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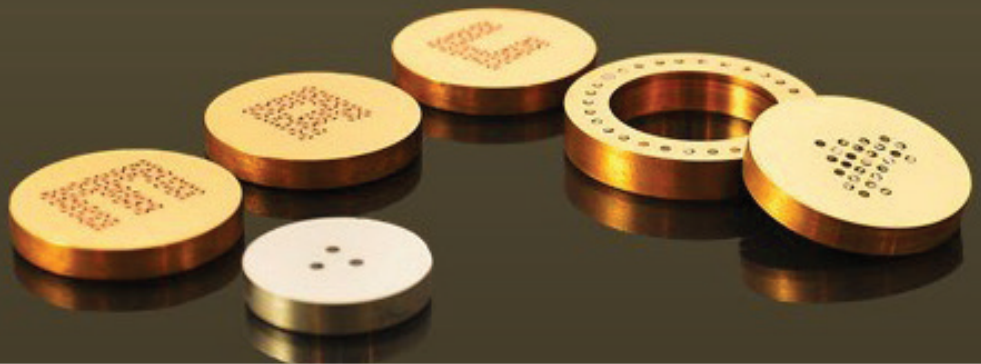
Reference Standards For X-ray Microanalysis



September 2017

Micro-Analytical Standards

The production of standards for X-ray Microanalysis is a skilled and time consuming operation. Much care and pride is taken by MAC's staff during the production process to ensure a quality product.

When the standards are ready for despatch they have been through a series of rigorous checks. The final polished finish is produced through a procession of diamond polishes, ending with a 1/4 micron finish.
The standards are then coated (if applicable) with approximately 25 nanometres of carbon.

The standards materials are mounted in a resin suitable for its suitability to:

- Affix the standards in position
- Harden without blow holes
- Withstand a vacuum and not burn readily under the action of the electron beam.

The guarantee of the standards concerns the fact that they are the materials stated and the standards are:

- Of a known composition.
- Homogeneous unless otherwise indicated.
- Suitable for the intended use. 'Caution/advisory notes' may be given.

Where applicable, each material will be accompanied with either a certificate of analysis or certificate of conformity.

We are able to trace all of our standards blocks back over the last 30+ years to the first one produced by MAC and still provide copies of certificates of analysis and layout plans for them. MAC's have a Quality Management System that has been approved under ISO 9001 :2008 and we are currently registered with National Quality Assurance Ltd. (NQA). Our Certificate number is 8960.

Our attention to detail has gained MAC a reputation for unsurpassed technical excellence during the past 30+ years.

Care of Standards

All Standards
When the standard is ready for shipment it has been through a series of rigorous checks.

The surface should not be interfered with in anyway, but if any dust should be present it should be removed using a gentle 'clean' air jet, if appropriate.

Blocks of Standards
The customer should never attempt to clean the standard or remove the Carbon coating if applied. The surface is polished to such a high degree that rubbing with the softest of tissue can damage it. Only recognised cleaning agents such as Evolve CH15 should be used if it is felt necessary and should be carried out by a qualified technician.

ON NO ACCOUNT SHOULD THE STANDARD BE SUBJECTED TO ULTRASONIC CLEANING AS THIS IS TOO RIGOROUS AN ACTION.

All Standards
Your standard has been carefully packed with silica gel to keep moisture at bay.
This is used for transportation purposes only and is not meant as a means for permanent storage.

AT ALL TIMES THEY SHOULD BE STORED UNDER VACUUM OR IN A SUITABLE DESICCATOR.

We cannot accept responsibility for the misuse or inadequate storage of the standard by the customer. If in doubt please contact us or your MAC distributor for assistance.

Universal Reference Standards

September 2017

Universal Reference Standards

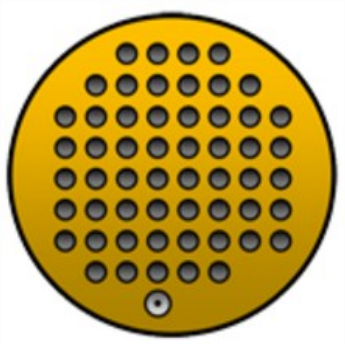
MAC's Range of Universal Reference Standards have been thoughtfully designed and manufactured to incorporate an extensive selection of elements from across the periodic table, with a number of them focusing on specialized areas. With input from leading manufacturers, respected professionals, analysts and Electron Microscopy Users worldwide, these standards provide you with a comprehensive catalogue of reference materials.

The Universal Standards are manufactured in either a 25mm or 32mm diameter brass mount depending on your requirements.
Our standards are used worldwide by:

- OEM Engineers in the setup and servicing of equipment
- Testing Laboratories
- Research & Development Laboratories
- Universities, Colleges and Schools
- Geological Societies
- Police Forensic Science Departments
- Government Agencies

MAC's Blocks of Standards are supplied in a specially designed storage/ transportation case that contains:

- The standard—protected again by another specially designed case
- A full electronic booklet on a USB, containing
  - The standard plan/layout
  - Certificates of analysis of conformance for each material
  - Details on storage and care for your standards
  - Certificate of final inspection & recommended re-polishing date
- A replaceable silica gel capsule for protection whilst in transit.
- A credit card sized quick refence guide.



Universal 55 Reference Standard + Faraday Cup

Available as:

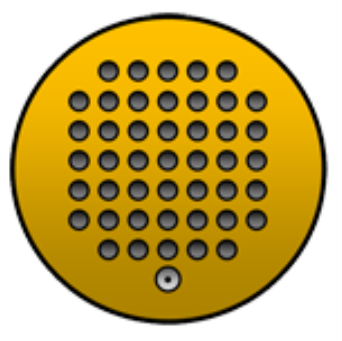
UNI5532

Manufactured in a Brass Mount 32mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	Be - Beryllium	20	Cr - Chromium	39	Cd - Cadmium
2	B - Boron	21	Mn - Manganese	40	InAs - Indium Arsenide
3	BN - Boron Nitride	22	Fe - Iron	41	Sn - Tin
4	C - Carbon	23	Pyrite - FeS_2	42	Sb - Antimony
5	Albite - $Na(AlSi_3O_8)$	24	Co - Cobalt	43	BaF_2 - Barium Fluoride
6	NaCl - Sodium Chloride	25	Ni - Nickel	44	LaB_6 - Lanthanum Hexaboride
7	MgO - Magnesium Oxide	26	Cu - Copper	45	CeO_2 - Cerium (IV) Oxide
8	Al_2O_3 - Aluminium Oxide	27	Zn - Zinc	46	Hf - Hafnium
9	Si - Silicon	28	GaP - Gallium Phosphide	47	Ta - Tantalum
10	Si_3N_4 - Silicon Nitride	29	Ge - Germanium	48	W - Tungsten
11	SiO_2 - Silicon (IV) Oxide	30	Se - Selenium	49	Re - Rhenium
12	SiC - Silicon Carbide	31	SrF_2 - Strontium Fluoride	50	Ir - Iridium
13	Orthoclase - $K(AlSi_3O_8)$	32	Y - Yttrium	51	Pt - Platinum
14	KBr - Potassium Bromide	33	Zr - Zirconium	52	Au - Gold
15	CaF_2 - Calcium Fluoride	34	Nb - Niobium	53	HgTe - Mercury (II) Telluride
16	Wollastonite - $CaSiO_3$	35	Mo - Molybdenum	54	PbTe - Lead (II) Telluride
17	Sc - Scandium	36	Rh - Rhodium	55	Bi - Bismuth
18	Ti - Titanium	37	Pd - Palladium		
19	V - Vanadium	38	Ag - Silver	F/C	150 µm Faraday cup

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.



Universal 45 Reference Standard + Faraday Cup

Available as:

UNI4532

Manufactured in a Brass Mount 32mm dia. x 5mm thick

Uni4525

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	B - Boron	17	Cu - Copper	33	Sb - Antimony
2	BN - Boron Nitride	18	Zn - Zinc	34	BaF_2 - Barium Fluoride
3	C - Carbon	19	GaP - Gallium Phosphide	35	LaB_6 - Lanthanum Hexaboride
4	Jadeite - $NaAlSi_2O_6$	20	Ge - Germanium	36	$CeAl_2$ - Cerium Alumate
5	MgO - Magnesium Oxide	21	Se - Selenium	37	Hf - Hafnium
6	Al_2O_3 - Aluminium Oxide	22	SrF_2 - Strontium Fluoride	38	Ta - Tantalum
7	Orthoclase - $K(AlSi_3O_8)$	23	Y - Yttrium	39	W - Tungsten
8	Wollastonite - $CaSiO_3$	24	Zr - Zirconium	40	Ir - Iridium
9	Ti - Titanium	25	Nb - Niobium	41	Pt - Platinum
10	V - Vanadium	26	Mo - Molybdenum	42	Au - Gold
11	Cr - Chromium	27	Rh - Rhodium	43	HgTe - Mercury (II) Telluride
12	Mn - Manganese	28	Pd - Palladium	44	PbTe - Lead (II) Telluride
13	Fe - Iron	29	Ag - Silver	45	Bi - Bismuth
14	Pyrite - FeS_2	30	Cd - Cadmium		
15	Co - Cobalt	31	InAs - Indium Arsenide		
16	Ni - Nickel	32	Sn - Tin	F/C	150 µm Faraday cup

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.

Universal 42 Reference Standard

Available as:

UNI4232

Manufactured in a Brass Mount 32mm dia. x 5mm thick

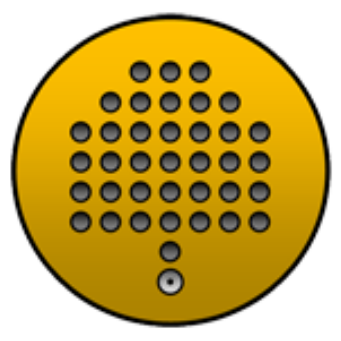
Uni4225

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	Jadeite - $NaAlSi_2O_6$	15	Zn - Zinc	29	Sn - Tin
2	MgO - Magnesium Oxide	16	GaP - Gallium Phosphide	30	Sb - Antimony
3	Al_2O_3 - Aluminium Oxide	17	Ge - Germanium	31	BaF_2 - Barium Fluoride
4	Orthoclase - $K(AlSi_3O_8)$	18	Se - Selenium	32	LaB_6 - Lanthanum Hexaboride
5	Wollastonite - $CaSiO_3$	19	SrF_2 - Strontium Fluoride	33	$CeAl_2$ - Cerium Alumate
6	Ti - Titanium	20	Y - Yttrium	34	Hf - Hafnium
7	V - Vanadium	21	Zr - Zirconium	35	Ta - Tantalum
8	Cr - Chromium	22	Nb - Niobium	36	W - Tungsten
9	Mn - Manganese	23	Mo - Molybdenum	37	Ir - Iridium
10	Fe - Iron	24	Rh - Rhodium	38	Pt - Platinum
11	Pyrite - FeS_2	25	Pd - Palladium	39	Au - Gold
12	Co - Cobalt	26	Ag - Silver	40	HgTe - Mercury (II) Telluride
13	Ni - Nickel	27	Cd - Cadmium	41	PbTe - Lead (II) Telluride
14	Cu - Copper	28	InAs - Indium Arsenide	42	Bi - Bismuth

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.



Universal 37 Reference Standard + Faraday Cup

Available as:

UNI3732

Manufactured in a Brass Mount 32mm dia. x 5mm thick

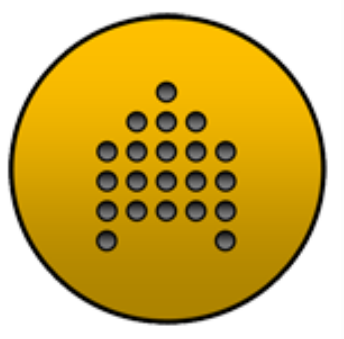
Uni3725

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	B - Boron	14	Pyrite - FeS_2	27	InAs - Indium Arsenide
2	C - Carbon	15	Co - Cobalt	28	Sn - Tin
3	MgO - Magnesium Oxide	16	Ni - Nickel	29	Sb - Antimony
4	Albite - $Na(AlSi_3O_8)$	17	Cu - Copper	30	BaF_2 - Barium Fluoride
5	Al_2O_3 - Aluminium Oxide	18	Zn - Zinc	31	Hf - Hafnium
6	Si - Silicon	19	GaP - Gallium Phosphide	32	Ta - Tantalum
7	Orthoclase - $K(AlSi_3O_8)$	20	SrF_2 - Strontium Fluoride	33	W - Tungsten
8	Wollastonite - $CaSiO_3$	21	Zr - Zirconium	34	Pt - Platinum
9	Ti - Titanium	22	Nb - Niobium	35	Au - Gold
10	V - Vanadium	23	Mo - Molybdenum	36	PbTe - Lead (II) Telluride
11	Cr - Chromium	24	Pd - Palladium	37	Bi - Bismuth
12	Mn - Manganese	25	Ag - Silver		
13	Fe - Iron	26	Cd - Cadmium	F/C	150 µm Faraday cup

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.



Semi-Conductor Reference Standard

Available as:

SCR32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

SCR25

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	B Boron	8	Pyrite FeS_2	15	CdS Cadmium Sulphide
2	C Carbon	9	Chalcocite Cu_2S	16	InP Indium Phosphide
3	Mg_2Sn Magnesium Tin Alloy	10	ZnS Zinc Sulphide	17	InSb Indium Antimode
4	Kyanite Al_2SiO_5	11	GaS Gallium Phosphide	18	HgTe Mercury Telluride
5	Si Silicon	12	GaAs Gallium Arsenide	19	PbTe Lead Telluride
6	CaF_2 Calcium Fluoride	13	Ge Germanium	20	Bi_2Se_3 Bismuth Selenide
7	$FeSi_2$ Iron Silicide	14	Ag_2S Silver Sulphide	21	Bi_2Te_3 Bismuth Telluride

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.

Mineral Reference Standard

Available as:

MIN32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

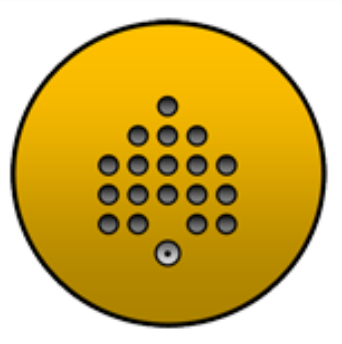
MIN25

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	Beryl $Be_3Al_2Si_6O_{18}$	11	Diopside $CaMgSi_2O_6$	21	Pyrite FeS_2
2	Cryolite Na_3AlF_6	12	Augite $(Ca,Mg,Fe)_2(SiAl)_2O_6$	22	Willemite Zn_2SiO_4
3	Albite $Na(AlSi_3O_8)$	13	Wollastonite $CaSiO_3$	23	Celestine $SrSO_4$
4	MgO Magnesium Oxide	14	Apatite (CaF) $Ca_5(PO_4)_3(F,Cl,OH)$	24	Zircon $ZrSiO_4$
5	Forsterite Mg_2SiO_4	15	Anhydrite $CaSO_4$	25	Baryte $BaSO_4$
6	Olivine $(Mg,Fe)_2SiO_4$	16	TiO Titanium (II) Oxide	26	Benitoite $BaTiSi_3O_9$
7	Kyanite Al_2SiO_5	17	Rhodonite $MnSiO_3$	27	Gadolinium Gallium Garnet $Gd_3Ga_5O_{12}$
8	Orthoclase $K(AlSi_3O_8)$	18	Spessartine $Mn_3Al_2Si_3O_{12}$		
9	Calcite $CaCO_3$	19	Hematite Fe_2O_3		
10	Fluorite CaF_2	20	Almandine $Fe_3Al_2Si_3O_{12}$	F/C	150 µm Faraday cup

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.



Biological Reference Standard

Available as:

BGL32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

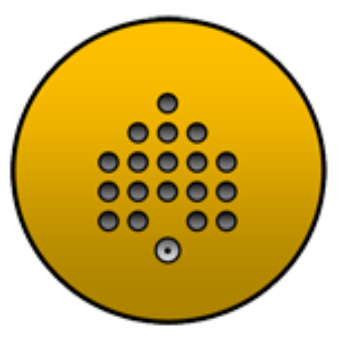
BGL25

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	B Boron	8	Pyrite FeS_2	15	CdS Cadmium Sulphide
2	C Carbon	9	Chalcocite Cu_2S	16	InP Indium Phosphide
3	Mg_2Sn Magnesium Tin Alloy	10	ZnS Zinc Sulphide	17	InSb Indium Antimode
4	Kyanite Al_2SiO_5	11	GaS Gallium Phosphide	18	HgTe Mercury Telluride
5	Si Silicon	12	GaAs Gallium Arsenide	19	PbTe Lead Telluride
6	CaF_2 Calcium Fluoride	13	Ge Germanium	20	Bi_2Se_3 Bismuth Selenide
7	$FeSi_2$ Iron Silicide	14	Ag_2S Silver Sulphide	21	Bi_2Te_3 Bismuth Telluride

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.



Sulphide Mineral / Heavy Metals Reference Standard

Available as:

SMH32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

SMH25

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	W - Tungsten	11	Cu - Copper	21	CdS - Cadmium Sulphide
2	Zircon - $ZrSiO_4$	12	Ni - Nickel	22	Mo - Molybdenum
3	Ag_2Te - Silver Telluride	13	Rh - Rhodium	23	HgS - Mercury Sulphide-Black
4	PbS - Lead Sulphide	14	Mn - Manganese	24	Pd - Palladium
5	Au - Gold	15	Bi - Bismuth	25	Nb - Niobium
6	Chalcopyrite - $CuFeS_2$	16	Pyrite - FeS_2	26	Pt - Platinum
7	Th - Thorium 5% in Glass	17	Se - Selenium	27	Ta - Tantalum
8	InAs - Indium Arsenide	18	SnO_2 - Tin (IV) Oxide	28	InSb - Indium Antimonide
9	Fe - Iron	19	ZnS - Zinc Sulphide	29	U - Uranium 4% in Glass
10	Co - Cobalt	20	Ir - Iridium	30	Andradite - $Ce_3Fe_2(SiO_4)_3$

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.

Geological Reference Standard

Available as:

GGL32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

GGl25

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	Andradite $Ca_3Fe_2SiO_4)_3$	**11**	Hematite Fe_2O_3	**21**	ZnS Zinc Sulphide
2	Zircon $ZrSiO_4$	**12**	Orthoclase $K(AlSi_3O_8)$	**22**	Celestine $SrSO_4$
3	MgO Magnesium Oxide	**13**	Rb - Rubidium 10% in Glass	**23**	Ni Nickel
4	Cs - Caesium 10% in Glass	**14**	V Vanadium	**24**	Cr_2O_3 Chromium Oxide
5	Apatite (CaF) $Ca_5(PO_4)_3(F,Cl,OH)$	**15**	Pyrite FeS_2	**25**	Almandine $Fe_3Al_2Si_3O_{12}$
6	Jadeite $NaAlSi_2O_6$	**16**	NaCl Sodium Chloride	**26**	Cu Copper
7	TiO Titanium (II) Oxide	**17**	Fluorite CaF_2	**27**	Diopside $CaMgSi_2O_6$
8	Baryte $BaSO_4$	**18**	Peridot - Forsterite $(Mg,Fe)_2SiO_4$	**28**	Al_2O_3 Aluminium Oxide
9	Co Cobalt	**19**	Rhodonite $MnSiO_3$		
10	Wollastonite $CaSiO_3$	**20**	Kyanite Al_2SiO_5	**F/C**	150 µm Faraday cup

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials
Standard specific EDX analysis can be provided at extra cost if required.

Micro-Analysis Consultants Ltd

www.micro-analysis.com

Universal Reference Standards

Low Carbon Analysis Reference Standard

Available as:

LCA32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

LCA25

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	SRM 13g 0.6% Carbon Steel	**5**	BCS No. 238/2 0.2% Carbon Steel	**9**	SRM 160b Austenitic Stainless Steel
2	SRM 663 Cr/V Steel (Modified)	**6**	SRM 12h 0.4% Carbon Steel	**10**	SiC Silicon Carbide
3	C Carbon	**7**	AISI 304L Austenitic Stainless Steel	**11**	Si Silicon
4	SRM 73c Stainless Steel 13% Cr	**8**	Fe Iron	**F/C**	150 µm Faraday cup

The purity/composition for each of these materials is certified by the manufacture/supplier.

Universal Reference Standards

Rare Earth (Synthetic) Reference Standard

Available as:

REE32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

REE25

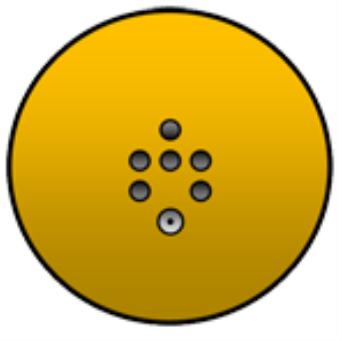
Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	LaB_6 Lanthanum Hexaboride	7	EuF_3 Europium Fluoride	13	ErF_3 Erbium Fluoride
2	LaF_3 Lanthanum Fluoride	8	GdF_3 Gadolinium Fluoride	14	Tm Thulium
3	$CeAl_2$ Cerium Alumate	9	TbF_3 Terbium Fluoride	15	$TmSi_2$ Thulium Silicide
4	PrF_3 Praseodymium Fluoride	10	$TbSi_2$ Terbium Silicide	16	YbF_3 Ytterbium Fluoride
5	NdF_3 Neodymium Fluoride	11	DyF_3 Dysprosium Fluoride	17	LuF_3 Lutetium Fluoride
6	SmF_3 Samarium Fluoride	12	HoF_3 Holmium Fluoride	18	$LuSi_2$ Lutetium Silicide

The purity/composition for each of these materials is certified by the manufacture/supplier.

Universal Reference Standards



Rare Earth 4% Multi REE Reference Standard

Available as:

REM32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

REM25

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	Glass Blank Al2O3, CaO, SiO2 Glass	3	Multi. Element REE Approx. 4% each La, Sm, Gd, Yb In Glass	5	Multi. Element REE Approx. 4% each Y, Pr, Dy, Er In Glass
2	Multi. Element REE Approx. 0.5% each La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y In Glass	4	Multi. Element REE Approx. 4% each Ce, Eu, Ho, Tm In Glass	6	Multi. Element REE Approx. 4% each Nd, Tb, Lu In Glass
				F/C	150 µm Faraday cup

These glasses have been developed to replace the fluorides and pure metals traditionally used as standards for REE analysis. REE glasses have the advantage of providing a standard which is easily polished, free from surface oxidation and generally lowers the magnitude of the analysis ZAF Correction.

The purity/composition for each of these materials is certified by the manufacture/supplier.

Rare Earth (Glass) Reference Standard

Available as:

RES32

Manufactured in a Brass Mount 32mm dia. x 5mm thick

RES25

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following materials mounted in periodic order left to right, starting in the top left corner:

No	Material	No	Material	No	Material
1	Glass Blank	7	Europium in Glass Eu = 8.93% wt.	13	Thulium in Glass Tm = 9.99% wt.
2	Lanthanum in Glass La = 10.11% wt.	8	Gadolinium in Glass Gd = 10.91% wt.	14	Ytterbium in Glass Yb = 11.27% wt.
3	Cerium in Glass Ce = 9.51% wt.	9	Terbium in Glass Tb = 9.85% wt.	15	Lutetium in Glass Lu = 10.99% wt.
4	Praseodymium in Glass Pr = 8.61% wt.	10	Dysprosium in Glass Dy = 10.43% wt.	16	Yttrium in Glass Y = 10.29% wt.
5	Neodymium in Glass Nd = 10.62% wt.	11	Holmium in Glass Ho = 10.79% wt.		
6	Samarium in Glass Sm = 9.31% wt.	12	Erbium in Glass Er 10.03% wt.		

These glasses have been developed to replace the fluorides and pure metals traditionally used as standards for REE analysis. REE glasses have the advantage of providing a standard which is easily polished, free from surface oxidation and generally lowers the magnitude of the analysis ZAF Correction.

The purity/composition for each of these materials is certified by the manufacture/supplier.

Universal Reference Standards

Quality Control Test Standards

September 2017

Quality **C**ontrol **T**est Standards

MAC's Range of **Q**uality **C**ontrol **T**est Standards have been thoughtfully designed and manufactured to help aid the user in checking and monitoring the performance and accuracy of their EDX/WDX-SEM equipment and to help identify any potential problems that may effect the quality of the analysis results they are achieving.

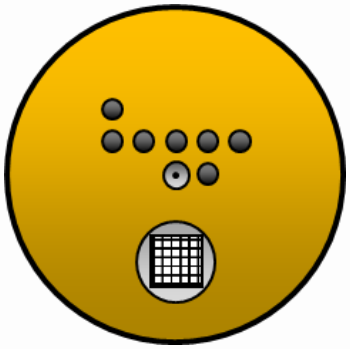
Our standards are used worldwide by:

- OEM Engineers in the setup and servicing of equipment
- Testing Laboratories
- Research & Development Laboratories
- Universities, Colleges and Schools
- Geological Societies
- Police Forensic Science Departments
- Government Agencies

All of the QCT standards we manufacture can be customised by the customer if an alternative material or accessory is preferred or required. If we do not have the material you need from the 1,000+ materials we hold in stock, we will do our best to source it for you.

MAC's Blocks of Standards are supplied in a specially designed storage/ transportation case that contains:

- The standard—protected again by another specially designed case
- A full electronic booklet on a USB, containing
  - The Standard plan/layout
  - Certificates of analysis of conformance for each material
  - Details on storage and care for your standards
  - Certificate of final inspection & recommended re-polishing date
- A replaceable silica gel capsule for protection whilst in transit.
- A credit card sized quick refence guide.



Basic Quality Control Test Standard

Available as EDXCAL

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following:

- Manganese used for Detector resolution (FWHM)
- Chromium used for Detector sensitivity / contamination
- Carbon used for Beam measurement & energy calibration (Low)
- Nickel used for Detector sensitivity / contamination
- Cobalt used for Beam measurement & energy calibration
- Almandine (mineral) used for Quant. verification
- 150 µm Faraday cup used for Beam current stability
- Silicon Test Grid used for Magnification calibration & image distortion

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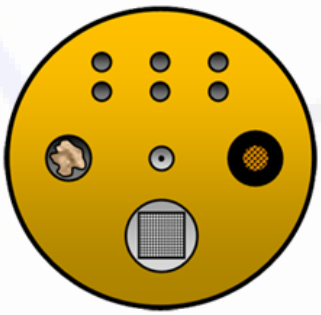


Quality Control Test Standard

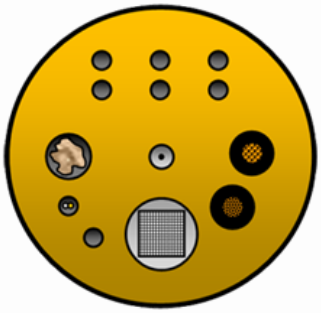
Available as QCTA

Manufactured in a Brass Mount 32mm dia. x 8mm thick

This Standard contains the following:

- Six selectable materials to be embedded from our recommended list
- Duplex Brass used for Back scattered Detector (BSE) resolution
- Au/C Resolution Std. used for SEM resolution 50,000x to 200,000x mag.
- 150 µm Faraday cup used for Beam current stability
- Silicon Test Grid used for Magnification calibration & image distortion

Quality Control Test Standards



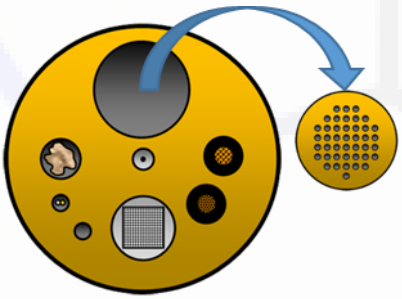
Enhanced Quality Control Test Standard

Available as QCTB

Manufactured in a Brass Mount 25mm dia. x 5mm thick

This Standard contains the following:

- Six selectable materials to be embedded from our recommended list
- A selectable dual BSE std. with an atomic number difference of 1 Z i.e. Pd/Ag
- Duplex Brass used for Back scattered Detector (BSE) resolution
- Au/C Resolution Std. used for SEM resolution 50,000x to 200,000x mag.
- Au/C Resolution Std. used for SEM resolution 50,000x to 250,000x mag.
- 150 µm Faraday cup used for Beam current stability
- Silicon Test Grid used for Magnification calibration & image distortion
- Cobalt used for Beam measurement and energy calibration



Quality Control Test Carousel

Available as QCTC

Manufactured in a Brass Mount 50mm dia. x 8mm thick

This standard has been designed to allow an existing 25mm dia. x 5mm thick block of standards to be inserted within the Quality Control Test Ring (25mm block of standards not included). The carousel contains the same materials and accessories as the Enhanced Quality Control Test Standard with the exception of the six selectable materials.

Quality Control Test Standards

Selectable Materials for the QCTA and QCTB Standards

High Purity Materials Recommended for Energy Calibration

Si	**Sc**	**Ti**	**V**	**Cr**	**Mn**
Fe	**Co**	**Ni**	**Cu**	**Zn**	

X-ray peaks often involve multiple lines therefore in order to achieve accurate calibration, a large peak with well-known line energies and intensities is required. We recommend that for energy calibration a pure element is used; Si, Co, Ni or Cu are the most common.

High Purity Materials Recommended for Beam Measurement

C	**Si**	**Ti**	**V**	**Cr**	**Mn**
Fe	**Co**	**Ni**	**Cu**	**Zn**	

Pure Co resists oxidation and polishes well and is therefore the most suitable choice to monitor beam current when you want to obtain accurate un-normalized or "absolute" estimates of composition. However, below 15kV, Co K-line is weakly excited and it is preferable to choose another pure element for monitoring.
If the beam measurement material is oxidized, contaminated or has a rough surface, then this will have a direct effect on the analysis results.
When using very low accelerating voltages, a pure carbon standard (ideally glassy carbon) can be used for beam calibration. The resolution must be sufficient to leave background regions either side of the carbon peak, so that the peak is clearly separated from the triggered noise peak (near zero keV) and any oxygen peak near 0.5 keV. Furthermore, the voltage must be sufficient to excite an adequately large C K-line emission.
Most EDX software allows calibration using the zero strobe peak and a known element. If the software on your system does not allow this then calibration is recommended using an Al+Cu sample. These two 1mm wires are embedded side by side in a single hole. For low accelerating voltages a Al/C sample would be used.

Recommended Materials for Checking Energy Resolution

Mn	Cu	C	F

Resolution is quoted as the width of the peak at half its maximum height (FWHM). The lower the number the better the resolution of the detector and therefore the better it will be at resolving peaks due to closely spaced X-ray lines.
Many manufacturers test the performance of an EDS detector using Fe55. This is convenient as it can be achieved without the need of mounting the detector on an SEM.
The resolution of a detector is traditionally specified for the Manganese Kα X-rays at 5.895 KeV as this is the energy of the most intense X-ray line emitted by the Fe55 source.
Mn Kα energy is most commonly used to specify EDS resolution as the peaks are well separated. However, much more serious overlaps occur below 3keV and the resolution performance at low energies is critical to good performance for all elements. Mn (FWHM) is a very insensitive measure to characterize the noise of a detector and predict the resolution at low energy. Therefore to characterize the resolution of a detector at low energy, the resolution is also quoted for another line, typically Fluorine Kα.
The resolution of the C Kα peak measured using pure Carbon is very useful due to its sensitivity to noise and incomplete charge collection. A low value guaranteed here means excellent detector resolution for all energies.

Recommended Material for Checking Detector Performance Changes

Ni	Cr

A gradual decrease in low energy sensitivity over time will result in a decrease in the height of peaks at low energy. This can be checked by monitoring the relative height of K and L lines from a transition metal element. The ratio of L to K line heights from pure nickel measured at 20kV is a common test. A more sensitive test for the presence of ice and water vapour on a detector window is to look at the L spectrum from pure Cr.

Miscellaneous Materials

Beryllium is often used for checking the low end sensitivity of high performance detectors
Boron Nitride is used for checking the low end energy performance of thin window and windowless detectors
Silicon Oxide is used to test the Oxygen sensitivity of the EDS
Almandine is used to verify the quant. analysis achieved for oxides after calibration
AISI 316 S/S is used to verify the quant. analysis achieved after calibration

SEM Magnification Calibration/Verifications Options

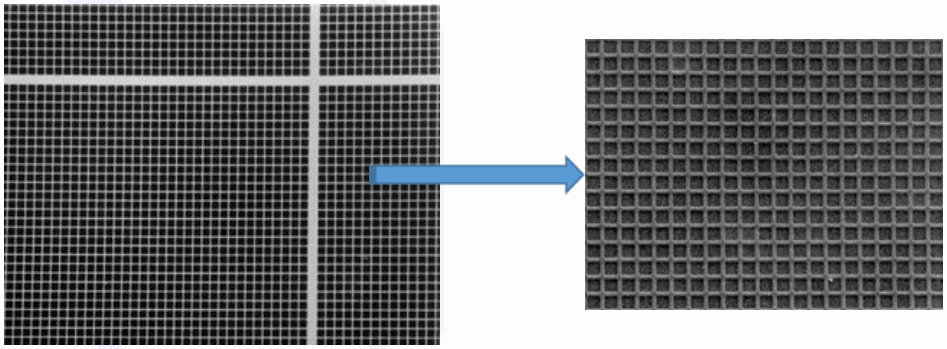
The default magnification grid fitted into our QCT standards can be modified to any of the following options, please note however that the magnification grid selected may affect the overall price of the standard.

Planotec Silicon Test Standard

Available as MG01 **This is the default standard fitted into our QCT standards**

or

MG02(Calibrated)



The Planotec silicon test standard is useful for checking the Magnification and Image distortion in SEM, table top SEM, FIB, Auger, SIMS and Reflected Light Microscopy.
With a magnification range of approximately 100x to 1000x , this grid is made up of 10 µm squares 300 nm deep with dividing lines of 1.9 µm. There is also a broader dividing line every 500 µm
A certified version, supplied with a certificate of calibration is also available at an additional cost (MG02).

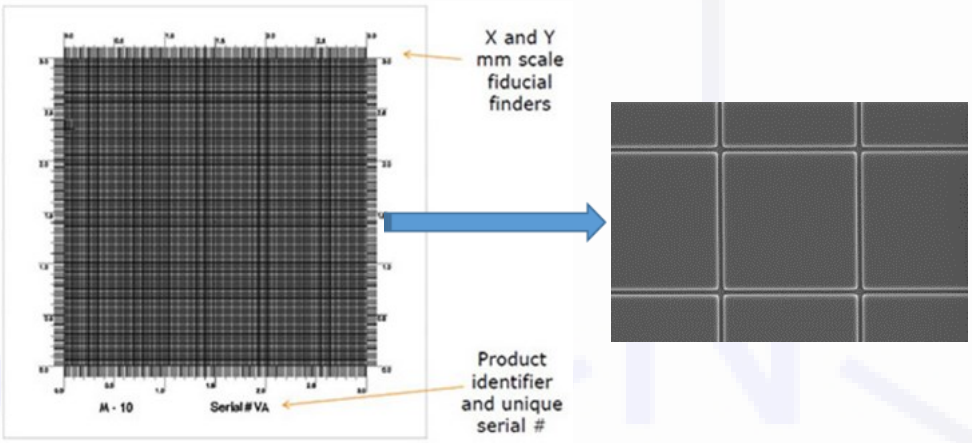
Quality Control Test Standards

EM-Tec M-10 and M-1 Silicon Grid Magnification Standards

Available as MG05 (10 µm)

or

MG08 (1 µm)



The EM-Tec silicon grid magnification calibration standards are intended for use in SEM, table top SEM, FIB, Auger, Sims and Reflected Light Microscopy.

Both options have lines directly etched into a conductive ultra-flat silicon substrate.

The MG05 (10 µm) version has a magnification range of approximately 100x to 1000x and is made up of 10 µm lines 300 nm deep with a width of 300 nm and 100 µm lines 300 nm deep with a width of 400 nm.

The MG08 (1 µm) version has a magnification range of approximately 100x to 10,000x and has additional 1 µm lines 300 nm deep with a width of 200 nm.

Both of these standards are suppled with a wafer level certificate of traceability that is traceable to a NIST calibrated standard.

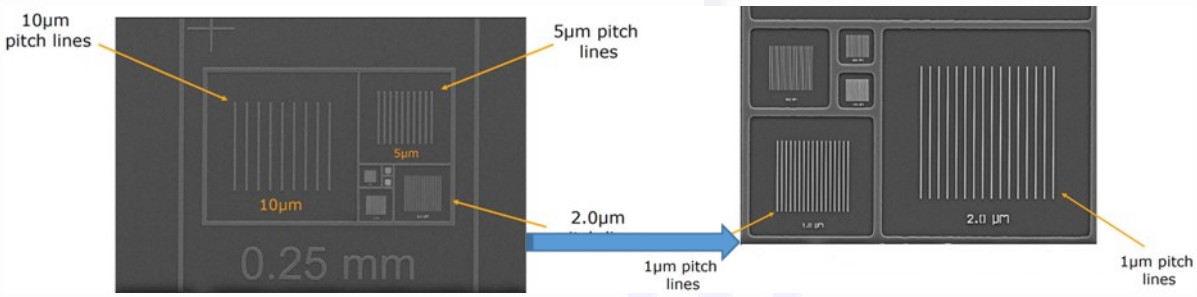
Quality Control Test Standards

EM-Tec MCS series of Magnification Calibration Standards

Available as MG06(1 µm) traceable, MG07 (1 µm) calibrated

or

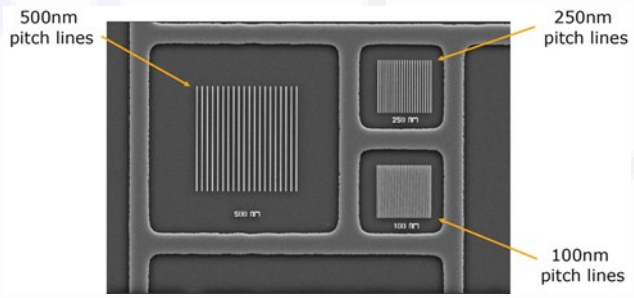
MG09 (0.1 µm) traceable, MG10 (0.1 µm) calibrated

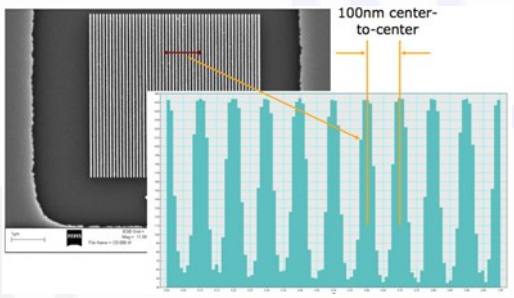


The MCS series are a fully featured Critical Dimension Standard for calibration over a wide measurement range in SEM, table top SEM, FIB, Auger, Sims and Reflected Light Microscopy

The MG06 (1 µm) traceable and MG07 (1 µm) calibrated versions have a magnification range of approximately 10x to 20,000x and have a scale range of 2.5 mm to 1 µm

The MG09 (0.1 µm) traceable and MG10 (0.1 µm) calibrated versions have a magnification range of approximately 10x to 200,000x and have a scale range of 2.5 mm to 100 nm





Mg06 and MG09 are NIST traceable and supplied with a global certificate of calibration using the average data measured for each production wafer.
MG07 and MG10 are NIST traceable and supplied with an individual certificate of calibration for higher accuracy.

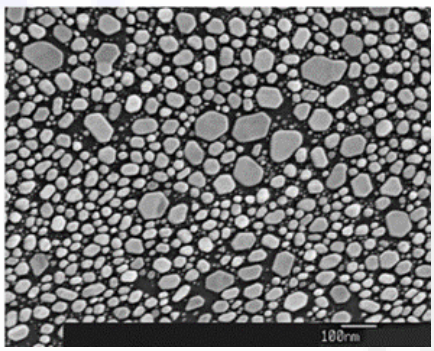
Quality Control Test Standards

SEM Resolution Options

The default resolution standards fitted into our QCT standards can be modified to any of the following options, please note however that the resolution option selected may affect the overall price of the standard.

Gold on Carbon Medium Resolution standard

This is the default standard fitted into our QCT standards



Available as RS02

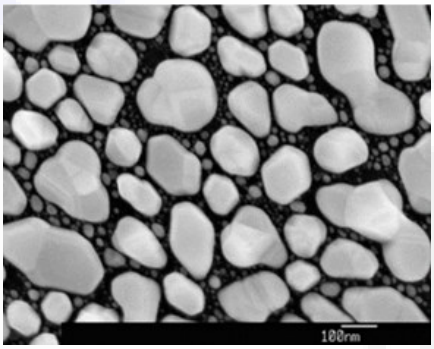
This specimen has a particle size range from approximately 5 – 150 nm

This calibration specimen provides a means of testing scanning electron microscopes. The various sizes of the gaps between gold crystals grown on a graphite substrate allow tests for the resolution attainable under real operating conditions.
As an aid in use, there is an outline image of a square mesh on the surface of the specimen which is useful for preliminary focusing at magnifications below 150x magnification.

Quality Control Test Standards

Standard gold or tin on carbon resolution specimens may not be suitable for operating at low accelerating voltages or for use with older instruments. This may be due to inferior resolution at low voltage or poor signal-to-noise ratio when operating at high scanning rates with small spot sizes. The larger gold islands give high contrast while retaining small gaps for resolution measurement, making this specimen easier to use at non-optimal operating conditions.

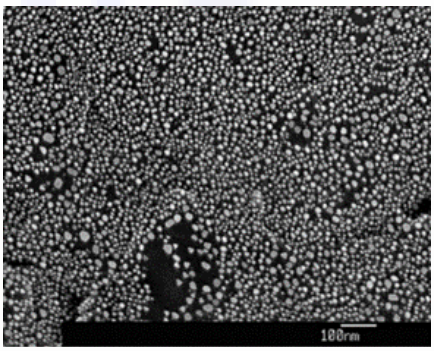
Gold on Carbon Low Voltage Resolution standard



Available as RS01

This specimen has a particle size range from approximately <30 – 300 nm

Gold on Carbon High Resolution standard



Available as RS03

This specimen has a particle size range from approximately <3 – 50 nm

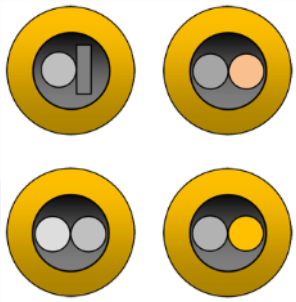
Quality Control Test Standards

BSD Reference Standards

September 2017

BSD Reference Standards

An electron microscope, when equipped with a Backscattered Electron Detector, has the capacity to produce images in which contrast is controlled by the differences in atomic numbers (Z) across the specimen. We currently have four reference specimens which are available for testing the atomic number contrast performance of backscattered electron detection systems. Further standards are available from our range of QCT standards.



BSD Test Standards

Available as:

ANC1314 = Al/Si **ANC2829 = Ni/Cu**

ANC4647 = Pd/Ag **ANC7879 = Pt/Ag**

Manufactured in individual Brass Mounts 5mm dia. x 5mm

Each of the reference specimens consists of two high purity elements that have an atomic number difference of 1. They are embedded side by side in a contrasting matrix and are available as a single mount or can be incorporated into a set of standards.

Duplex Brass BSD Test Standard

Available as ANCDBR

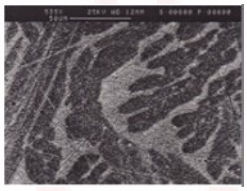
Manufactured in a Brass Mount 5mm dia. x 5mm thick

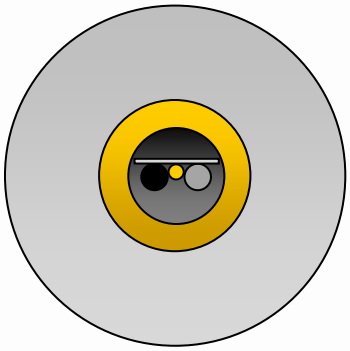
This standard allows checking the resolution and performance of the Backscattered Electron Detector. The resolution of a detector is usually quoted as 0.1 (Z) where the atomic number (Z) = 30. This is obtained in our standard by the mean atomic number between the phases of α/β Brass, being 0.1Z.

Phases of Duplex Brass:

Darker Phase Z = 29.37

Lighter Phase Z = 29.47





Basic Backscattered Detector Test Standard

Available as ANCPAS

Manufactured in a 12.5mm dia. Aluminium Pin Stub

This Standard contains the following:

Carbon, Gold, Rhodium and Cobalt mounted within close proximity and cover the low, mid and high BSE grey scales. The Carbon and Cobalt standard can also be used for the EDX/WDX energy beam and energy calibration (see "selectable materials for QCTA and QCTB standards for further information.

Enhanced Backscattered Detector Test Standard

Available as BSE30C

Manufactured in a Carbon Mount 30mm dia. x 5mm thick

This Standard contains the following materials embedded into a conductive matrix

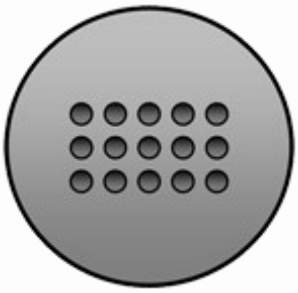
Duplex Brass BSE Std	The resolution of a detector is usually quoted as 0.1 Z where the atomic number Z = 30. This is obtained in our standard by the mean atomic number between the phases of α/β Brass, being 0.1 Z.
Carbon	Beam measurement & energy calibration (Low)
Aluminium/Silicon Nickel/Copper Palladium/Silver Platinum/Gold	These groups of material are embedded in pairs (in close proximity) and have an atomic number difference of 1 Z they can not only be used for checking the BSE detector across the full range of grey scales but can also be used as EDS/WDX energy Beam and energy calibration standards.
150µm Faraday Cup	Used to test the Beam current stability

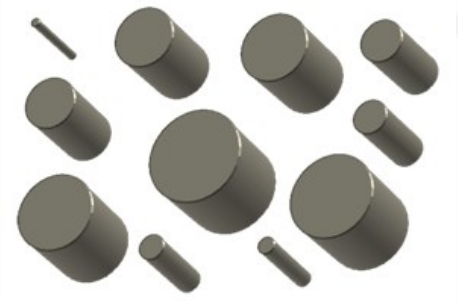
Quality Control Test Standards (BSD)

Auger Spectroscopy Standards

September 2017

Auger Spectroscopy Standards





MAC have developed multi-element blocks of reference materials suitable for the compilation of a reference library of Auger sensitivity factors when used with Auger Electron Spectroscopy (A.E.S.)

There are approximately 180 high purity single element and compound reference materials from which to choose. Most of them are synthetic materials obtained from many sources worldwide together with 31 natural minerals that are suitable for geological investigations. There are also 56 standards to choose from in the MBH/NIST/BAS-EURO section of the materials selection.

A carefully selected range of elements or compounds will enable the surface analyst to compile a valuable reference library of spectra for those materials of specific interest to his field of study. A.E.S. is of particular value in the investigation of the surface chemistry of electronics materials, so we have put together an Electronics Materials Set containing 33 relevant reference materials.

A Faraday Cup, for the accurate measurement of specimen current, is available as an optional extra on all reference blocks.

Multi-element blocks containing up to 50 reference materials can be made to suit the configuration of most instruments, but the actual number of materials and the shape and size of the reference block is determined by the physical limitations imposed by the specimen holder and chamber. The reference materials each have an exposed area about 2mm^2.

Auger Spectroscopy Standards

Each block of reference materials is made from AISI 304 grade austenitic stainless steel, set with elements and compounds of your choice and polished to a ¼ micron diamond finish. All blocks are supplied with certificates of analysis and a map showing the locations of the reference materials.

The design of the reference blocks for A.E.S. is based upon that used for the production of our already established range of electron probe x-ray microanalysis (E.P.M.A.) standards blocks. For surface analysis in ultra-high vacuum (U.H.V.) environments, the design of the A.E.S. blocks has three significant differences over the E.P.M.A. blocks:

- For E.P.M.A. the reference standards are set into drilled brass blocks. However, for U.H.V. work, the brass would outgas, so non-magnetic stainless steel is used for the A.E.S. reference blocks.
- There is no coating of electrically conductive carbon on the A.E.S. blocks. For E.P.M.A. work, this coating is needed to neutralise any electron beam induced charge.
- E.P.M.A. standards are mounted using epoxy resin, which would
- rapidly out gas under U.H.V. conditions. The A.E.S. reference blocks are set with Wood's Fusible Metal. This is an alloy of bismuth, lead, tin and cadmium.

Wood's Metal, being electrically conductive, also serves as an electrical connection between the reference material and the stainless steel block thereby dissipating any electrical charge. However, some of the reference materials are electrical insulators, so these must be charge neutralised using a high specimen tilt angle or a lower primary beam accelerating potential.

WARNING
The block of reference materials should not be baked prior to analysis. Wood's Metal melts at about 70° C and also, because of its high vapour pressure, cadmium vapour would be liberated into the specimen chamber.

Customised Standards

September 2017

Customised Standards

Although our range of universal standards are extremely comprehensive, M.A.C. are aware that they do not always provide the specialisation that some users require. This is why MAC is happy to work directly with you to help to produce standards as unique as the environment in which they are to be used and reflect the requirements which have been identified.

We are able to design, produce & manufacture standards for all microanalysis instrumentation including customised mounts specially designed for your needs. We are able to offer mounts manufactured in Brass, Aluminium or Stainless Steel.

When enquiring about custom built standards, we would ask that the following information is provided, to help you with the most appropriate solution:

- Make and model of instrument in which standards are to be used
- Specify quantity and standard materials required
- Outer diameter of the mount or individual required
- Inner diameter where appropriate
- Thickness of mount(5mm normally supplied)
- Material of the mount to be used (normally Brass)
- Whether a Faraday Cup is required
- Any limitation of the X and Y movements of the stage
- Any additional requirements

Customised Standards – Single

Individual standards are usually supplied as 2, 3 or 5mm diameter brass tubes. Although they can be mounted in any size mount.

Unmounted Standards

We are also able to offer unmounted samples/grains of certified materials which are available. Grains are usually $2mm^3$ in size.

Customised Standards - Multiple

The number of standards we would be able to embed into a single mount would be restricted by the mount dimensions. These range from 10mm – 32mm and are usually 5mm thick, although mounts can be manufactured to your specific requirements.

Please Contact us or your MAC distributor to discuss your individual requirements.

Mount Examples

Carousels

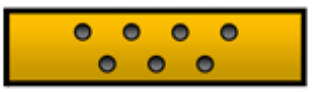
The carousel is able to nestle around the outside of the users original mount. These mounts are custom made and therefore the original mount dimensions are required. The number of standards which can be embedded in this type of mount is dependent on the dimensions required.

Specially Manufactured Mounts

If our range of mounts do not accommodate your requirements, we would be happy to work with you to provide your exact specifications. Examples are detailed below.

Available as: JL-01

Available as: JL-03



Available as: JL-02

Customised Standards

Refurbishment Programme

September 2017

Refurbishments

We recommend that the standards we manufacture are returned every 2 years for re-polishing. This is to ensure that they consistently deliver the results that are expected. With ISO certification playing a larger role in businesses worldwide, having your standards refurbished on a regular basis can show your commitment to delivering part of the servicing requirements of this certification.

With regular refurbishment of your block of standards, you will be able to consistently achieve the results that your require.

Typical signs that indicate that your block of standards may need refurbishment are:-

- Charging
- Scarring caused by the electron beam
- Deep scratches
- Surface contamination

The refurbishment Service which is offered at MAC allows you to have your set of standards restored to a “like new” condition at a fraction of the cost of a replacement.

With over 30 years of expertise in the manufacturing of standards that contain a wide variety of materials, we are able to apply this knowledge and experience, not only in the restoration of the standards that we have produced but also in restoring standards produced by other manufacturers

The cost of the refurbishment would be dependant upon the type of standard and the work required to return it to an “as new” condition. This can only be possible once the standard has been received at MAC and inspected.

We are happy to offer a preliminary quotation for a basic service which would include:

- Initial standard inspection both optically and in our SEM
- Checking the analysis results via EDS prior to any work commencing
- Cleaning and re-polishing the standard
- Re-application of the Carbon coating (if required)
- Final Inspections and EDS analysis test.
- Certificate of Refurbishment.

This preliminary quotation would be confirmed or amended once your standard had been received and inspected.

What happens?

Once your standard has been received at MAC it will undergo an initial inspection. The standard will be checked both optically; under a microscope and electronically in our SEM. Whilst the standard is in our SEM the analysis will also be checked using EDS.

Upon completion of the inspection
If no additional works have been identified and no further recommendations have been made, the preliminary quotation will be confirmed and once authorisation has been received the standard will enter our refurbishment process.

If it is discovered that there is a need for additional work or recommendations, we will contact you, detailing our findings.
The refurbishment of the returned block will at this point be put on hold until authorisation has been received to continue.

Examples of previous recommendations include:

- Faraday Cup replacement
- Standard replacement
- Calibration standard replacement

Once your standard has entered our refurbishment process, it will continue via our normal procedures ending with a final polish of ¼ µm and the Carbon coating re-applied (if required). Your standard will then be tested and checked against the original certification issued with the standard (if available).

Should you require new certificates of analysis based upon our EDS final testing we would require pre-notification as this will be charged for.

A standard refurbishment usually takes 14 days, however this time can be affected by any additional work that maybe required.

We are aware of the inconvenience that not having your block can impose and the restriction that may be caused, therefore, we maybe able to offer a loan standard that can be used whilst yours is being refurbished.

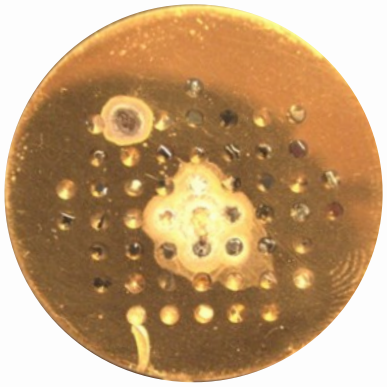
Whilst your standard is with us for refurbishment, it may be worth considering the addition of extra standards as the refurbishment process offers an ideal opportunity for this to occur (please advise during initial conversations if this is something that you may be interested in).

If you are unsure if your standards need to be refurbished please contact us and we will be happy to advise you

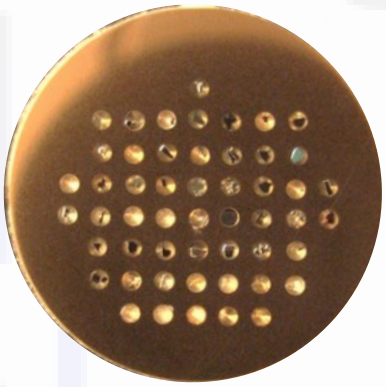
Examples of Refurbishments Completed

Prices shown are from our 2015 catalogue and are for example purposes

Degraded Materials



Before



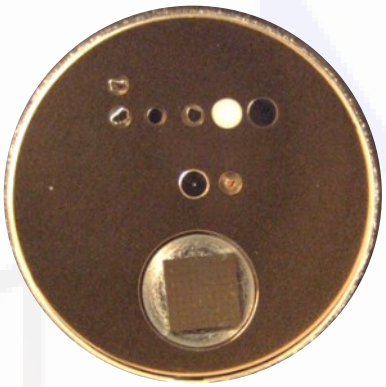
After

The moisture sensitive materials in this standard had degraded due to incorrect storage/handling. The degradation spread across the surface of the mount contaminating the surrounding materials. The effected materials were replaced; complete standard re-polished and Carbon coat re-applied.

Cost of a replacement standard	£2753.93
Cost of refurbishment	£ 435.00
Saving	**£2318.93**

Beam Damage

Before



After

The PTFE material mounted into this standard had suffered with extensive damage from the electron beam. The sample was replaced along with the faraday cup; complete standard re-polished; Carbon coat re-applied and a new silicon magnification grid fitted.

Cost of a replacement standard	£ 901.00
Cost of refurbishment	£ 335.00
Saving	**£ 566.00**

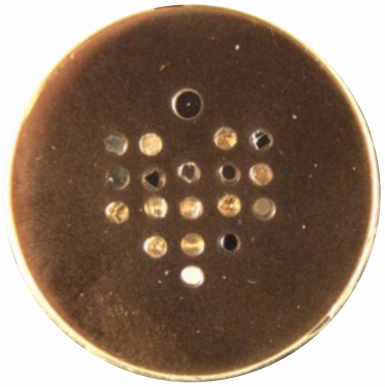
Micro-Analysis Consultants Ltd

www.micro-analysis.com

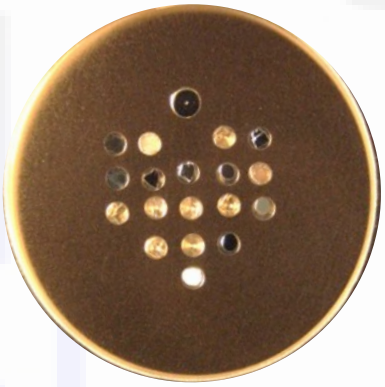
Refurbishment Programme

Examples of Refurbishments Completed

Standard clean and re-polish



Before

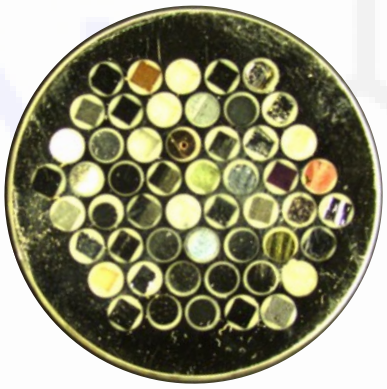


After

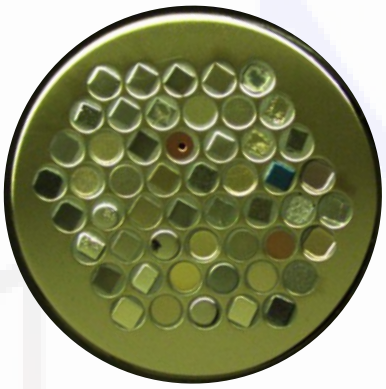
The surface of the standard had been contaminated by incorrect handling (fingerprints). The complete standard was re-polished and the Carbon coat re-applied.

Cost of a replacement standard	£1467.00
Cost of refurbishment	£ 195.00
Saving	**£1272.00**

Non MAC standard



Before



After

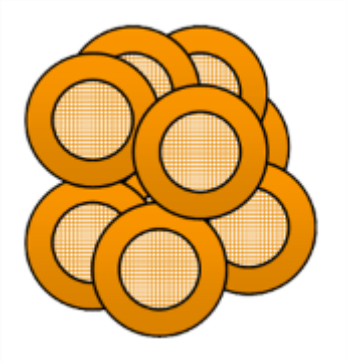
This old Charles Taylor standard had suffered from general use over many years. The surface of the mount was dirty and many of the standards were scratched and contaminated. The complete standard was re-polished and the Carbon coat re-applied.

Cost of a replacement standard	£3058.00 (approx. as no longer made)
Cost of refurbishment	£ 400.00
Saving	**£2658.00**

Refurbishment Programme

TEM Thin Film Standards

September 2017



Thin Films Standards Set (25) - Universal

Available as:

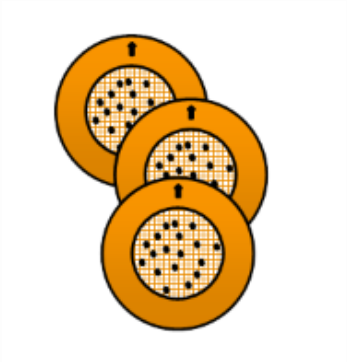
FILM25

Powders dispersed onto Holey Carbon Films, supported by 3.05mm(dia) 400 mesh Copper Grids

This Set of Thin Film Standards contain the following:

No	Material	No	Material	No	Material
1	Baryte $BaSO_4$	10	Cryolite Na_3AlF_6	19	Olivine $(Mg,Fe)_2SiO_4$
2	Beryl $Be_3Al_2Si_6O_{18}$	11	G.G.G $Gd_3Ga_5O_{12}$	20	Orthoclase $KAlSi_3O_8$
3	Bi_2Se_3 Bismuth Selenide	12	GaAs Gallium Arsenide	21	Ag_2Te Silver Telluride
4	CdTe Cadmium Telluride	13	InSb Indium Antimonide	22	$SrTiO_3$ Strontium Titanate
5	$CaMoO_4$ Calcium Molybdenate	14	InP Indium Phosphide	23	TlBr Thallium (I) Bromide
6	$CaWO_4$ Calcium Tungstate	15	LaB_6 Lanthanum Hexaboride	24	ZnS Zinc Sulphide
7	$CeAl_2$ Cerium Alumate	16	K453 Lead Germanate Glass	25	Zircon $ZrSiO_4$
8	Chalcocite Cu_2S	17	$Li_2Ta_2O_6$ Lithium Tantalate		
9	Chromite $FeCr_2O_4$	18	HgTe Mercury (II) Telluride		

The purity/composition for each of these materials is certified by the manufacture/supplier.
The mineral formulas stated are the CNMMN/CNMNC approved formulas. These natural minerals may contain phases/inclusions of other materials. Minerals are supplied with a typical EDX analysis recorded from our specimen standard for these materials



Thin Films Standards Set (14) - Rare Earth

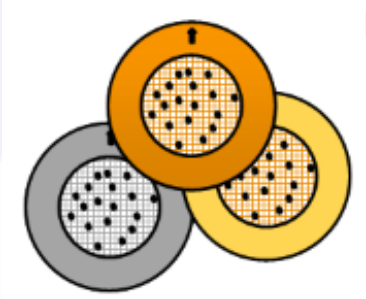
Available as:

FILM14

Powders dispersed onto Holey Carbon Films, supported by 3.05mm(dia) 400 mesh Copper Grids

This Set of Thin Film Standards contain the following:

No	Material	No	Material	No	Material
1	$CeAl_2$ Cerium Alumate	6	HoF_3 Holmium Fluoride	11	SmF_3 Samarium Fluoride
2	DyF_3 Dysprosium Fluoride	7	LaF_3 Lanthanum Fluoride	12	TbF_3 Terbium Fluoride
3	ErF_3 Erbium Fluoride	8	LuF_3 Lutetium Fluoride	13	TmF_3 Thulium Fluoride
4	EuF_3 Europium Fluoride	9	NdF_3 Neodymium Fluoride	14	YbF_3 Ytterbium Fluoride
5	GdF_3 Gadolinium Fluoride	10	PrF_3 Praseodymium Fluoride		



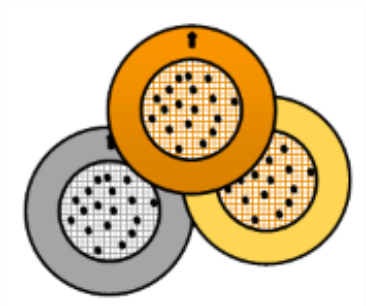
Thin Films Standards - Single

Available as:

FILM1

The purity/composition for each of these materials is certified by the manufacture/supplier.

TEM Thin Film Standards



Thin Films Standards - Single

Available as:

FILM1

We have a wide range of materials suitable for TEM Thin Film standards that can be selected. For an up to date list , please refer to our Materials List Brochure or our website -

http://www.micro-analysis.com/standards/thin-films/thin-film-single.asp

We stock a wide range of grids for these powders to be dispersed onto, for example:

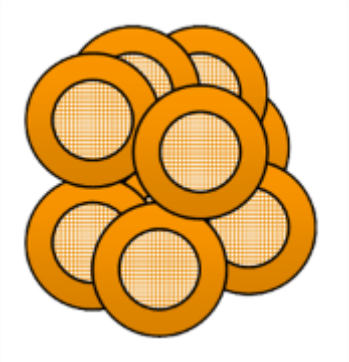
- Coated grids
  - Holey Carbon Film
  - Lacey Carbon Film
- Grid materials
  - Copper
  - Nickel
  - Gold
  - All with various mesh sizes
- Finder grids
  - Various mesh sizes and types

If you require a special type of grid, please contact us or your MAC distributor.

TEM Thin Film Standards

STEM Thin Foil Standards

September 2017



Thin Foil Standards Set (25) - Universal

Available as:

FOIL25

These are high purity metal foils, each measuring 3mm diameter x 0.1mm thick which fit into TEM grid holders for use in the STEM mode.

This Set of Thin Foil Standards contain the following:

No	Material	No	Material	No	Material
1	Al - Aluminium	10	Mo - Molybdenum	19	Ti - Titanium
2	Cd - Cadmium	11	Ni - Nickel	20	W - Tungsten
3	Co - Cobalt	12	Nb - Niobium	21	V - Vanadium
4	Cu - Copper	13	Pd - Palladium	22	Y - Yttrium
5	Au - Gold	14	Pt - Platinum	23	Zn - Zinc
6	Hf - Hafnium	15	Rh - Rhodium	24	Zr - Zirconium
7	In - Indium	16	Ag - Silver	25	AISI 316 - Stainless Steel
8	Fe - Iron	17	Ta - Tantalum		
9	Mg - Magnesium	18	Sn - Tin		

These standards are also available to order as singles or part sets.

The purity/composition for each of these materials is certified by the manufacture/supplier.

STEM Thin Foil Standards

X-ray Fluorescence Spectroscopic Standards

September 2017

X-ray Fluorescence Spectroscopic Standards

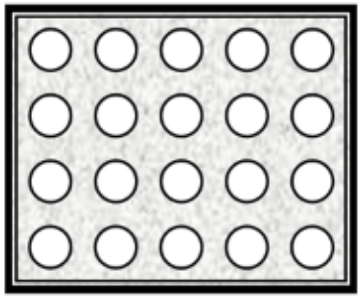
MAC's XRF Standards are available for 60 elements and can be purchased individually or as a set. For an up to date list , please refer to our Materials List Brochure or our website -

http://www.micro-analysis.com/standards/thin-films/thin-film-single.asp

These Standards are supplied as 1¼" diameter pressed pellets or where appropriate metals foils and are prepared from carefully selected elements and compounds to ensure interference free spectra. Each pellet is supported by a thin-walled aluminium cup which affords protection from damage during handling. The precious metal foils are approximately 0.125mm thick and are stretched across plastic supports.

MAC XRF standard sets are supplied in a specially designed storage/ transportation case that contains:

- The standards—protected again by another specially designed case
- A full electronic booklet on a USB, containing
  - The plan/layout
  - Certificates of analysis for each material
  - Details on storage and care for your standards
  - Certificate of final inspection
- A replaceable silica gel capsule for protection whilst in transit.
- A credit card sized quick refence guide.



XRF Standards Set (20) - Universal

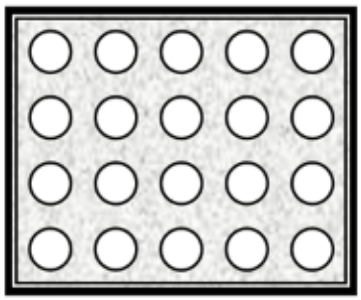
Available as:

XRFUNI

This Set of XRF Standards contains the following pellets:

No	Material	No	Material	No	Material
1	Aluminium Powder used: Al Binder used: 0%	8	Lead Powder used: Pb Binder used: 0%	15	Sodium Powder used: Na2CO3 Binder used: 0%
2	Barium Powder used: Ba(NO3)2 Binder used: 0%	9	Magnesium Powder used: Mg Binder used: 10%	16	Sulphur Powder used: S Binder used: 0%
3	Calcium Powder used: CaCO3	10	Manganese Powder used: Mn	17	Tin Powder used: Sn
4	Chlorine Powder used: NaCl Binder used: 0%	11	Nickel Powder used: Ni Binder used: 0%	18	Titanium Powder used: Ti Binder used: 0%
5	Chromium Powder used: Cr Binder used: 5%	12	Niobium Powder used: Nb2O3 Binder used: 10%	19	Tungsten Powder used: W Binder used: 10%
6	Copper Powder used: Cu	13	Phosphorus Powder used: CaHPO4	20	Zinc Powder used: Zn
7	Iron Powder used: Fe Binder used: 0%	14	Silicon Powder used: Si Binder used: 25%		

XRF Spectroscopic Standards



XRF Standards Set (20) - SET A

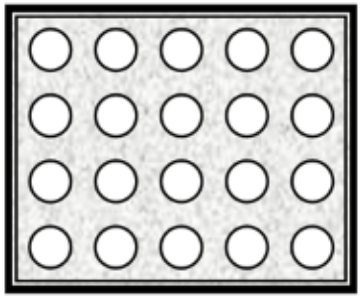
Available as:

XRFA

This Set of XRF Standards contains the following pellets:

No	Material	No	Material	No	Material
1	Aluminium Powder used: Al Binder used: 0%	8	Iron Powder used: Fe Binder used: 0%	15	Silicon Powder used: Si Binder used: 25%
2	Barium Powder used: Ba(NO3)2 Binder used: 0%	9	Lead Powder used: Pb Binder used: 0%	16	Sodium Powder used: Na2CO3 Binder used: 0%
3	Calcium Powder used: CaCO3 Binder used: 0%	10	Magnesium Powder used: Mg Binder used: 10%	17	Sulphur Powder used: S Binder used: 0%
4	Chlorine Powder used: NaCl Binder used: 0%	11	Manganese Powder used: Mn Binder used: 10%	18	Titanium Powder used: Ti Binder used: 0%
5	Chromium Powder used: Cr Binder used: 5%	12	Nickel Powder used: Ni Binder used: 0%	19	Vanadium Powder used: V2O5 Binder used: 10%
6	Cobalt Powder used: Co Binder used: 0%	13	Phosphorus Powder used: CaHPO4 Binder used: 10%	20	Zinc Powder used: Zn Binder used: 0%
7	Copper Powder used: Cu	14	Potassium Powder used: KHCO3		

XRF Spectroscopic Standards



XRF Standards Set (20) - SET B

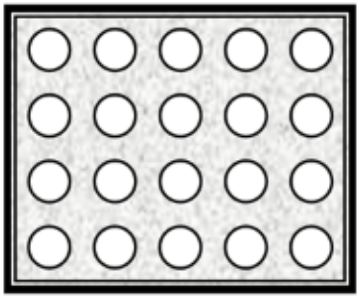
Available as:

XRFB

This Set of XRF Standards contains the following pellets:

No	Material	No	Material	No	Material
1	Antimony Powder used: Sb_2O_3	8	Iodine Powder used: CuI	15	Tantalum Powder used: Ta
2	Arsenic Powder used: As_2O_3 Binder used: 10%	9	Mercury Powder used: HgO Binder used: 0%	16	Tellurium Powder used: Te Binder used: 10%
3	Bismuth Powder used: Bi_2O_3 Binder used: 10%	10	Molybdenum Powder used: Mo Binder used: 5%	17	Tin Powder used: Sn Binder used: 0%
4	Bromine Powder used: NH_4Br Binder used: 5%	11	Niobium Powder used: Nb_2O_3 Binder used: 10%	18	Tungsten Powder used: W Binder used: 10%
5	Cadmium Powder used: CdO Binder used: 5%	12	Rubidium Powder used: $RbClO_4$ Binder used: 95%	19	Yttrium Powder used: Y_2O_3 Binder used: 10%
6	Caesium Powder used: $CsNO_3$ Binder used: 10%	13	Selenium Powder used: Se Binder used: 90%	20	Zirconium Powder used: ZrO_2 Binder used: 25%
7	Hafnium Powder used: HfO_2	14	Strontium Powder used: $Sr(NO_3)_2$		

XRF Spectroscopic Standards



XRF Standards Set (10) - Rare Earth

Available as:

XRFRE

This Set of XRF Standards contains the following pellets:

No	Material	No	Material	No	Material
1	Cerium Powder used: CeO2 Binder used: 95%	5	Holmium Powder used: Ho2O3 Binder used: 95%	9	Samarium Powder used: Sm2O3 Binder used: 95%
2	Dysprosium Powder used: Dy2O3 Binder used: 95%	6	Lanthanum Powder used: La2O3 Binder used: 95%	10	Ytterbium Powder used: Yb2O3 Binder used: 95%
3	Europium Powder used: Eu2O3 Binder used: 95%	7	Neodymium Powder used: Nd2O3 Binder used: 95%		
4	Gadolinium Powder used: Gd2O3	8	Praseodymium Powder used: Pr6O11		

XRF Standards - Single standards or multiples

Available as:

XRF

For an up to date list of available standards, please refer to our Materials List Brochure or our web-site - http://www.micro-analysis.com/standards/thin-films/thin-film-single.asp

XRF Spectroscopic Standards

Materials

September 2017

MAC's Materials

MAC only ever purchase materials from some of the world leading material manufacturers and suppliers.

Before any new material is accepted into stock and made available for embedding it goes through a series of vigorous checks:

Our material checks include:

- **A Visual Inspection**

  The material is checked to confirm that the form is as expected And all associated material documentation has been received.

- **Unmounted (loose) SEM Inspection (if needed)**

  The form and approximate composition of the material is checked prior to being processed to the next stage and the results recorded and kept on file.

- **Mounted SEM Inspection**

  A sample of the material is embedded, polished and if required

  Carbon coated. This embedded piece (our specimen standard) is a checked in the SEM with both the Secondary and Back scattered

  images recorded and saved on file. The material is then subjected to a full analysis using our own EDS equipment and the results stored on file and used as a reference for all future embeddings. These Reference standards are cleaned and re-polished every two years.

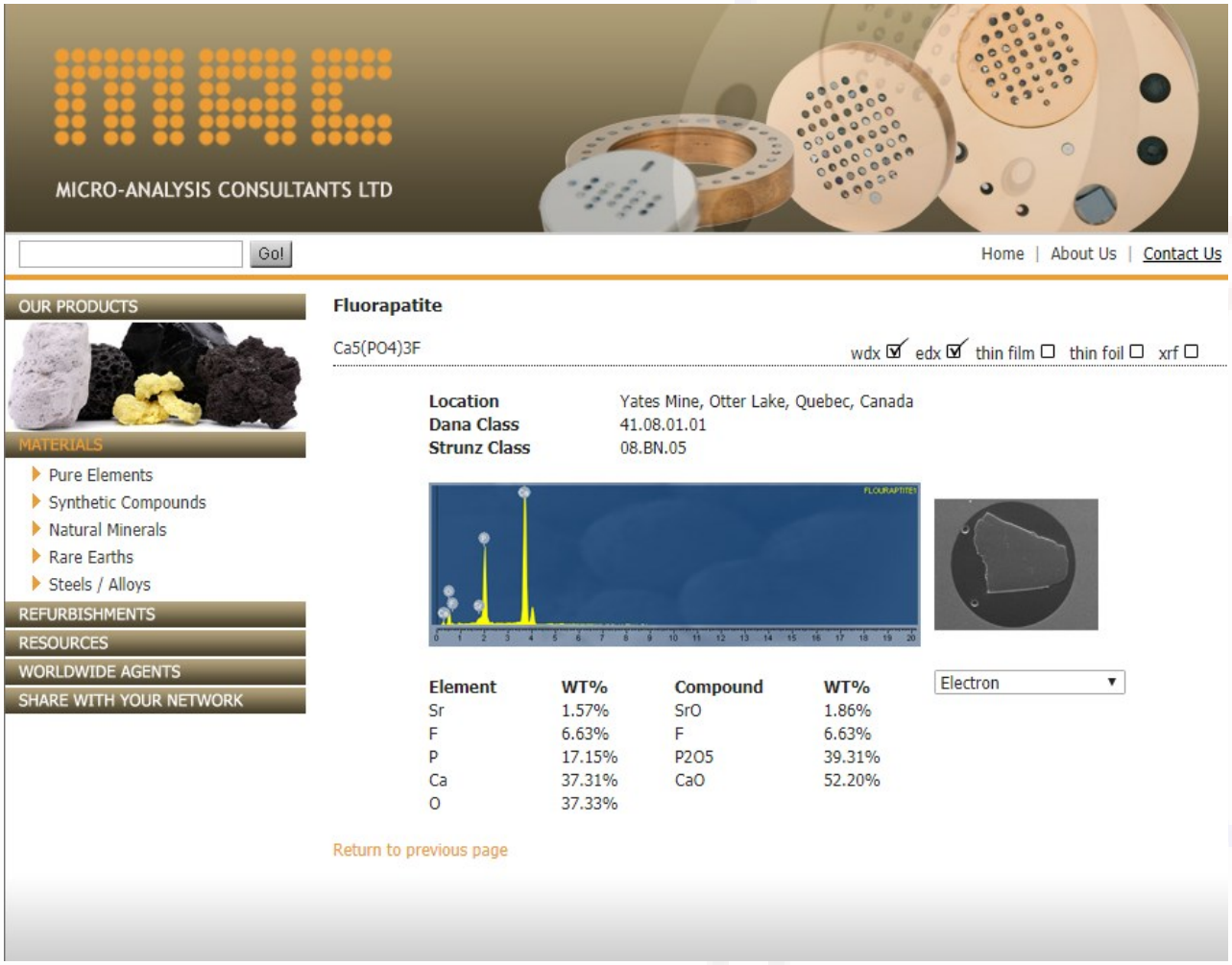
We keep a constantly evolving range of materials available from:

- High Purity Single Elements
- High Purity Synthetic Compounds
- Steels and Alloys, many of which are traceable to a national institution such as NIST
- Natural Minerals and Rocks

For an up to date list of the materials available, please refer to our website where you will find comprehensive information for each material available (see example on the next page)

Should we not be able to fulfil your requirements from our available Materials, we will do our best to find a source of enquire about having it custom made.

Example Material from our website



Materials

distributed by

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