

Reference Standards for UHV-EL Retainers

Abbreviations

M	Natural mineral
Opt	Optical crystal
P	Powder or grains: mixed with either Ag or Sn (for S containing materials) and pressed
TF	Thin film on silicon wafer
VD	Vapor deposit (CVD, LPCVD, etc.)
B	Bulk material
C	Crystalline
EM	End member mineral
F	Foil
HP	Hot pressed
Purity	"N" is the # of "9"'s. 5N stands for 99.999% pure, 2N5 is 99.5% pure
"+"	Higher purity
?	No certificate available. Most original containers with marked purity. With EDS analysis we see no additional elements (>0.1%)
*	These standards are very sensitive to humidity and should be kept in vacuum. We suggest using our Vacu-Storr™ Desiccators .

Element/Compound		Symbol	Form	Purity
1.	Aluminum	Al	F	4N
2.	Aluminum Fluoride	AlF3	P	2N5
3.	Aluminum Oxide	Al2O3	C	4N ?
4.	Aluminum Nitride	AlN	P	2N+
5.	Antimony	Sb	B	4N8
6.	Barium Fluoride	BaF2	C	2N
7.	Barium Sulfate	BaSO4	P	3N ?
8.	Barium Titanate	BaTi4O9	HP	2N5 ?
9.	Barium Titanate	BaTiO3	P	3N
10.	Beryllium (For Sale in U.S.A. Only)	Be	F	2N
11.	Bismuth (For Sale in U.S.A. Only)	Bi	B	6N ?
12.	Bismuth Oxide (NO EXPORT)	Bi2O3	P	2N5 ?
12A.	Bismuth Telluride (For Sale in U.S.A. Only)	Bi2Te3	B	5N
13.	Boron	B	B	2N5
14.	Boron Carbide	B4C	P	5N ?
15.	Boron Nitride	BN	B	4N
16.	Boron Phosphide	BP	P	3N
17.	Cadmium	Cd	F	4N7
17A.	Cadmium Sulfide	CdS	P	3N
17B.	Cadmium Telluride	CdTe	B	5N
18.	Calcium Carbonate	CaCO3	C	3N ?
19.	Calcium Fluoride	CaF2	C	3N
20.	Carbon (Pyrolytic)	C	CVD	3N ?
21.	Carbon (Diamond), same as #168 (additional cost)	C (cleaved ~1mm)	C	?
22.	Cerium Oxide	CeO2	P	2N1
23.	Cesium Iodide	CsI	O *	2N ?
23A.	Cesium Bromide	CsBr	P *	4N
24.	Chromium	Cr	P	4N6
24A.	Chromium Carbide	Cr3C2	P	2N8
25.	Chromium Nitride	Cr2N	P	2N5
26.	Chromium Oxide	Cr2O3	HP	5N
27.	Cobalt	Co	F	5N
28.	Cobalt Oxide	Co3O4	P	3N
29.	Cobalt Silicide	CoSi2	P	2N
29A.	Copper Sulfide	CoS	P	2N5

Element/Compound		Symbol	Form	Purity
77.	Molybdenum Carbide	Mo2C	F	3N5 ?
78.	Molybdenum Silicide	MoSi2	HP	3N
79.	Molybdenum Oxide	MoO3	P	2N5 ?
81.	Osmium	Os	P	4N5
81A.	Neodymium Fluoride	NdF3	F	3N
81C	Neodymium Oxide	Nd2O3	P	2N8
82.	Nickel	Ni	C	4N4
82A.	Nickel Aluminide	NiAl	F	2N5
83.	Nickel Oxide	NiO	F	3N5 ?
84.	Nickel Phosphide	Ni2P	P	3N
85.	Nickel Silicide	NiSi2	P	3N ?
86.	Niobium	Nb	P	3N7
87.	Niobium Carbide	NbC	P	2N5 ?
88.	Niobium Oxide	Nb2O5	HP	3N5 ?
88A.	Niobium Nitride	NbN	P	2N5
89.	Palladium	Pd	P	3N
90.	Platinum	Pt	F	3N
91.	Potassium Bromide	KBr	F	4N ?
92.	Potassium Chloride	KCl	C	3N5 ?
93.	Potassium Iodide	KI	C	3N ?
93A.	Praeseodymium Fluoride	PrF3	C	3N8
94.	Rhenium	Re	HP	3N7
94A.	Rhenium Oxide	ReO	F	3N ?
96.	Rhodium	Rh	W	2N8
97.	Rubidium Chloride	RbCl	F	3N ?
97A.	Rubidium Iodide	RbI	P	2N7
98.	Ruthenium	Ru	P	3N
99.	Samarium	Sm	P	3N
100.	Scandium	Sc	F	2N9
101.	Selenium	Se	C	3N
102.	Silicon	Si	C	5N
103.	Silicon Carbide	SiC	CVD	Opt ?
104.	Silicon Dioxide	SiO2	EM	2N5 ?
105.	1000Å SiO2/Si	SiO2	TF	3N5
106.	Silicon Nitride	Si3N4	HP	2N

30.	Copper	Cu	F	4N5
31.	Cupric Oxide	CuO	P	3N
32.	Cuprous Oxide	Cu2O	EM	3N
32A.	Copper Selenide	CuSe	B	2N5
33.	Copper Sulfide	CuS	M	3N
34.	Copper Sulfide	Cu2S	M	2N+?
35.	Dysprosium	Dy	F *	3N
36.	Erbium	Er	F *	3N ?
37.	Europium Oxide	Eu2O3	HP	3N
38.	Gadolinium	Gd	F *	3N ?
39.	Gallium Arsenide	GaAs	C	5N ?
40.	Gallium Nitride	GaN	P	3N
41.	Gallium Phosphide	GaP	P	2N5
42.	Gallium Antimonide	GaSb	P	2N5 ?
42A.	Gallium Selenide	GaSe	P	4N
42B.	Gallium Sulfide	Ga2S3	B	4N
43.	Germanium	Ge	B	2N
44.	Germanium Oxide	GeO	P	2N5
45.	Gold	Au	F	4N
46.	Hafnium	Hf	F	2N5 ?
46A.	Hafnium Boride	HfB2	P	4N7
47.	Hafnium Carbide	HfC	B	6N
47A.	Hafnium Nitride	HfN	P	2N5
47B.	Hafnium Oxide	HfO2	P	3N ?
48.	Holmium	Ho	B	3N
49.	Indium	In	F	4N
50.	Indium Arsenide	InAs	C	?
50A.	Indium Antimonide	InSb	P	3N ?
51.	Indium Phosphide	InP	C	5N ?
52.	Indium Tin Oxide 10% In, Inhomogenous	ITO	P	4N
52A.	Indium Selenide	In2Se3	P	4N
52B.	Indium Sulfide	In2S3	P	3N8
53.	Iridium	Ir	F	3N5
54.	Iron	Fe	P	4N
54A.	Iron Carbide	Fe3C	F	3N
56.	Iron Fluoride	FeF3	P	3N

107.	468Å Si3N4/Si	Si3N4	TF	2N5
108.	Silver	Ag	F	3N
109.	Silver Chloride	AgCl	C *	5N
109A.	Silver Oxide	Ag2O	P	3N ?
110.	Silver Sulfide	Ag2S	C	?
111.	Sodium Chloride	NaCl	C	2N5
112.	Sodium Fluoride	NaF	C	5N
113.	Strontium Fluoride	SrF2	P	3N
114.	Tantalum	Ta	F	3N5
115.	Tantalum Carbide	TaC	HP	3N ?
116.	Tantalum Nitride	TaN	P	4N8
117.	Tantalum Oxide	Ta2O5	P	1N8 ?
118.	1000Å Ta2O5/Ta	Ta2O5	TF	2N
120.	Tantalum Silicide	TaSi2	P	2N5
121.	Tellurium	Te	B	5N
122.	Terbium	Tb	F	3N
123.	Thallium Chloride	TlCl	P	3N ?
125.	Thulium	Tm	F	2N5
126.	Tin	Sn	F	5N
127.	Tin Oxide	SnO2	EM	2N5
127A.	Tin Sulfide	SnS	P	2N5
127B.	Tin Selenide	SnSe	P	5N
128.	Titanium	Ti	F	2N5
128A.	Titanium Al Carbide	Ti2AlC	P	2N ?
129.	Titanium Carbide	TiC	HP	2N5
130.	Titanium Diboride	TiB2	HP	2N5 ?
131.	Titanium Dioxide	TiO2	EM	2N5
132.	Titanium Nitride	TiN	P	4N5
132A.	Titanium Oxide	TiO	HP	3N
133.	Titanium Silicide	TiSi2	P	3N
134.	Tungsten	W	F	4N
135.	Tungsten Carbide	WC	HP	4N8
137.	Tungsten Oxide	WO3	P	2N+
138.	Tungsten Silicide	WSi2	P	2N5
139.	Tungsten Sulfide	WS2	P	2N8
140.	Vanadium	V	F	2N5

58.	Iron Oxide	FeO	P	3N ?
59.	Iron Oxide	Fe2O3	P	5N
60.	Iron Oxide	Fe3O4	EM	5N
61.	Iron Phosphide	FeP	EM	3N
62.	Iron Sulfide	FeS2	P	3N ?
63.	Lead	Pb	P	4N8
64.	Lead Oxide	PbO	F	2N8
64A.	Lead Telluride	PbTe	P	5N
65.	Lead Sulfide	PbS	P	Opt ?
66.	Lanthanum Hexaboride	LaB6	P	3N5 ?
66A.	Lanthanum Fluoride	LaF3	P	Opt
67.	Lutetium Fluoride	LuF3	P	3N
68.	Lithium Fluoride	LiF	P	4N
69.	Magnesium	Mg	C *	3N
70.	Magnesium Fluoride	MgF2	F	3N ?
71.	Magnesium Oxide	MgO	C	4N
72.	Manganese	Mn	B	3N
73.	Manganese Sulfide	MnS	B	2N5
74.	Manganese Oxide	MnO2	P	?
75.	Mercury Sulfide	HgS	P	4N5 ?
75A	Mercury Telluride	HgTe	C	5N
76.	Molybdenum	Mo	C	4N
76A.	Molybdenum Boride	MoB	P	2N

141.	Vanadium Carbide	VC	HP	4N ?
141A.	Vanadium Nitride	VN	HP	2N5 ?
142.	Vanadium Oxide	V2O5	P	4N ?
142A.	Ytterbium	Yb	F	3N
142B.	Ytterbium Oxide	YB2O3	P	3N
143.	Yttrium	Y	F *	3N
143A.	Yag	YAIO	C	?
144.	Yttrium Oxide	Y2O3	P	4N
145.	Zinc	Zn	F	3N8
146.	Zinc Oxide	ZnO	HP	3N
147.	Zinc Selenide	ZnSe	C	?
148.	Zinc Sulfide	ZnS	C	?
149.	Zirconium	Zr	F	3N5
150.	Zirconium Carbide	ZrC	HP	?
150A.	Zirconium Nitride	ZrN	P	2N5
151.	Zirconium Oxide (Mineral)	ZrO2	C	2N7 ?

Mineral			Formula (approximate)			Mineral			Formula (approximate)		
152.	Acanthite		Ag ₂ S			169A.	Diopside		CaMgSi ₂ O ₆		
153.	Albite		NaAlSi ₃ O ₈			170.	Dolomite		CaMg(CO ₃) ₂		
154.	Almandine		Fe ³⁺ ₂ Al ₂ (SiO ₄) ₃			170A.	Fayalite		Fe ²⁺ SiO ₄		
155.	Andradite		Ca ₃ Fe ²⁺ ₃ (SiO ₄) ₃			171.	Fluorapatite		Ca ₅ (PO ₄) ₃ F		
156.	Anorthite		CaAl ₂ Si ₂ O ₈			172.	Forsterite		Mg ₂ SiO ₄		
156A.	Augite		(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al) ₂ O ₆			173.	Hematite		Fe ₂ O ₃		
157.	Baddeleyite		ZrO ₂ (traces of Ti and Fe)			174.	Hornblende (Amphibole)		Ca ₂ (Mg,Fe ²⁺) ₄ Al(Si ₇ Al) ₂ O ₂₂ (OH,F) ₂		
157A.	Barite		BaSO ₄			175.	Kyanite		Al ₂ O ₃ .SiO ₂		
158.	Benitoite		BaTiSi ₃ O ₉			176.	Magnetite		Fe ₃ O ₄		
159.	Biotite (black mica)		K(Mg,Fe ²⁺) ₃ (Al,Fe ³⁺)Si ₃ O ₁₀ (OH,F) ₂			177.	Orthoclase		K ₂ O.Al ₂ O ₃ .6SiO ₂		
160.	Bytownite		(Na, Ca)Al(Al,Si)Si ₂ O ₈			177A.	Pyrope		Mg ₃ Al ₂ (SiO ₄) ₃		
161.	Calcium Carbonate		CaCO ₃			178.	Quartz		SiO ₂		
162.	Cassiterite		SnO ₂			179.	Rutile		TiO ₂		
163.	Chalcocite		Cu ₂ S			180.	Sodalite		Na ₄ (AlCl)Al ₂ (SiO ₄) ₃		
164.	Cinnabar		HgS			180A.	Spessartine		Mn ²⁺ ₃ Al ₂ (SiO ₄) ₃		
165.	Chrysoberyl		BeAl ₂ O ₄			181.	Spinel		MgAl ₂ O ₄		
166.	Covellite		CuS			181B.	Titanite		CaTiSiO ₅		
167.	Cuprite		Cu ₂ O			182.	Willemite (Troosite)		Zn ₂ SiO ₄		
168.	Diamond, same as #21 (additional cost)		C (cleaved ~1mm)			183.	Wollastonite		CaSiO ₃		

Note: electron probe compositions provided upon request or with standard. Some mineral standards have minor phases of other materials.

SRM# National Institute of Standards & Technology (formerly NBS) Please see note below regarding alloys.																					
Glasses		B2O3	Na2O	MgO	Al2O3	SiO2	Cl	K2O	CaO	TiO2	V2O5	Cr2O3	MnO2	Fe2O3	ZrO2	PbO	Bi2O3	BaO	ZnO	CoO	CuO
184.	612		14.0		2.0	72.0			12.0		+50 ppm of 51 other elements										
185.	93a	12.5	3.9		2.2	80.8	.06	.01	.01	.01				.028	.04						
186.	K252					40.0							5.0					35.0	10.0	5.0	5.0
187.	K229					30.0										70.0					
188.	K326	30.0	2.0	30.1		29.9			8.0												
189.	K309				15.0	40.0			15.0					15.0				15.0			

Ti Alloys		Fe	C	Mn	P	S	Si	Cu	Zn	Pb	Sn	Ni	Cr	V	Mo	Ti	As	W	Zr	Nb	Ta	Al	Co
190.	654b	.23					.045	.004			.023	.028	.025	4.31	.013	88.05			.008			6.34	
191.	1128	.134	.011								3.04		2.96	15.13		75.64						3.06	
Miscellaneous NIST Standards																							
192.	1104	.088			.005			61.33	35.31	2.77	.43	.07											
193.	1108	.044		.0025				64.9	34.4	0.06	.39	.033											
194.	1110	.033						84.5	15.2	0.03	.051	.053											
195.	1230	Bal	.044	.64	.023	.0007	.43	.14				2.42	14.8	.23	1.18	2.12						.24	.15
195A.	1243	.79	.024	.019	.003	.0018	.018	.007				58.78	19.20	.12	4.25	3.06			.053			1.23	12.46
195B.	1297	Bal	.066	7.11	.038	.0033	.397	.442				5.34	16.69	.08	.33								.13
196.	C2402	7.3	.01	.64	.007	.018	.85	.19				51.5	16.15	.22	17.1			4.29					1.5
196A.	2321	Solder : Sn 60% / Pb 40%																					
197.	SRM-482 5 wires in one 3mm ø mount. Cu:Au (20:80, 40:60, 60:40, 80:20) + pure Cu (additional cost)																						
197A.	SRM-481 6 wires in one 3mm ø mount. Ag:Au (pure Ag, pure Au, 20:80, 40:60, 60:40, 80:20) (additional cost)																						
197B.	871 Phosphor Bronze (CDA-521) (additional cost)																						
Steels		Fe	C	Mn	P	S	Si	Cu	Zn	Pb	Sn	Ni	Cr	V	Mo	Ti	As	W	Zr	Nb	Ta	Al	Co
198.	461	Bal	.15	.36	.053	.019	.047	.34		.003	.022	1.73	.13	.024	.3	.01	.028	.01	<.005	.011	.002	.005	.26
199.	462	Bal	.40	.94	.045	.019	.28	.20		.006	.066	.70	.74	.058	.08	.037	.046	.053	.063	.096	.036	.02	.10
200.	464	Bal	.54	1.32	.017	.021	.48	.094		.02	.043	.13	.078	.29	.029	.004	.018	.022	.01	.037	.069	.005	.02
201.	465	Bal	.037	.032	.008	.01	.029	.019		<.0005	.001	.026	.004	.002	.005	.20	.01	.001	.002	.001	.001	.19	.08
202.	466	Bal	.065	.11	.012	.009	.025	.033		.001	.005	.051	.011	.007	.011	.057	.014	.006	<.005	.005	.002	.01	.04
203.	467	Bal	.11	.23	.003	.009	.26	.067		.000	.1	.088	.036	.041	.021	.26	.14	.20	.094	.29	.23	.16	.07
204.	468	Bal	.26	.47	.023	.02	.075	.26		<.0005	.009	1.03	.54	.17	.20	.011	.008	.077	<.005	.006	.005	.04	.16
205.	661	Bal	.39	.66	.015	.015	.223	.042			.01	1.99	.69	.011	.19	.02	.017	.01	.009	.22	.02	.02	.03
206.	663	Bal	.57	1.50	.02	.005	.74	.09		.0022		.32	1.31	.31	.30	.05	.01	.04	.05	.049		.24	.05
207.	664	Bal	.87	.25	.01	.025	.066	.25		.024		.14	.06	.10	.49	.23	.05	.10	.069	.15	.11		.15
208.	665	Bal	.008	.0057	.002	.0059	.008	.0058				.041	.007	.0006	.005	.0006	.002						.01
209.	1761	Bal	1.03	.68	.043	.033	.19																
210.	1762	Bal	.034	2.03	.036	.03	.36																
211.	1763	Bal	.20	1.59	.012	.022	.65																
212.	1764	Bal	.59	1.22	.023	.012	.06																
213.	1765	Bal	.006	.14	.007	.004	.005																
214.	1766	Bal	.015	.06	.004	.002	.01																
215.	1767	Bal	.051	.02	.005	.009	.02																
216.	1768	Bal	.001	.014	.0013	.0003		.0006				.0014										.002	.002

Alloys- Certified by a group of laboratories, NIST traceable. Analysis provided with each alloy purchased. Nominal Compositions`see below

Stainless Steels + High Temp		Low Alloy + Specialty Alloys		Nickel/Cobalt		Copper/Brass/Bronze	
216B.	AISI 302	233.	C-4140	242.	Inco 600	249.	CDA 360
217.	AISI 303	234.	C-4340	243.	Inco 625	250.	CDA 510
218.	AISI 304	235.	C-8620	244.	Inco 718	251.	CDA 655
219.	AISI 316	236.	Tool Steel A-6	245.	Inco 800	252.	CDA 857
220.	AISI 321	237.	Tool Steel D-2	246.	Hastelloy C-22		
221.	AISI 410	238.	Tool Steel H-13	247.	Hastelloy C-276		
222.	AISI 440C	239.	Tool Steel M-2	248.	Hastelloy X		
223.	PH13-8MO	240.	2Cr-1Mo (36a)				
224.	15-5 PH	241.	9Cr-1Mo (38a)				
225.	17-4PH	241A.	50 NIL				
226.	CARP 20CB3	241B.	52100				
227.	Maraging 300	241C.	AISI 4820				
228.	HK-40	241D.	AISI 9310				

Miscellaneous Standards:

229.	BPSG (not an NIST standard), 4% P, 3.3% B.
230.	Al-Cu: NIST traceable standard for energy dispersive x-ray detector calibration (additional cost).
231.	C-Cu-Ag: Standard for electron backscattering adjustment. Used for gun shot residue calibration
232.	GSR- Gun shot residue: mixture of Ba, Sb, Pb particles in epoxy and carbon coated.

Faraday Cup, for beam current measurement, is available for all of the retainers and will take one of the spaces.

PLEASE READ CAREFULLY!

The metal alloys on this list cannot be assumed to be homogenous at the micrometer scale. If you intend to use ZAF corrections electron beam excited x-ray analysis (wavelength or energy dispersive), the sample volume must be homogenous within the electron excited volume. It is a misuse to use these metal alloys for bulk quantitative analyses. Nevertheless, they are useful for comparison purposes (in a least square sense) to compare against unknown materials. Every effort is made to insure that cutting, grinding, and polishing of the materials do not alter their composition.

Nominal Composition

Table 1: Nominal Composition of Stainless Steel

Nominal Composition in %													
Alloy	Fe	C	Mn	Si	Cr	Ni	Mo	Ti	Nb	Cu	Co	Al	Other
AISI 302	BAL	0.12	1.60	0.80	18	9	-	-	-	-	-	-	-
AISI 303	BAL	0.12	1.60	0.80	18	9	-	-					
AISI 304	BAL	0.06	1.60	0.80	19	10	-	-					
AISI 316	BAL	0.06	1.60	0.80	17	12	2.5	-					
AISI 321	BAL	0.06	1.60	0.80	18	10.5	-	0.5					
AISI 410	BAL	0.12	1.00	1.00	12.5	-	0.6						
AISI 440C	BAL	1.05	1.00	1.00	17	-							
PH13-8Mo	BAL	0.04	0.08	0.08	12.5	8	2.25					1.25	
15-5 PH	BAL	0.04	0.75	0.50	14.5	4.8	-			3.5	-	-	(Nb+TA 0.3)
17-4 PH	BAL	0.04	0.40	0.50	16.5	4.3	-	0.25	3.6	-	-	-	
CARP 20CB3	BAL	0.07	2.00	1.00	20	3.5	2.5	-	0.8	3.5	-	-	
MARAGING 300	BAL	0.30	0.10	0.10	-	18.5	4.4	0.65	0.8	-	8.75	0.10	
HK 40	BAL	0.40	1.25	1.50	25	21.5							

Table 2: Nominal Composition of Low Alloy and Specialty Alloys

[illegible]

Table 3: Nominal Composition of Nickel/Cobalt Alloys

Nominal Composition in %													
Alloy	Fe	C	Mn	Si	Cr	Ni	Mo	Ti	W	Cu	Co	Al	Other
INCO 600	8	0.15	1.00	0.50	15.5	72	-	-	-	6.5	-	-	
INCO 625	5	0.10	0.50	0.50	21.5	58	9	0.4			1	0.4	(Nb+Ta 3.6)
INCO 718	17	0.08	0.35	0.35	19	52.5	-	0.9		0.3	1	0.6	
INCO 800	BAL	0.08	1.2	0.8	21.5	32.5	-	0.4		0.6	-	0.4	(Nb+Ta 5.1)
HASTELLOY C-22	3.0	0.01	0.50	0.08	22	56	13	-	3		2.5		(V 0.35)
HASTELLOY C-276	5.5	0.01	1.0	0.08	15.5	57	16	-	4		2.5		(V 0.35)
HASTELLOY X	18.5	0.1	1.0	1.0	22	47	9	0.15	0.6	0.5	1.5	0.5	

Table 4: Nominal Composition of Copper/Brass/Bronze Alloys

Nominal Composition in %										
Alloy	Cu	Zn	Sn	Pb	Fe	Mn	Ni	Si	Be	
CDA 360	61.5	35.4	-	3	0.25	-	-	-	-	
CDA 510	BAL	0.2	5	-	-	-	-	-	-	
CDA 655	BAL	1.5	-	-	-	1	.6	3.3	-	
CDA 857	96.3	-	-	-	0.8	-	1.25	-	2.45	