxide (wt%)

	MgO	SiO ₂	CaO	MnO	FeO
Area 1	0.13	51.13	47.88	0.64	0.22
Area 2	0.01	51.61	47.56	0.67	0.17
Area 3	0.08	51.72	47.35	0.61	0.25
Area 4	0.51	51.52	46.44	0.84	0.69
Area 5	0.51	51.67	46.59	0.62	0.61
Area 6	0.11	51.30	47.74	0.73	0.13
Area 7	0.00	51.73	47.58	0.49	0.20
Area 8	0.06	52.05	46.88	0.78	0.23
Area 9	0.00	51.85	47.32	0.46	0.37
Area 10	0.99	51.58	45.76	0.55	1.12
Area 11	0.90	51.76	45.56	0.66	1.13

Average **0.30** **51.63** **46.97** **0.64** **0.47**

Std dev. 0.37 0.25 0.79 0.12 0.37

Analysis

Analysis performed on an embedded, polished and Carbon coated sample of this material by Micro-Analysis Consultants Limited, UK.
The results shown are the average values from a total of 11 random area scans, analysed for a mixture of 25 second and 500k counts per area.

Equipment Used

Tescan Vega 4 SEM equipped with an Oxford Instruments X-Max 20 EDS SDD detector

Software: Oxford Instruments Aztec v3.3

Operating Conditions

20 keV Accelerating Voltage. Working distance: 15mm. Take of angle: 35° Tilt: 0°



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-021-1-0001

CAS. No.: 7440-20-2

Purity: 99.99%
metals basis

Form: Solid

Supplier: Testbourne

Batch: V30724-2

Sc

Scandium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Impurity analysis shown for materials used in the manufacture of the material.

Major Elements

TREM	99.5%
SC/TREM	99.99%

Trace Elements

La	5	Fe	189	Ce	6	Si	120
Pr	3	Ca	2	Nd	4	Mg	0.5
Sm	0.5	Al	45	Eu	2	Ni	50
Er	0.5	W	5	Gd	6	Mo	5
Tb	3	F	38	Dy	3	Ti	35
Ho	5	Ta	1100	Tm	0.1	Nb	10
Yb	0.1	O	1500	Lu	7	Y	25

Notes

Scandium forms a protective oxide layer when exposed to air.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-022-1-0011

CAS. No.: 7440-32-6

Purity: 99.9%
metals basis

Form: Solid

Supplier: NewMet

Batch: NMB/039192

Ti

Titanium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

The overall purity of the product indicated reflects metallic impurities only.

Major Elements

Ti	rem
-----------	------------

Trace Elements

Fe	0.018
-----------	--------------



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-023-1-0006

CAS. No.: 7440-65-2

Purity: 99.5%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: X16G009



Vanadium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

All elements determined by GDMS unless otherwise noted.

Major Elements

V 99.94%

Trace Elements

Ag	<0.1	Al	170	As	0.14	Au	<0.05
B	0.37	Ba	<0.01	Be	<0.01	Bi	<0.005
Br	<0.05	C	33	Ca	<0.1	Cd	<0.05
Ce	<0.005	Cl	0.07	Co	2.2	Cr	0.21
Cs	<0.01	Cu	<0.05	Dy	<0.005	Er	<0.005
Eu	<0.005	F	<0.05	Fe	11	Ga	<0.05
Gd	<0.005	Ge	0.21	H	18	Hf	0.03
Hg	<0.1	Ho	<0.005	I	<0.01	In	<0.05
Ir	0.02	K	<0.05	La	<0.01	Li	<0.01
Lu	<0.005	Mg	<0.01	Mn	<0.01	Mo	57
N	140	Na	0.02	Nb	0.37	Nd	<0.005
Ni	5.1	O	180	Os	<0.01	P	9.5
Pb	<0.01	Pd	<0.05	Pr	<0.005	Pt	0.09
Rb	<0.01	Re	0.02	Rh	0.02	Ru	<0.05
S	<5	Sb	<0.05	Sc	<0.01	Se	<0.1
Si	340	Sm	<0.005	Sn	<0.05	Sr	<0.5
Ta**	<5	Tb	<0.005	Te	<0.05	Th	<0.005
Tl	1.4	Ti	<0.005	Tm	<0.005	U	0.44
W	2.2	Y	<0.5	Yb	<0.005	Zn	<0.05
Zr	1.6						

Carbon, nitrogen, and oxygen determined by LECO



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-024-1-0004

CAS. No.: 7440-47-3

Purity: 99.998%
metals basis

Form: Solid

Supplier: Johnson Matthey

Batch: 34413

Cr

Chromium

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

Major Elements

Cr	99.998
----	--------

Trace Elements

Total Impurities = <0.002%

Notes

Chromium forms a protective oxide layer when exposed to air.



Micro-Analysis Consultants Ltd

CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-025-1-0003
CAS. No.: 7439-96-5
Purity: 99.98%
metals basis
Form: Solid

Supplier: Alfa Aesar
Batch: RC12C009

Mn

Manganese

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Major Elements

Mn	rem
----	-----

Trace Elements

Al	<8	Co	5	Cr	<6	Cu	5
Fe	15	Mg	3	Se	1	Si	3
Ti	6						

MAC ref. No.: 1-026-1-0007

CAS. No.: 7439-89-6

Purity: 99.995%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: P06D001

Fe

Iron

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

All elements determined by GDMS unless otherwise noted.

Major Elements

Fe 99.995%

Trace Elements

Ag	< 0.05	Al	5.5	As	< 0.05	Au	< 0.05
Ba	0.01	Ba	< 0.05	Be	< 0.005	Bi	< 0.01
Br	< 0.05	C	44	Ca	< 0.05	Cd	< 0.05
Ce	< 0.05	Cl	< 0.05	Co	2.5	Cr	2.7
Cs	< 0.01	Cu	2.3	Dy	< 0.01	Er	< 0.01
Eu	< 0.01	F	< 0.05	Ga	0.27	Gd	< 0.01
Ge	10	H	< 5	Hf	< 0.01	Hg	< 0.05
Ho	< 0.01	I	< 0.01	In	< 0.01	Ir	< 0.05
K	< 0.05	La	< 0.01	Li	< 0.005	Lu	< 0.01
Mg	0.01	Mn	2.7	Mo	0.15	N	< 10
Na	0.02	Nb	0.13	Nd	< 0.01	Ni	1.3
O	34	Os	< 0.01	P	3.9	Pb	< 0.01
Pd	< 0.05	Pr	< 0.01	Pt	< 0.05	Rb	< 0.01
Re	< 0.01	Rh	< 0.05	Ru	< 0.05	S	< 10
Sb	< 0.05	Sc	< 0.01	Se	< 0.05	Si	10
Sm	< 0.01	Sn	0.33	Sr	0.07	Ta	< 1
Tb	< 0.01	Te	< 0.05	Th	< 0.001	Ti	0.87
Tl	< 0.01	Tm	< 0.01	U	< 0.001	V	0.03
W	0.59	Y	< 0.005	Yb	< 0.01	Zn	< 0.05
Zr	< 0.05						

Carbon and Sulfur determined by Combustion-IR

Oxygen determined by IGF-NDIR

Hydrogen determined by ICF-TCD

Nitrogen determined by IGF-TC



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-026-3-0022

Dana Class: 02.12.01.01

Strunz Class: 02.EB.05a

Pyrite

FeS₂

Form: Solid

Supplier: Alfa Aesar (E23Y032)

Batch: Peru

Typical Analysis Result

All data is presented as un-normalised and values shown in weight % unless otherwise noted.

Method of analysis: EPMA

S	53.06	Fe	46.45	Cu	0.02
Zn	0.03	As	0.02	Pb	0.14

Total = 99.72

	S	Fe	Cu	Zn	As	Pb	Total
1	52.9900	46.3000	0.0308	0.0000	0.0633	0.0676	99.4517
2	52.6500	46.0800	0.0255	0.0000	0.0000	0.1131	98.8686
3	53.0500	46.4000	0.0000	0.0215	0.0716	0.2233	99.7664
4	53.0300	46.2000	0.0000	0.0021	0.0000	0.1743	99.4064
5	52.9100	46.5200	0.0000	0.0975	0.0000	0.0735	99.6010
6	53.1900	46.5900	0.0059	0.0357	0.0185	0.1603	100.0004
7	53.3100	46.8300	0.0044	0.0709	0.0000	0.1288	100.3441
8	53.1700	46.5000	0.0535	0.0000	0.0407	0.0824	99.8466
9	53.0800	46.4300	0.0357	0.0359	0.0000	0.2061	99.7877
10	53.2500	46.6400	0.0282	0.0745	0.0000	0.1714	100.1641
min	52.6500	46.0800	0.0000	0.0000	0.0000	0.0676	98.8686
max	53.3100	46.8300	0.0535	0.0975	0.0716	0.2233	100.3441
ave	53.0630	46.4490	0.0184	0.0338	0.0194	0.1401	99.7237
sig	0.1899	0.2192	0.0189	0.0360	0.0286	0.0555	0.4884

Analysis

Analysis performed on a sample of this material by:

School of Earth & Environmental Sciences, The University of St Andrews, SCOTLAND

Equipment Used

Jeol JXA-ISP100 electron probe micro-analyser with 5x WDS spectrometers



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-027-1-0012

CAS. No.: 7440-48-4

Purity: 99.995%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: Y27D058

Co

Cobalt

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

All elements determined by GDMS unless otherwise noted.

Major Elements

Co 99.999%

Trace Elements

Ag	<0.01	Al	0.16	As	<0.1	Au	<0.05
B	<0.001	Ba	<0.005	Be	<0.001	Bi	<0.001
Br	<0.01	C	3	Ca	<0.05	Cd	<0.05
Ce	<0.005	Cl	<0.01	Cr	0.02	Cs	<0.01
Cu	0.15	Dy	<0.005	Er	<0.005	Eu	<0.005
F	<0.05	Fe	1.8	Ha	<0.01	Gd	<0.005
Ge	<0.05	H	<1	Hf	<0.01	Hg	<0.05
Ho	<0.005	I	<0.01	In	<0.05	Ir	<0.001
K	<0.01	La	<0.005	Li	<0.001	Lu	<0.005
Mg	0.14	Mn	0.02	Mo	<0.01	N	1
Na	0.16	Nb	<0.005	Nd	<0.005	Ni	4.2
O	43	Os	<0.001	P	1.1	Pb	<0.01
Pd	<0.01	Pr	<0.005	Pt	<0.05	Rb	<0.005
Re	<0.01	Rh	<0.005	Ru	<0.01	S	1
Sb	<0.01	Sc	<0.001	Se	<0.02	Si	0.62
Sm	<0.005	Sn	<0.05	Sr	<0.001	Ta	<1
Tb	<0.005	Te	<0.05	Th	<0.0001	Ti	0.1
Tl	<0.005	Tm	<0.005	U	<0.0001	V	0.009
W	<0.01	Y	<0.001	Yb	<0.005	Zn	<0.1
Zr	<0.01						

Carbon, hydrogen, nitrogen, oxygen and sulfur determined by LECO



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-028-1-0010

CAS. No.: 7440-02-0

Purity: 99.8%
metals basis

Form: Solid

Supplier: Goodfellow

Batch: NI005173/8

Ni

Nickel

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

Manufacturers Accredited Laboratory Test Report No. 81381

Major Elements

Ni	99.8%
----	-------

Trace Elements

C	0.004	Co	<0.003	Cu	<0.01	Fe	0.04
Mg	0.02	Mn	0.01	S	<0.001	Si	0.13
Ti	0.02						



Micro-Analysis Consultants Ltd



CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-029-1-0013

CAS. No.: 7440-50-8

Purity: 99.999%
metals basis

Form: Solid

Supplier: NewMet

Batch: NMB/032684

Cu

Copper

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

The overall purity of the product indicated reflects metallic impurities only

Major Elements

Cu rem

Trace Elements

Ag	<0.01	Al	0.003	Bi	<0.002	Ca	<0.005
Cd	<0.05	Co	<0.0005	Cr	<0.002	Fe	0.017
K	<0.005	Li	<0.001	Mg	<0.001	Mn	0.046
Na	<0.001	Nb	<0.0005	Ni	<0.005	Sn	<0.01
Th	<0.0001	Ti	0.006	U	<0.0002	V	<0.0002
W	<0.002	Zn	<0.05	Zr	<0.0005		

Notes

Copper forms a protective oxide layer when exposed to air.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-030-1-0001

CAS. No.: 7440-66-6

Purity: 99.9985%

metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: NM25241

Zn

Zinc

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Analysis technique employed was d.c. arc emission spectroscopy, unless otherwise denoted below.

Major Elements

Zn rem

Trace Elements

Elements sought and limits of detection appropriate to the matrix, analytical standards and method used.

Al	1	Sb	3	As	20	Ba	1
Bi	1	B	1	Cd	1	Ca	1
Cs	30	Cr	1	Co	1	Cu	1
Ga	1	Ge	1	In	1	Fe	1
Pb	1	Li	1	Mg	1	Mn	1
Hg	30	Mo	1	Ni	1	P	300
K	3	Rb	10	Si	1	Ag	1
Na	1	Sr	1	Te	10	Tl	3
Sn	1	Ti	10	V	1	Zr	100
Au	1						

Elements detected (ppm)

Cd	5	Cu	<1	Fe	<1	Mg	<1
Si	<1						

Notes

Zinc forms a protective oxide layer when exposed to air.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-031-2-0001

CAS ref. No.: 12063-98-8

Purity: 99.999%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: L13Y007

GaP

Gallium Phosphide

Typical EDS Analysis Result

Element Name	Ga	P
Average	70.10	29.90
Standard Deviation	0.30	0.30
Sample Size	21	21
Conf. Coeff. (95%)	1.96	1.96
Margin Of Error	0.13	0.13
Upper Bound	70.23	30.03
Lower Bound	69.97	29.77
Max	70.67	30.43
Min	69.57	29.33

Alfa Aesar Trace Analysis

Ag	0.01	Al	0.05	Cr	0.05	Cu	0.05
Fe	0.1	Mg	0.1	Mn	0.05	Ni	0.05
Pb	0.02	Si	0.1	Sn	0.1	Zn	0.05

Values given in ppm unless otherwise stated

The typical EDS results were obtained from our reference standard for this material at 20kV and each analysis was conducted for 25 seconds live time

Processing Option: All Elements - Normalized

All figures in weight % unless otherwise noted



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-032-1-0001

CAS. No.: 7440-56-4

Purity: 99.9999+%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: K29R014

Ge

Germanium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Analysis determined by GDMS

Major Elements

Ge rem

Trace Elements

Li	<0.01	Be	<0.01	B	0.002	Na	0.025
Mg	0.001	Al	0.002	Si	0.16	P	0.003
S	0.006	K	0.012	Ca	0.006	Ti	0.0005
V	<0.001	Cr	0.002	Mn	<0.01	Fe	0.02
Co	<0.001	Ni	0.025	Cu	0.004	Zn	0.008
Ga	<0.01	As	<0.1	Se	<0.01	Zr	<0.01
Nb	<0.01	Mo	<0.05	Ag	<0.1	Sn	<0.05
Sb	<0.05	Te	<0.05	Hf	<0.01	Ta	<0.1
W	<0.01	Pb	<0.01	Bi	<0.01		



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-034-1-0002

CAS. No.: 7782-49-2

Purity: 99.999%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: T10A044

Se

Selenium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Analysis determined by ICP

Major Elements

Se rem

Trace Elements

Na	0.7	Si	<1	S	<1	Ca	1
Cr	<0.1	Fe	0.4	Ni	<0.1	Cu	<0.1
Zn	<0.2	As	<1	Ag	<0.05	Cd	<0.2
Te	<1	Pb	0.4	Bi	<0.02		



Micro-Analysis Consultants Ltd



CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-038-2-0005

CAS. No.: 7783-48-4

Purity: 99.9%
Typical

Form: Solid

Supplier: Alfa Aesar

Batch: K21R023



Strontium Fluoride

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

(C) = calculated from the formula assuming total $\text{SrF}_2 = 99.9\%$

Major Elements

F	30.22(C)	Sr	69.68(C)
---	----------	----	----------

Trace Elements

Values given in ppm unless otherwise noted.

Total	<0.1
-------	------



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-039-1-0002

CAS. No.: 7440-65-5

Purity: 99.9%

R.E.O. basis

Form: Solid

Supplier: Alfa Aesar

Batch: D22X016

Y

Yttrium

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

Major Elements

Y rem

Trace Elements

Al	<0.01	Ca	<0.01	Dy	<0.01	Er	<0.01
Fe	0.018	Gd	<0.01	Ho	<0.01	La	<0.01
Lu	<0.01	Mg	<0.01	Mn	<0.01	Nd	<0.01
Ni	<0.01	Si	<0.01	Sm	<0.01	Ta	present
Tb	<0.01	Tm	<0.01	Yb	0.014		

Notes

Yttrium forms a protective oxide layer when exposed to air.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-040-1-0005
CAS. No.: 7440-67-7
Purity: 99.5% exc Hf (Hf 1.3%)
metals basis
Form: Solid

Zr

Zirconium

Supplier: NewMet
Batch: NMB/031972

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

The overall purity of the product indicated reflects metallic impurities only.

Major Elements

Zr	rem	Hf	1.3%
----	-----	----	------

Trace Elements

Fe+Cr	800 ppm
-------	---------

Notes

Zirconium forms a protective oxide layer when exposed to air.

This material may contain surface anomalies which should be avoided during analysis.



Micro-Analysis Consultants Ltd



CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-041-1-0001

CAS. No.: 7440-03-1

Purity: 99.8%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: C23Y004

Nb

Niobium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Major Elements

Nb 99.995%

Trace Elements

C	20	Fe	3	H	<5	Hf	<1
Mo	3	N	32	Ni	<1	O	101
Si	<10	Ta	733.333	Ti	<1	W	<1
Zr	23						

Notes

Niobium forms a protective oxide layer when exposed to air.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-042-1-0001
CAS. No.: 7439-98-7
Purity: 99.95%
metals basis
Form: Solid
Supplier: Alfa Aesar
Batch: 1-042-1-0001

Mo

Molybdenum

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Major Elements

Mo rem

Trace Elements

Al	<8	Ca	<2	Cr	<8	Cu	<6
Fe	34	Mg	<2	Mn	<5	Ni	11
Si	<8	Sn	<8	Pb	<5	W	125
K	21	Na	<5				



MAC ref. No.: 1-045-1-0008
CAS. No.: 7440-16-6
Purity: 99.8%
metals basis
Form: Solid

Supplier: Alfa Aesar
Batch: Y03D027

Rh
Rhodium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted
ND = Not detected

Major Elements

Rh rem

Trace Elements

Elements Detected

Ag	ND	Al	2	As	ND	Au	ND
B	ND	Ba	ND	Bi	ND	Ca	4
Cd	ND	Co	ND	Cr	1	Cu	ND
Fe	31	Ga	ND	Ge	ND	In	3
Ir	ND	Li	ND	Mg	ND	Mn	1
Mo	1	Ni	3	Os	ND	P	ND
Pb	ND	Pd	ND	Pt	ND	Ru	13
Sb	ND	Si	1	Sm	ND	Sn	1
Ta	ND	Te	ND	Ti	ND	V	ND
W	8	Zn	ND	Zr	1		

Detection Limits (ppm)

Ag	1	Al	1	As	1	Au	1
B	1	Ba	1	Bi	1	Ca	1
Cd	1	Co	1	Cr	1	Cu	1
Fe	1	Ga	1	Ge	1	In	1
Ir	1	Li	1	Mg	1	Mn	1
Mo	1	Ni	1	Os	1	P	1
Pb	1	Pd	1	Pt	1	Ru	1
Sb	1	Si	1	Sm	1	Sn	1
Ta	1	Te	1	Ti	1	V	1
W	1	Zn	1	Zr	1		



MAC ref. No.: 1-046-1-0001

CAS. No.: 7440-05-3

Purity: 99.99+%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: L02W046

Pd

Palladium

Suppliers Analysis Result

Values given in ppm unless otherwise noted

The result shown above are the TYPICAL ANALYSIS for the starting material. ND = Not detected

Major Elements

Pd rem

Trace Elements

Pt	22	Rh	ND	Ru	ND	Ir	ND
Au	13	Ag	ND	Os	ND	Ca	19
Fe	8	Cu	3	Ni	ND	Zn	1
Mo	ND	Cd	ND	W	ND	Pb	ND
Cr	2	Mn	ND	Al	2	Mg	ND
Sn	ND	As	ND	Sb	ND	Bi	ND
Te	ND	B	ND	Co	ND	Si	ND
P	ND	Na	ND	Se	ND		



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-047-1-0001

CAS. No.: 7440-22-4

Purity: 99.9985%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: B12Z007

Ag

Silver

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Major Elements

Ag 99.999%

Trace Elements

Al	<1	Au	1	As	<1	Bi	1
B	<1	Cr	<1	Cd	<1	Fe	<1
Cu	4	Hg	<1	Ge	<1	Mg	<1
In	<1	Mo	<1	Mn	<1	Pb	<1
Ni	<1	Pt	<1	Pd	<1	Sb	2
S	<1	Si	<1	Se	<1	Te	<1
Sn	<1	Zn	<1	Ti	<1		



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-048-1-0003

CAS. No.: 7440-43-9

Purity: 99.998%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: Q25E033

Cd

Cadmium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Analysis method: ICP

Major Elements

Cd 99.998%

Trace Elements

Ag	<0.1	Al	<0.1	As	<0.5	Au	<0.1
B	<0.3	Ba	<0.1	Be	<0.1	Bi	<1
Ca	<0.5	Co	<0.1	Cr	<0.1	Cu	0.2
Fe	<0.1	Ga	<0.1	Ge	<0.5	Hg	0.6
In	<0.5	K	<1	Li	<0.1	Mg	<0.1
Mn	<0.1	Mo	<0.1	Na	<0.5	Ni	<0.3
P	<1	Pb	<0.5	Pt	<0.5	Sb	<1
Si	<0.5	Sn	<0.5	Sr	<0.1	Te	<5
Ti	<0.1	Tl	<0.5	V	<0.1	Zn	<0.1
Zr	<0.1						

This material is listed in the 'Candidate List of Substances of Very High Concern (SVHC)

The size of the embedded piece should offer no serious hazards provided that:

1. No attempt is made to remove the embedded piece of Cd from the brass mount.
2. Handling of the standard is kept to a minimum and suitable P.P.E is used.
3. The standard is stored as recommended in the Care of Standards Leaflet.
4. You carry out your own internal risk assessment.



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-049-2-0010

CAS ref. No.: 1303-11-3

Purity: 99.9999%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: E24X016

InAs

Indium Arsenide

Alfa Aesar Analysis

Dopant: Undoped

	Seed End
Resistivity:	1.24×10^{-2} ohm-cm
Hall mobility:	2.57×10^4 cm ² V ⁻¹ s ⁻¹
Carrier Concentration	1.97×10^{16} cm ⁻³

Tail End
9.40×10^{-3} ohm-cm
3.26×10^4 cm ² V ⁻¹ s ⁻¹
2.03×10^{16} cm ⁻³

MAC EDX Analysis Results

Element Name	Element Composition	
	As	In
Average	39.81	60.19
Standard Deviation	0.25	0.25
Sample Size	21.00	21.00
Conf. Coff. (95%)	1.96	1.96
Margin Of Error	0.11	0.11
Upper Bound	39.92	60.30
Lower Bound	39.70	60.08
Max	40.30	60.62
Min	39.38	59.70

The MAC EDX results were obtained at 20kV and each analysis was conducted for 20 seconds livetime.

Processing Option: All Elements - Normalized

All figures in weight % unless otherwise stated



MAC ref. No.: 1-050-1-0001

CAS. No.: 7440-31-5

Purity: 99.998%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: I19X002

Sn

Tin

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Elements determined by GDMS

Major Elements

Sn 99.9991%

Trace Elements

Ag	≤0.1	Al	0.005	As	<0.05	B	<0.01
Be	<0.01	Bi	<0.01	Ca	<0.05	Cd	≤0.1
Cl	0.005	Co	<0.01	Cr	0.006	Cu	0.33
F	<0.3	Fe	0.44	Ga	<0.01	In	0.5
K	0.02	Li	<0.01	Mg	<0.005	Mn	0.002
Mo	<0.01	Na	0.022	Nb	<0.01	Ni	0.26
P	0.01	Pb	4.3	S	1.3	Sb	1.4
Se	<0.1	Si	0.01	Ta	<1	Te	<0.05
Ti	0.003	V	<0.001	Zn	<0.01	Zr	<0.01

Notes

Tin forms a protective oxide layer when exposed to air.

Due to the malleability of this element, diamond particles may become embedded during the polishing process.

These inclusions should be avoided if possible during analysis.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-051-1-0003

CAS. No.: 7440-36-0

Purity: 99.9999%

metals basis

Form: Solid

Supplier: JMC

Batch: 32358

Sb

Antimony

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Major Elements

Sb **rem**

Trace Elements

Total Impurities = <1 ppm



Micro-Analysis Consultants Ltd

CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-056-2-0006

CAS. No.: 7787-32-8

Purity: 99.9%
Metals Basis

Form: Solid

Supplier: Alfa Aesar

Batch: F24Z043



Barium Fluoride

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

(C) = calculated from the formula assuming total $\text{BaF}_2 = 99.9\%$

Major Elements

F	21.65(C)	Ba	78.25(C)
----------	----------	-----------	----------

Trace Elements

Values given in ppm unless otherwise noted.

Cr	<10	Cu	<10	Fe	<20	Mn	<20
Pb	<5	Si	<20	V	<5		

Total controlled impurity for optical coating <90 ppm



Micro-Analysis Consultants Ltd



MAC ref. No.: 1-057-2-0008

CAS No.: 12008-21-8

Purity: 99.500%
metals basis

Form: Pieces

Supplier: Testbourne

Batch: LOT003655

LaB₆

Lanthanum Hexaboride

LaB₆ tends to be beam sensitive, It is advisable to use a lower beam current to avoid beam penetration.

Due to the porous nature of this material it is recommended to select a higher magnification prior to conducting an analysis.

Typical EDS Analysis Result

Element Name	B	La
Average	32.13	67.88
Standard Deviation	0.20	0.20
Sample Size	20	20
Conf. Coff. (95%)	1.96	1.96
Margin Of Error	0.09	0.09
Upper Bound	32.21	67.96
Lower Bound	32.04	67.79
Max	32.49	68.28
Min	31.72	67.51

These EDS Analysis were carried out at 20kV and is the result of 19x 20 second (live time) area scans and 1x whole area scan for 500,000 counts.

The results shown were taken from our reference standard for this material.

Testbourne Trace Analysis Result (ppm)

Mg	10	Al	10	Si	10	Cr	10
Mn	5	Fe	350	Co	10	Ni	10
Cu	10	Sn	10	Sb	10	Pb	10
Bi	5						

Metallic elements were analysed using ICP-OES



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-058-2-0002

CAS ref. No.: 1306-38-3

Purity: 99.900%
metals basis

Form: Solid

Supplier: Sigma Aldrich

Batch: 03505EF



Cerium (IV) Oxide

Sigma Aldrich Analysis

X-ray Diffraction Pattern: Conforms to Standard Pattern

Loss on Ignition: 0.04% (1000°C, 1Hr)

Trace Analysis Spectrographic: Si 10ppm, Mg 1ppm

Chemistry Elements: Ce, O

MAC Analysis Results

Element Name	<u>Element Composition</u>	
	O	Ce
Average	18.52	81.48
Standard Deviation	0.22	0.22
Sample Size	17.00	17.00
Conf. Coff. (95%)	1.96	1.96
Margin Of Error	0.11	0.11
Upper Bound	18.63	81.58
Lower Bound	18.42	81.37
Max	19.01	81.94
Min	18.06	80.99

These results were obtained at 20kV and each analysis was conducted for 20 seconds.

Processing Option: All Elements - Normalized

All figures in weight % unless otherwise stated

MAC ref. No.: 1-072-1-0004
CAS. No.: 7440-58-6
Purity: 99.95% (exc Zr)
metals basis
Form: Solid

Hf

Hafnium

Supplier: Alfa Aesar
Batch: J01U038

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Total Hf (exc Zr) detected = 99.96% Hf figure shown below has been calculated after subtracting Zr.

Major Elements

Hf	97.82%(D)	Zr	2.14%
-----------	------------------	-----------	--------------

Trace Elements

Al	<30	C	60	Cr	<30	Cu	<20
Fe	115	H	<3	Mo	<10	N	39
Nb	<50	O	310	Si	<25	Sn	<10
Ta	2	Ti	<20	V	<10	W	<20

Notes

Hafnium forms a protective oxide layer when exposed to air.

Due to the manufacturing process, this material may contain surface anomalies.

Analysis should be conducted at high magnification avoiding these anomalies.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-073-1-0007

CAS. No.: 7440-25-7

Purity: 99.95%
metals basis

Form: Solid

Supplier: Alfa Aesar

Batch: Y16G074

Ta

Tantalum

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

All elements determined by GDMS unless otherwise noted.

Major Elements

Ta 99.995%

Trace Elements

Ag	<0.005	Al	<0.005	As	<0.005	Au	<0.1
B	<0.005	Ba	<0.005	Be	<0.001	Bi	<0.005
Br	<0.01	Cl	<0.01	Ca	<0.01	Cd	<0.01
Ce	<0.005	Cu	0.05	Co	<0.001	Cr	0.02
Cs	<0.005	F	<0.05	Dy	<0.005	Er	<0.005
Eu	<0.005	Ge	<0.01	Fe	0.09	Ga	<0.01
Gd	<0.005	Ho	<0.005	I	<0.01	Hf	<0.05
Hg	<0.05	K	<0.01	La	<0.005	In	<0.005
Ir	<0.01	Mg	<0.005	Mn	<0.001	Li	<0.001
Lu	<0.005	Na	0.01	Nb	66	Mo	2.4
Ni	0.03	Pd	<0.005	Os	<0.005	Nd	<0.005
Pb	<0.005	Re	<0.01	Pr	<0.005	P	<0.005
Rb	<0.005	Sb	<0.01	Rh	<0.005	Pt	<0.05
S	<0.005	Sm	<0.005	Sc	<0.001	Ru	<0.01
Si	0.07	Te	<0.01	Sn	<0.05	Se	<0.01
Tb	<0.005	Tm	<0.005	Th	<0.001	Sr	<0.005
Tl	<0.005	Y	<0.001	U	<0.001	Ti	0.006
W	45	Zn	<0.01	Yb	<0.005	V	<0.001
Zr	0.01						

Carbon, hydrogen, nitrogen and oxygen determined by LECO

Notes

Tantalum forms a protective oxide layer when exposed to air.



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-074-1-0001

CAS. No.: 7440-33-7

Purity: $\geq 99.9\%$
metals basis

Form: Solid

Supplier: Sigma Aldrich

Batch: 06717CF



Tungsten

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Elements determined by ICP Assay

Major Elements

W rem

Trace Elements

Zr	25	Ca	2	Mg	0.1	Al	<2
Na	<2						



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-075-1-0006

CAS. No.: 7440-15-5

Purity: 99.97%
metals basis

Form: Solid

Supplier: Thermo Fisher

Batch: U20F015

Re

Rhenium

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Major Elements

Re 99.99%

Trace Elements

H	38	Al	<1	Cr	2	K	<3
Mo	<3	Si	<5	Zn	2	N	26
B	<1	Cu	<1	Mg	<1	Na	<3
Ti	<1	Zr	<1	O	964	Ca	<1
Fe	4	Mn	<1	Ni	7	V	<1



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-077-1-0009

CAS. No.: 7439-88-5

Purity: 99.9%
metals basis

Form: Solid

Supplier: NewMet

Batch: NMB/043156

Ir

Iridium

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

The overall purity of the product indicated reflects metallic impurities only

Major Elements

Ir rem

Trace Elements

Ag	<0.001	Al	<0.001	Au	<0.001	Ca	<0.001
Cu	<0.001	Fe	<0.001	Mg	<0.001	Mn	<0.001
Na	<0.001	Ni	<0.001	Pb	<0.001	Pd	<0.001
Pt	<0.001	Rh	<0.001	Ru	<0.001	Zn	<0.001



Micro-Analysis Consultants Ltd

MAC ref. No.: 1-078-1-0006

CAS. No.: 7440-06-4

Purity: 99.99%

Typically

Form: Solid

Supplier: Testbourne

Batch: LOT010578

Pt

Platinum

Suppliers Batch Analysis Result

Values given in weight % unless otherwise noted.

Elements determined by ICP/OES

Major Elements

Pt **99.98(4)%**

Test reference: F Pt14621 Dated: 17th June 2021



Micro-Analysis Consultants Ltd

CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-079-1-0012
CAS. No.: 7440-57-5
Purity: 99.99+%
metals basis
Form: Solid

Supplier: NewMet
Batch: NMB/028078

Au

Gold

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted
The overall purity of the product indicated reflects metallic impurities only

Major Elements

Au	rem						
Trace Elements							
Ag	2	Ca	6	Cu	1	Pt	28

Notes
Due to the malleability of this element, diamond particles may become embedded during the polishing process.
These inclusions should be avoided if possible during analysis.

MAC ref. No.: 1-080-2-0009

CAS No.: 12068-90-5

Purity: 99.999%
metals basis

Form: Pieces

Supplier: Alfa Aesar

Batch: H25W033

HgTe

Mercury (II) Telluride

The surface of this material shows eutectic regions of HgTe and should be avoided during analysis. Unfortunately, this has occurred during the manufacturing process where complete homogeneity has not been achieved. The majority of this standard material is suitable to use.

Typical EDS Analysis Result

Element Name	Te	Hg
Average	38.58	61.42
Standard Deviation	0.07	0.07
Sample Size	7.00	7.00
Conf. Coff. (95%)	1.96	1.96
Margin Of Error	0.05	0.05
Upper Bound	38.63	61.47
Lower Bound	38.53	61.37
Max	38.69	61.53
Min	38.47	61.31

Supplier Analysis Result

Al	<0.05	Sb	<0.1	As	<0.1	Bi	<0.05
Cd	<0.05	Ca	<0.05	Cr	<0.05	Cu	<0.05
Au	<0.05	Fe	<0.05	Pb	<0.05	Mg	<0.05
Mo	<0.1	Pt	<0.05	Si	<0.05	Ag	<0.05
Tl	<0.1	Sn	<0.05	V	<0.05	Zn	<0.1
Hg	61.29%						
Te	38.72%						

Values given in ppm unless otherwise stated

These EDS results were obtained at 20kV and each area scan analysis was conducted for 500,000 counts.

Processing Option: All Elements - Normalized

All figures in weight % unless otherwise stated



Micro-Analysis Consultants Ltd



CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-082-2-0011

CAS ref. No.: 1314-91-6

Purity: 99.999%
metals basis

Form: Solid

Supplier: Testbourne

Batch: T41213-11

PbTe

Lead (II) Telluride

Typical EDS Analysis Result

Element Name	Te	Pb
Average	37.29	62.71
Standard Deviation	0.29	0.29
Sample Size	27	27
Conf. Coff. (95%)	1.96	1.96
Margin Of Error	0.11	0.11
Upper Bound	37.40	62.82
Lower Bound	37.18	62.60
Max	37.83	63.44
Min	36.56	62.17

Suppliers Analysis Result

	wt%		wt%		wt%		wt%
Zn	0.00005	Ag	0.00002	Cu	0.00005	Al	0.00002
Mg	0.00004	Ni	0.00005	Sn	0.00003	Fe	0.00002
Sb	0.00005	As	0.00003	Se	0.00005	Si	0.00005
Cd	0.00002	Bi	0.00002				

The EDS results were obtained at 20kV and are the result of random 20 second live time and 500,000 count scans.

Processing Option: All Elements - Normalized

All figures in weight % unless otherwise stated



Micro-Analysis Consultants Ltd



CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

MAC ref. No.: 1-083-1-0003

CAS. No.: 7440-69-9

Purity: 99.999%
metals basis

Form: Solid

Supplier: Sigma Aldrich

Batch: MKBS9884V

Bi

Bismuth

Suppliers Batch Analysis Result

Values given in ppm unless otherwise noted

Bismuth component confirmed by ICP

Major Elements

Bi 99.999%

Trace Elements

Ag	1.6	Al	0.2	B	0.5	Ca	1.4
Cu	0.4	Ir	0.8	Mg	<0.1	Mo	0.3
Pb	1.8	Pt	1.1	Sr	<0.1	Zn	0.1

Notes

Bismuth forms a protective oxide layer when exposed to air.

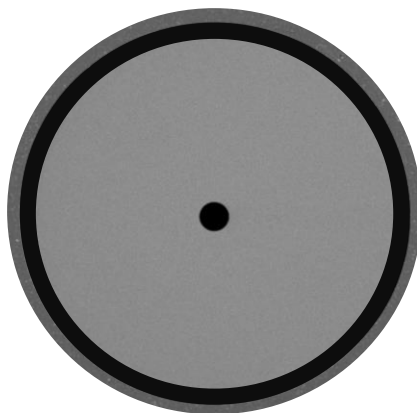


Micro-Analysis Consultants Ltd



CERTIFICATE | CERTIFICAT | ZERTIFIKAT | CERTIFICAAT | CERTIFICADO | CERTIFICATO

Faraday Cup



Overview

For good quantitative analysis using either Energy Dispersive Spectrometers (EDS) or Wavelength Dispersive Spectrometers (WDS) a stable beam current is essential.

A Faraday Cup allows for accurate beam current measurements as virtually all the electrons from the beam are trapped inside. MAC Faraday cups are manufactured to tight tolerances with precision drilled holes and available in a variety of aperture sizes. They can be made from either Pt95Ir5 alloy or Molybdenum.

The default Faraday cup used in our standards is constructed of Molybdenum with an aperture size of 150µm.

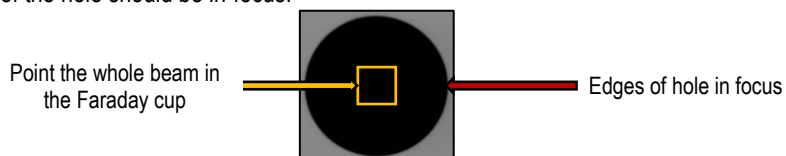
Using the Faraday cup

The Faraday cup should be used in conjunction with either your equipments in-built Absorbed Probe Current Meter or an optionally fitted pico-ammeter.

With a suitable vacuum and the electron beam turned on, Point analysis should be selected on your system and the Faraday cup positioned under the electron beam at the appropriate working distance.

The magnification should be set to a level that makes the field of view slightly smaller than the hole in the centre of the cup and the edges of the hole should be in-focus.

Example Image



Beam current stability should have a variation that is better than 1% per hour. Counts collected during analysis are directly proportional to the beam current. A 1% upwards drift in beam current can produce a 1% increase in all the reported mass fractions, resulting in a reported total >100%.

For quantitative analysis using standards, the beam current must be the same for both the specimen and the standards or one must be normalised to the other.

Measurement of the beam current over time can also be quite helpful in determining problems with instrument stability.

