

# Evaporation Guide for the Elements\*

## Vacuum Level, Crucible Temperature, Crucible Type, Effusion Cell Type, E-beam & Plasma Choices

H	<b>Evaporation Guide for the Elements*</b>															He	
Thermal Cracker, ECR or RF Plasma																	
Li (mp 180)	Be (mp 1287)	Element to be Vaporized												Cu (mp 1085° C)		mp = melting point in degrees Celsius	
Low Temp	Single Filament or High Temp	Recommended Effusion Cell or Evaporator System												Single Filament or High Temp			
Al <sub>2</sub> O <sub>3</sub> , PBN, (BeO)	VC, (BeO)	Recommended Crucibles												Al <sub>2</sub> O <sub>3</sub> , Mo, Ta, (BeO)			
10 <sup>-8</sup> 235	10 <sup>-8</sup> 707	vapor pressure												10 <sup>-8</sup> torr 722° C			
10 <sup>-6</sup> 306	10 <sup>-6</sup> 832	vapor pressure												10 <sup>-6</sup> torr 852° C			
10 <sup>-4</sup> 404	10 <sup>-4</sup> 997	vapor pressure												10 <sup>-4</sup> torr 1027° C			
Na (mp 98)	Mg (mp 650)	Explanation - Legend															
Low Temp	Low Temp	PBN = pyrolytic Boron Nitride.															
PBN, Quartz	Al <sub>2</sub> O <sub>3</sub> , PBN, VC	Low Temp = low temperature effusion cell															
10 <sup>-8</sup> 74	10 <sup>-8</sup> 185	High Temp = high temperature effusion cell															
10 <sup>-6</sup> 123	10 <sup>-6</sup> 246	E-beam = electron beam. Elements evaporated by E-beam do not use a crucible.															
10 <sup>-4</sup> 193	10 <sup>-4</sup> 327	Valved = valved effusion cell used for As, P, S, Se, and Te															
Gaseous elements, such as H, N, O, Cl and Ar are ionized using either an RF or ECR plasma. There are no settings for these materials.																	
K (mp 64)	Ca (mp 842)	Sc (mp 1541)	Ti (mp 1660)	V (mp 1910)	Cr (mp 1907)	Mn (mp 1246)	Fe (mp 1538)	Co (mp 1495)	Ni (mp 1455)	Cu (mp 1085)	Zn (mp 420)	Ga (mp 30)	Ge (mp 938)	As (mp 817)	Se (mp 221)	Br	Kr
Low Temp	Low Temp	High Temp or Dual Filament	E-beam or High Temp	E-beam or High Temp	High Temp	Single Filament or High Temp	E-beam or High Temp	High Temp	High Temp	Single Filament or High Temp	Low Temp	Dual or Single Filament	Dual or Single Filament	Valved Cracker or Low Temp	Valved Cracker or Low Temp		
Al <sub>2</sub> O <sub>3</sub> , PBN, Quartz	Al <sub>2</sub> O <sub>3</sub> , PBN, Quartz	Al <sub>2</sub> O <sub>3</sub> , (BeO)	TiC	Mo, W	VC	Al <sub>2</sub> O <sub>3</sub> , (BeO)	Al <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub> , (BeO)	Al <sub>2</sub> O <sub>3</sub> , VC, (BeO)	Al <sub>2</sub> O <sub>3</sub> , Mo, Ta, (BeO)	Al <sub>2</sub> O <sub>3</sub> , PBN, Quartz	Al <sub>2</sub> O <sub>3</sub> , PBN, Quartz, (BeO)	Al <sub>2</sub> O <sub>3</sub> , PBN, Quartz	PBN	PBN		
10 <sup>-8</sup> 21	10 <sup>-8</sup> 282	10 <sup>-8</sup> 772	10 <sup>-8</sup> 1067	10 <sup>-8</sup> 1162	10 <sup>-8</sup> 837	10 <sup>-8</sup> 505	10 <sup>-8</sup> 858	10 <sup>-8</sup> 922	10 <sup>-8</sup> 927	10 <sup>-8</sup> 722	10 <sup>-8</sup> 123	10 <sup>-8</sup> 619	10 <sup>-8</sup> 812	10 <sup>-8</sup> 104	10 <sup>-8</sup> 63		
10 <sup>-6</sup> 65	10 <sup>-6</sup> 357	10 <sup>-6</sup> 917	10 <sup>-6</sup> 1235	10 <sup>-6</sup> 1332	10 <sup>-6</sup> 977	10 <sup>-6</sup> 611	10 <sup>-6</sup> 998	10 <sup>-6</sup> 1067	10 <sup>-6</sup> 1072	10 <sup>-6</sup> 852	10 <sup>-6</sup> 177	10 <sup>-6</sup> 742	10 <sup>-6</sup> 947	10 <sup>-6</sup> 150	10 <sup>-6</sup> 107		
10 <sup>-4</sup> 123	10 <sup>-4</sup> 459	10 <sup>-4</sup> 1107	10 <sup>-4</sup> 1453	10 <sup>-4</sup> 1547	10 <sup>-4</sup> 1157	10 <sup>-4</sup> 747	10 <sup>-4</sup> 1180	10 <sup>-4</sup> 1257	10 <sup>-4</sup> 1262	10 <sup>-4</sup> 1027	10 <sup>-4</sup> 247	10 <sup>-4</sup> 907	10 <sup>-4</sup> 1137	10 <sup>-4</sup> 210	10 <sup>-4</sup> 164		
Rb (mp 38)	Sr (mp 777)	Y (mp 1526)	Zr (mp 1852)	Nb (mp 2468)	Mo (mp 2610)	Tc	Ru (mp 2310)	Rh (mp 1966)	Pd (mp 1555)	Ag (mp 962)	Cd (mp 321)	In (mp 157)	Sn (mp 232)	Sb (mp 631)	Te (mp 450)	I	Xe
Low Temp	Low Temp	High Temp	E-beam	E-beam	E-beam		E-beam	E-beam	High Temp	Single Filament or High Temp	Low Temp	Dual Filament	Dual or Single Filament	Valved Cracker or Low Temp	Valved Cracker		
	Mo, VC	Al <sub>2</sub> O <sub>3</sub>	---	---	---		---	---	Al <sub>2</sub> O <sub>3</sub> , (BeO)	Al <sub>2</sub> O <sub>3</sub> , Mo	Al <sub>2</sub> O <sub>3</sub> , Quartz, PBN	Al <sub>2</sub> O <sub>3</sub> , PBN	PBN	PBN	PBN		
	10 <sup>-8</sup> 241	10 <sup>-8</sup> 957	10 <sup>-8</sup> 1477	10 <sup>-8</sup> 927	10 <sup>-8</sup> 1592	Radioactive	10 <sup>-8</sup> 1780	10 <sup>-8</sup> 1277	10 <sup>-8</sup> 842	10 <sup>-8</sup> 574	10 <sup>-8</sup> 74	10 <sup>-8</sup> 488	10 <sup>-8</sup> 682	10 <sup>-8</sup> 279	10 <sup>-8</sup> 155		
	10 <sup>-6</sup> 309	10 <sup>-6</sup> 1117	10 <sup>-6</sup> 1702	10 <sup>-6</sup> 1072	10 <sup>-6</sup> 1822		10 <sup>-6</sup> 1990	10 <sup>-6</sup> 1472	10 <sup>-6</sup> 992	10 <sup>-6</sup> 685	10 <sup>-6</sup> 119	10 <sup>-6</sup> 597	10 <sup>-6</sup> 807	10 <sup>-6</sup> 345	10 <sup>-6</sup> 209		
	10 <sup>-4</sup> 404	10 <sup>-4</sup> 1332	10 <sup>-4</sup> 1987	10 <sup>-4</sup> 1262	10 <sup>-4</sup> 2117		10 <sup>-4</sup> 2260	10 <sup>-4</sup> 1707	10 <sup>-4</sup> 1192	10 <sup>-4</sup> 832	10 <sup>-4</sup> 177	10 <sup>-4</sup> 742	10 <sup>-4</sup> 997	10 <sup>-4</sup> 425	10 <sup>-4</sup> 280		
Cs (mp 29)	Ba (mp 727)	La (mp 920)	Hf (mp 2227)	Ta (mp 2996)	W (mp 3410)	Re (mp 3180)	Os	Ir (mp 2410)	Pt (mp 1768)	Au (mp 1064)	Hg (mp -39)	Tl (mp 304)	Pb (mp 328)	Bi (mp 271)	Po	At	Rn
Low Temp	Low Temp	High Temp	E-beam	E-beam	E-beam	E-beam		E-beam	High Temp	High Temp or Single Filament	Near Ambient	Low Temp	Low Temp or Single Filament	Low Temp			
Quartz, PBN	Ta, Mo	Al <sub>2</sub> O <sub>3</sub>	---	---	---	---		---	C, ThO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub> , PBN, VC	Al <sub>2</sub> O <sub>3</sub> , PBN, Quartz	Al <sub>2</sub> O <sub>3</sub> , Quartz	Al <sub>2</sub> O <sub>3</sub> , Mo, PBN, Ta, W	Al <sub>2</sub> O <sub>3</sub> , VC, (BeO)			
10 <sup>-8</sup> -16	10 <sup>-8</sup> 272	10 <sup>-8</sup> 990	10 <sup>-8</sup> 2160	10 <sup>-8</sup> 1960	10 <sup>-8</sup> 2117	10 <sup>-8</sup> 1928		10 <sup>-8</sup> 1850	10 <sup>-8</sup> 1292	10 <sup>-8</sup> 807	10 <sup>-8</sup> -72	10 <sup>-8</sup> 280	10 <sup>-8</sup> 342	10 <sup>-8</sup> 329	Radioactive	Radioactive	Radioactive
10 <sup>-6</sup> 22	10 <sup>-6</sup> 354	10 <sup>-6</sup> 1212	10 <sup>-6</sup> 2250	10 <sup>-6</sup> 2240	10 <sup>-6</sup> 2407	10 <sup>-6</sup> 2207		10 <sup>-6</sup> 2080	10 <sup>-6</sup> 1492	10 <sup>-6</sup> 947	10 <sup>-6</sup> -44	10 <sup>-6</sup> 360	10 <sup>-6</sup> 427	10 <sup>-6</sup> 409			
10 <sup>-4</sup> 80	10 <sup>-4</sup> 462	10 <sup>-4</sup> 1388	10 <sup>-4</sup> 3090	10 <sup>-4</sup> 2590	10 <sup>-4</sup> 2757	10 <sup>-4</sup> 2570		10 <sup>-4</sup> 2380	10 <sup>-4</sup> 1747	10 <sup>-4</sup> 1132	10 <sup>-4</sup> 7	10 <sup>-4</sup> 470	10 <sup>-4</sup> 497	10 <sup>-4</sup> 517			

Others	Source	Crucible
Methane	ECR Plasma	----
Bio-Materials	Single Filament	Al <sub>2</sub> O <sub>3</sub> , Mo, Ta
Polymers	Near Ambient	Al <sub>2</sub> O <sub>3</sub> , PBN
Thorium (mp 1845)	E-beam	Al <sub>2</sub> O <sub>3</sub> , PBN

Ce (mp 795)	Pr	Nd	Pm	Sm	Eu (mp 822)	Gd	Tb	Dy (mp 1412)	Ho	Er (mp 1529)	Tm	Yb (mp 824)	Lu (mp 1663)
High Temp					Low Temp or Dual Filament			High Temp		Dual or Single Filament		Low Temp	High Temp
Al <sub>2</sub> O <sub>3</sub> , VC, (BeO)					Al <sub>2</sub> O <sub>3</sub> , Mo, PBN, Ta			Ta		PBN, Ta, W		Ta	Al <sub>2</sub> O <sub>3</sub>
10 <sup>-8</sup> 970			Radioactive		10 <sup>-8</sup> 283			10 <sup>-8</sup> 625		10 <sup>-8</sup> 649		10 <sup>-8</sup> 247	10 <sup>-8</sup> 870
10 <sup>-6</sup> 1150				10 <sup>-6</sup> 361		10 <sup>-6</sup> 750		10 <sup>-6</sup> 777		10 <sup>-6</sup> 317	10 <sup>-6</sup> 1228		
10 <sup>-4</sup> 1380				10 <sup>-4</sup> 466		10 <sup>-4</sup> 900		10 <sup>-4</sup> 897		10 <sup>-4</sup> 417	10 <sup>-4</sup> 1376		

\* All values are based on the work of Edward Graper of the Lebow Corporation, Albrecht Fischer of VTS-CreaTec GmbH, Christian Bradley of Oxford Scientific and Dietrich von Diemar of Specs Scientific. © B. Vincent Crist, 2008  
 Some materials and their compounds are extremely toxic and must be handled with great care. Manufacturers safety, MSDS guidelines and handling instructions must be strictly followed each and every time it is used!  
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