

Vacuum Deposition Techniques and Tables

for thin film applications

The vacuum deposition techniques table lists the best suited methods, such as thermal evaporation, E-Beam evaporation or sputtering for a large number of materials. The list is sorted by material name. It also suggests the best thermal source, if applicable. The table also lists useful information such as melting point, density, and temperatures for given vapor pressures. This list is useful to determine the optimum vacuum deposition technique, thermal source, and power supply requirements.

* influenced by composition	G = good
** Cr-plated rod or strip	F = fair
***All metals alumina coated	P = poor
C = carbon	S = sublimes
Gr = graphite	D = decomposes
Q = quartz	RF = RF sputtering is effective
Incl = Inconel	RF-R = reactive
VC = vitreous carbon	RF sputter is effective
SS = stainless steel	DC = DC sputtering is effective
Ex = excellent	DC-R = reactive DC sputtering is effective

Material	Symbol	MP (°C)	S/D	g/cm ³	Temp.(°C) for Given Vap. Press. (Torr)			E-Beam	Evaporation Techniques				Sputter	Comments
					10 ⁻⁸	10 ⁻⁶	10 ⁻⁴		Thermal Sources					
									Boat	Coil	Basket	Crucible		
Aluminum	Al	660		2.70	677	821	1010	Ex	TiB ₂ ,W	W	W	TiB ₂ -BN, ZrB ₂ , BN	RF, DC	Alloys and wets. Stranded W is best.
Aluminum Antimonide	AlSb	1080		4.3	-	-	-	-	-	-	-	-	RF	-
Aluminum Arsenide	AlAs	1600		3.7	-	-	~ 1300	-	-	-	-	-	RF	-
Aluminum Bromide	AlBr ₃	97		2.64	-	-	~ 50	-	Mo	-	-	Gr	RF	-
Aluminum Carbide	Al ₄ C ₃	~1400	D	2.36	-	-	~ 800	F	-	-	-	-	RF	n = 2.7
Aluminum, 2% Copper	Al2%Cu	640		2.82	-	-	-	-	-	-	-	-	RF, DC	Wire feed and flash. Difficult from dual sources.
Aluminum Fluoride	AlF ₃	1291	S	2.88	410	490	700	P	Mo, W, Ta	-	-	Gr	RF	-
Aluminum Nitride	AlN	>2200	S	3.26	-	-	~1750	F	-	-	-	-	RF, RF-R	Decomposes. Reactive evap in 10 ⁻³ T N ₂ with glow discharge.
Aluminum Oxide	Al ₂ O ₃	2072		3.97	-	-	1550	Ex	W	-	W	-	RF-R	Sapphire excellent in E-beam; forms smooth, hard films. n = 1.66

Aluminum Phosphide	AlP	2000		2.42	-	-	-	2	-	-	-	-	RF	-
Aluminum, 2% Silicon	Al2%Si	640		2.69	-	-	1010	-	-	-	-	TiB ₂ -BN	RF, DC	Wire feed and flash. Difficult from dual sources.
Antimony	Sb	630	S	6.68	279	345	425	P	Mo,*** Ta***	Mo, Ta	Mo, Ta	BN, C, Al ₂ O ₃	RF, DC	Toxic. Evaporates well.
Antimony Oxide	Sb ₂ O ₃	656	S	5.2	-	-	~300	G	Pt	-	Pt	BN, Al ₂ O ₃	RF-R	Toxic. Decomposes on W. n = 2.09, 2.18, 2.35
Antimony Selenide	Sb ₂ Se ₃	611		-	-	-	-	-	Ta	-	-	C	RF	Stoichiometry variable.
Antimony Sulfide	Sb ₂ S ₃	550		4.64	-	-	~200	G	Mo, Ta	-	Mo, Ta	Al ₂ O ₃	-	No decomposition. n=3.19, 4.06, 4.3
Antimony Telluride	Sb ₂ Te ₃	629		6.50	-	-	600	-	-	-	-	C	RF	Decomposes over 750°C.
Arsenic	As	817	S	5.73	107	150	210	P	C	-	-	Al ₂ O ₃ , BeO, VC	-	Toxic. Sublimes rapidly at low temperature.
Arsenic Oxide	As ₂ O ₃	312		3.74	-	-	-	-	-	-	-	-	-	-
Arsenic Selenide	As ₂ Se ₃	~360		4.75	-	-	-	-	-	-	-	Al ₂ O ₃ , Q	RF	-
Arsenic Sulfide	As ₂ S ₃	300		3.43	-	-	~400	F	Mo	-	-	Al ₂ O ₃ , Q	RF	n = 2.4, 2.81, 3.02
Arsenic Telluride	As ₂ Te ₃	362		-	-	-	-	-	Flash	-	-	-	-	JVST. 1973;10:748.
Barium	Ba	725		3.51	545	627	735	F	W, Ta, Mo	W	W	Metals	RF	Wets without alloying reacts with ceramics.
Barium Chloride	BaCl ₂	963		3.92	-	-	~650	-	Ta, Mo	-	-	-	RF	Preheat gently to outgas. n = 1.73
Barium Fluoride	BaF ₂	1355	S	4.89	-	-	~700	G	Mo	-	-	-	RF	n = 1.47
Barium Oxide	BaO	1918		5.72	-	-	~1300	P	Pt	-	Pt	Al ₂ O ₃	RF, RF-R	Decomposes slightly. n = 1.98
Barium Sulfide	BaS	1200		4.25	-	-	1100	-	Mo	-	-	-	RF	n = 2.16
Barium Titanate	BaTiO ₃	-	D	6.02	-	-	-	-	-	-	-	-	RF	Gives Ba. Co-evap. from 2 sources or sputter. n = 2.40
Beryllium	Be	1278		1.85	710	878	1000	Ex	W, Ta	W	W	BeO, C, VC	RF, DC	Wets W/Mo/Ta. Powder and oxides toxic. Evaporates easily.
Beryllium Carbide	Be ₂ C	>2100	D	1.90	-	-	-	-	-	-	-	-	-	-
Beryllium Chloride	BeCl ₂	405		1.90	-	-	~150	-	-	-	-	-	RF	-
Beryllium Fluoride	BeF ₂	800	S	1.99	-	-	~200	G	-	-	-	-	-	Toxic. n = <1.33
Beryllium Oxide	BeO	2530		3.01	-	-	1900	G	-	-	W	-	RF, RF-R	Toxic. No decomposition from E-beam guns. n=1.72
Bismuth	Bi	271		9.80	330	410	520	Ex	W, Mo, Ta	W	W	Al ₂ O ₃ , VC	DC, RF	Toxic vapor. Resistivity high. No shorting of baskets.
Bismuth Fluoride	BiF ₃	727	S	5.32	-	-	~300	-	-	-	-	Gr	RF	n = 1.74
Bismuth Oxide	Bi ₂ O ₃	860		8.55	-	-	~1400	P	Pt	-	Pt	-	RF, RF-R	Toxic vapor. n = 1.91
Bismuth Selenide	Bi ₂ Se ₃	710	D	6.82	-	-	~650	G	-	-	-	Gr, Q	RF	Co-evaporate from two sources or sputter.
Bismuth Sulfide	Bi ₂ S ₃	685	D	7.39	-	-	-	-	-	-	-	-	RF	n = 1.34, 1.46
Bismuth Telluride	Bi ₂ Te ₃	573		7.7	-	-	~600	-	W, Mo	-	-	Gr, Q	RF	Co-evaporate from two sources or sputter.

Bismuth Titanate	Bi ₂ Ti ₂ O ₇	-	D	-	-	-	-	3	-	-	-	-	RF	Sputter or co-evaporate from two sources in 10 ⁻² Torr oxygen.
Boron	B	2300		2.34	1278	1548	1797	Ex	C	-	-	C, VC	RF	Explodes with rapid cooling. Forms carbide with container.
Boron Carbide	B ₄ C	2350		2.52	2500	2580	2650	Ex	-	-	-	-	RF	Similar to chromium.
Boron Nitride	BN	~3000	S	2.25	-	-	~1600	P	-	-	-	-	RF, RF-R	Decomposes under sputtering; reactive preferred.
Boron Oxide	B ₂ O ₃	~450		1.81	-	-	~1400	G	Pt, Mo	-	-	-	-	n = 1.48
Boron Sulfide	B ₂ S ₃	310		1.55	-	-	800	-	-	-	-	Gr	RF	-
Cadmium	Cd	321		8.64	64	120	180	P	W, Mo, Ta	-	W, Mo, Ta	Al ₂ O ₃ , Q	DC, RF	Bad for vacuum systems. Low sticking coefficient.
Cadmium Antimonide	Cd ₃ Sb ₂	456		6.92	-	-	-	-	-	-	-	-	-	-
Cadmium Arsenide	Cd ₃ As ₂	721		6.21	-	-	-	-	-	-	-	Q	RF	-
Cadmium Bromide	CdBr ₂	567		5.19	-	-	~300	-	-	-	-	-	-	-
Cadmium Chloride	CdCl ₂	568		4.05	-	-	~400	-	-	-	-	-	-	-
Cadmium Fluoride	CdF ₂	1100		6.64	-	-	~500	-	-	-	-	-	RF	n = 1.56
Cadmium Iodide	CdI ₂	387		5.67	-	-	~250	-	-	-	-	-	-	-
Cadmium Oxide	CdO	>1500	D	6.95	-	-	~530	-	-	-	-	-	RF-R	Disproportionates. n = 2.49
Cadmium Selenide	CdSe	>1350	S	5.81	-	-	540	G	Mo, Ta	-	-	Al ₂ O ₃ , Q	RF	Evaporates easily. n = 2.4
Cadmium Sulfide	CdS	1750	S	4.82	-	-	550	F	W, Mo, Ta	-	W	Al ₂ O ₃ , Q	RF	Sticking coefficient affected by substrate temperature. Stoichiometry variable. n = 2.51, 2.53
Cadmium Telluride	CdTe	1121		5.85	-	-	450	-	W, Mo, Ta	W	W, Ta, Mo	-	RF	Stoichiometry depends on substrate temperature. n~ 2.6
Calcium	Ca	839	S	1.54	272	357	459	P	W	W	W	Al ₂ O ₃ , Q	-	Corrodes in air.
Calcium Fluoride	CaF ₂	1423		3.18	-	-	~1100	-	W, Mo, Ta	W, Mo, Ta	W, Mo, Ta	Q	RF	Rate control important. Preheat gently to outgas. n = 1.43
Calcium Oxide	CaO	2614		~3.3	-	-	~1700	-	W, Mo	-	-	ZrO ₂	RF, RF-R	Forms volatile oxides with tungsten and molybdenum. n = 1.84
Calcium Silicate	CaSiO ₃	1540		2.91	-	-	-	G	-	-	-	Q	RF	n = 1.61, 1.66
Calcium Sulfide	CaS	-	D	2.5	-	-	1100	-	Mo	-	-	-	RF	Decomposes. n = 2.14
Calcium Titanate	CaTiO ₃	1975		4.10	1490	1600	1690	P	-	-	-	-	RF	Disproportionates except in sputtering. n = 2.34
Calcium Tungstate	CaWO ₄	-		6.06	-	-	-	G	W	-	-	-	RF	n = 1.92
Carbon	C	~3652	S	1.8-2.1	1657	1867	2137	Ex	-	-	-	-	RF	E-beam preferred. Arc evaporation. Poor film adhesion.
Cerium	Ce	798		~6.70	970	1150	1380	G	W, Ta	W	W, Ta	Al ₂ O ₃ , BeO, VC	DC, RF	-
Cerium	CeF ₃	1460		6.16	-	-	~900	G ₃	W, Mo,	-	Mo, Ta	-	RF	Preheat gently to

Fluoride								4	Ta					outgas. n ~ 1.7
Cerium (III) Oxide	Ce ₂ O ₃	1692		6.86	-	-	-	F	W	-	-	-	-	Alloys with source. Use 0.015"-0.020" tungsten boat. n = 1.95
Cerium (IV) Oxide	CeO ₂	~2600		7.13	1890	2000	2310	G	W	-	-	-	RF, RF-R	Very little decomposition.
Cesium	Cs	28		1.88	-16	22	80	-	SS	-	-	Q	-	-
Cesium Bromide	CsBr	636		3.04	-	-	~400	-	W	-	-	-	RF	n = 1.70
Cesium Chloride	CsCl	645		3.99	-	-	~500	-	W	-	-	-	RF	n = 1.64
Cesium Fluoride	CsF	682		4.12	-	-	~500	-	W	-	-	-	RF	n = 1.48
Cesium Hydroxide	CsOH	272		3.68	-	-	550	-	Pt	-	-	-	-	-
Cesium Iodide	CsI	626		4.51	-	-	~500	-	W	-	-	Pt, Q	RF	n = 1.79
Chiolote	Na ₅ Al ₃ F ₁₄	-		2.9	-	-	~800	-	Mo, W	-	-	-	RF	n = 1.33
Chromium	Cr	1857	S	7.20	837	977	1157	G	**	W	W	VC	RF, DC	Films very adherent. High rates possible.
Chromium Boride	CrB	2760(?)		6.17	-	-	-	-	-	-	-	-	RF, DC	-
Chromium Bromide	CrBr ₂	842		4.36	-	-	550	-	Incl	-	-	-	RF	-
Chromium Carbide	Cr ₃ C ₂	1980		6.68	-	-	~2000	F	W	-	-	-	RF, DC	-
Chromium Chloride	CrCl ₂	824		2.88	-	-	550	-	Fe, Incl	-	-	-	RF	-
Chromium Oxide	Cr ₂ O ₃	2266		5.21	-	-	~2000	G	W, Mo	-	W	-	RF, RF-R	Disproportionates to lower oxides; reoxidizes at 600°C in air. n = 2.55
Chromium Silicide	Cr ₃ Si ₂	-		5.5	-	-	-	-	-	-	-	-	RF, DC	-
Chromium-Silicon Monoxide	Cr-SiO	-	S	*	*	*	*	G	W	-	W	-	DC, RF	Flash.
Cobalt	Co	1495		8.9	850	990	1200	Ex	W, Nb	-	W	Al ₂ O ₃ , BeO	DC, RF	Alloys with refractory metals.
Cobalt Bromide	CoBr ₂	678	D	4.91	-	-	400	-	Incl	-	-	-	RF	-
Cobalt Chloride	CoCl ₂	724	D	3.36	-	-	472	-	Incl	-	-	-	RF	-
Cobalt Oxide	CoO	1795		6.45	-	-	-	-	-	-	-	-	DC-R, RF-R	Sputter preferred.
Copper	Cu	1083		8.92	727	857	1017	Ex	Mo	W	W	Al ₂ O ₃ , Mo, Ta	DC, RF	Adhesion poor. Use interlayer (Cr). Evaporates using any source material.
Copper Chloride	CuCl	430		4.14	-	-	~600	-	-	-	-	-	RF	n = 1.93
Copper Oxide	Cu ₂ O	1235	S	6.0	-	-	~600	G	Ta	-	-	Al ₂ O ₃	DC-R, RF-R	n = 2.71
Copper Sulfide	Cu ₂ S	1100		5.6	-	-	-	-	-	-	-	-	-	-
Cryolite	Na ₃ AlF ₆	1000		2.9	1020	1260	1480	Ex	W, Mo, Ta	-	W, Mo, Ta	VC	RF	Large chunks reduce spitting. Little decomposition.
Dysprosium	Dy	1412		8.55	625	750	900	G	Ta	-	-	-	RF, DC	-
Dysprosium Fluoride	DyF ₃	1360	S	-	-	-	~800	G	Ta	-	-	-	RF	-
Dysprosium Oxide	Dy ₂ O ₃	2340		7.81	-	-	~1400	-	Ir	-	-	-	RF, RF-R	Loses oxygen.
Erbium	Er	1529	S	9.07	650	775	930	G	W, Ta	-	-	-	DC, RF	-
Erbium	ErF ₃	1350		-	-	-	~750	4	Mo	-	-	-	RF	JVST.

Fluoride								5						1985;A3(6):2320.
Erbium Oxide	Er ₂ O ₃	Infus.		8.64	-	-	~1600	-	Ir	-	-	-	RF, RF-R	Loses oxygen.
Europium	Eu	822	S	5.24	280	360	480	F	W, Ta	-	-	Al ₂ O ₃	RF, DC	Low tantalum solubility.
Europium Fluoride	EuF ₂	1380		6.50	-	-	~950	-	Mo	-	-	-	RF	-
Europium Oxide	Eu ₂ O ₃	-		7.42	-	-	~1600	G	Ir, Ta, W	-	-	ThO ₂	RF, RF-R	Loses oxygen. Films clear and hard.
Europium Sulfide	EuS	-		5.75	-	-	-	G	-	-	-	-	RF	-

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RF = RF sputtering is effective
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Material	Symbol	MP (°C)	S/D	g/cm ³	Temp.(°C) for Given Vap. Press. (Torr)			Evaporation Techniques				Sputter	Comments	
					10 ⁻⁸	10 ⁻⁶	10 ⁻⁴	E-Beam	Thermal Sources					
									Boat	Coil	Basket			Crucible
Gadolinium	Gd	1313		7.90	760	900	1175	Ex	Ta	-	-	Al ₂ O ₃	RF, DC	High tantalum solubility.
Gadolinium Carbide	GdC ₂	-		-	-	-	1500	-	-	-	-	C	RF	Decomposes under sputtering.
Gadolinium Oxide	Gd ₂ O ₃	2330		7.41	-	-	-	F	Ir	-	-	-	RF, RF-R	Loses oxygen.
Gallium	Ga	30		5.90	619	742	907	G	-	-	-	Al ₂ O ₃ , BeO, Q	-	Alloys with refractory metals. Use E-beam gun.
Gallium Antimonide	GaSb	710		5.6	-	-	-	F	W, Ta	-	-	-	RF	Flash evaporate.
Gallium Arsenide	GaAs	1238		5.3	-	-	-	G	W, Ta	-	-	C	RF	Flash evaporate.
Gallium Nitride	GaN	800	S	6.1	-	-	~200	-	-	-	-	Al ₂ O ₃	RF, RF-R	Evaporates gallium in 10-3 Torr nitrogen.
Gallium Oxide	Ga ₂ O ₃	1900		6.44	-	-	-	-	Pr, W	-	-	-	RF	Loses oxygen. n = 1.92
Gallium Phosphide	GaP	1540		4.1	-	770	920	-	W, Ta	-	W	Q	RF	Does not decompose. Rate control important.
Germanium	Ge	937		5.35	812	957	1167	Ex	W, C, Ta	-	-	Q, Al ₂ O ₃	DC, RF	Excellent films from E-beam guns.
Germanium Nitride	Ge ₃ N ₂	450	S	5.2	-	-	~650	-	-	-	-	-	RF-R	Sputtering preferred.
Germanium (II) Oxide	GeO	710	S	-	-	-	500	-	-	-	-	Q	RF	n = 1.61
Germanium (III) Oxide	GeO ₂	1086		6.24	-	-	~625	G	Ta, Mo	-	W, Mo	Q, Al ₂ O ₃	RF-R	Similar to SiO ₂ ; film predominantly GeO.
Germanium Telluride	GeTe	725		6.20	-	-	381	-	W, Mo	-	W	Q, Al ₂ O ₃	RF	-
Glass, Schott 8329	-	-		2.20	-	-	-	Ex	-	-	-	-	RF	Evaporable alkali glass. Melt in air before evaporating.
Gold	Au	1064		19.32	807	947	1132	Ex	W	W	W*** Mo***	Al ₂ O ₃ , BN, VC, W	DC, RF	Films soft, not very adherent.
Hafnium	Hf	2227		13.31	2160	2250	3090	G	-	-	-	-	DC, RF	-
Hafnium Boride	HfB ₂	3250		10.5	-	-	-	-	-	-	-	-	DC, RF	-
Hafnium Carbide	HfC	~3890	S	12.20	-	-	~2600	-	-	-	-	-	DC, RF	-
Hafnium	HfN	3305		-	-	-	-	-	5	-	-	-	RF, RF-	-

Nitride								6					R	
Hafnium Oxide	HfO ₂	2758		9.68	-	-	~2500	F	W	-	-	-	DC, RF, RF-R	Film HfO.
Hafnium Silicide	HfSi ₂	1750		7.2	-	-	-	-	-	-	-	-	RF	-
Holmium	Ho	1474		8.80	650	770	950	G	W, Ta	W	W	-	-	-
Holmium Fluoride	HoF ₃	1143		-	-	-	~800	-	-	-	-	Q	DC, RF	-
Holmium Oxide	Ho ₂ O ₃	2370		8.41	-	-	-	-	Ir	-	-	-	RF, RF-R	Loses oxygen.
Inconel	Ni/Cr/Fe	1425		8.5	-	-	-	G	W	W	W	-	DC, RF	Use fine wire wrapped on tungsten. Low rate required for smooth films.
Indium	In	157		7.30	487	597	742	Ex	W, Mo	-	W	Gr, Al ₂ O ₃	DC, RF	Wets tungsten and copper. Use molybdenum liner.
Indium Antimonide	InSb	535		5.8	-	-	-	-	W	-	-	-	RF	Decomposes; sputter preferred; or co-evaporate
Indium Arsenide	InAs	943		5.7	780	870	970	-	W	-	-	-	RF	-
Indium Nitride	InN	1200		7.0	-	-	-	-	-	-	-	-	-	-
Indium (I) Oxide	In ₂ O	~600	S	6.99	-	-	650	-	-	-	-	-	RF	Decomposes under sputtering.
Indium (III) Oxide	In ₂ O ₃	850		7.18	-	-	~1200	G	W, Pt	-	-	Al ₂ O ₃	-	-
Indium Phosphide	InP	1070		4.8	-	630	730	-	W, Ta	-	W, Ta	Gr	RF	Deposits are phosphorus rich.
Indium Selenide	In ₂ Se ₃	890		5.67	-	-	-	-	-	-	-	-	RF	Sputtering preferred; or co-evaporate from two sources; flash.
Indium (I) Sulfide	In ₂ S	653		5.87	-	-	650	-	-	-	-	Gr	RF	-
Indium (II) Sulfide	InS	692	S	5.18	-	-	650	-	-	-	-	Gr	RF	-
Indium (III) Sulfide	In ₂ S ₃	1050	S	4.90	-	-	850	-	-	-	-	Gr	RF	Film In ₂ S.
Indium (II) Telluride	InTe	696		6.29	-	-	-	-	-	-	-	-	-	-
Indium (III) Telluride	In ₂ Te ₃	667		5.78	-	-	-	-	-	-	-	-	RF	Sputtering preferred; or co-evaporate from two sources; flash.
Indium Tin Oxide	In ₂ O ₃ -SnO ₂	1800	S	-	-	-	-	-	-	-	-	-	-	-
Iridium	Ir	2410		22.42	1850	2080	2380	F	-	-	-	ThO ₂	DC, RF	-
Iron	Fe	1535		7.86	858	998	1180	Ex	W	W	W	Al ₂ O ₃ , BeO	DC, RF	Attacks tungsten. Films hard, smooth. Preheat gently to outgas.
Iron Bromide	FeBr ₂	684	D	4.64	-	-	561	-	-	-	-	Fe	RF	-
Iron Chloride	FeCl ₂	670	S	3.16	-	-	300	-	-	-	-	Fe	RF	n = 1.57
Iron Iodide	FeI ₂	-		5.32	-	-	400	-	-	-	-	Fe	RF	-
Iron (II) Oxide	FeO	1369		5.7	-	-	-	P	-	-	-	-	RF, RF-R	Decomposes; sputtering preferred. n=2.32
Iron (III) Oxide	Fe ₂ O ₃	1565		5.24	-	-	-	G	W	-	W	-	-	Disproportionates to Fe ₃ O ₄ at 1530°C. n = 3.01
Iron Sulfide	FeS	1193	D	4.74	-	-	-	-	-	-	-	Al ₂ O ₃	RF	Decomposes.
Kanthal	FeCrAl	-		7.1	-	-	-	-	W	W	W	-	DC, RF	-
Lanthanum	La	921		6.15	990	1212	1388	Ex	W, Ta	-	-	Al ₂ O ₃	RF	Films will burn in air if scraped.
Lanthanum Boride	LaB ₆	2210	D	2.61	-	-	-	G	-	-	-	-	RF	-
Lanthanum Bromide	LaBr ₃	783		5.06	-	-	-	-	-	-	Ta	-	RF	n=1.94. Hygroscopic.

Lanthanum Fluoride	LaF ₃	1490	S	~6.0	-	-	900	G	Z Ta, Mo	-	Ta	-	RF	No decomposition. n ~1.6
Lanthanum Oxide	La ₂ O ₃	2307		6.51	-	-	1400	G	W, Ta	-	-	-	RF	Loses oxygen. n~1.73
Lead	Pb	328		11.34	342	427	497	Ex	W, Mo	W	W, Ta	Al ₂ O ₃ , Q	DC, RF	Toxic.
Lead Bromide	PbBr ₂	373		6.66	-	-	~300	-	-	-	-	-	-	-
Lead Chloride	PbCl ₂	501		5.85	-	-	~325	-	Pt	-	-	Al ₂ O ₃	RF	Little decomposition.
Lead Fluoride	PbF ₂	855	S	8.24	-	-	~400	-	W, Pt, Mo	-	-	BeO	RF	n = 1.75
Lead Iodide	PbI ₂	402		6.16	-	-	~500	-	Pt	-	-	Q	-	-
Lead Oxide	PbO	886		9.53	-	-	~550	-	Pt	-	-	Q, Al ₂ O ₃	RF-R	No decomposition. n ~2.6
Lead Selenide	PbSe	1065	S	8.10	-	-	~500	-	W, Mo	-	W	Gr, Al ₂ O ₃	RF	-
Lead Stannate	PbSnO ₃	1115		8.1	670	780	905	P	Pt	-	Pt	Al ₂ O ₃	RF	Disproportionates.
Lead Sulfide	PbS	1114	S	7.5	-	-	500	-	W	-	W, Mo	Q, Al ₂ O ₃	RF	Little decomposition. n = 3.92
Lead Telluride	PbTe	917		8.16	780	910	1050	-	Mo, Pt, Ta	-	-	Al ₂ O ₃ , Gr	RF	Vapors toxic. Deposits aretellurium rich. Sputtering preferred or co-evaporate from two sources.
Lead Titanate	PbTiO ₃	-		7.52	-	-	-	-	Ta	-	-	-	RF	-
Lithium	Li	181		0.53	227	307	407	G	Ta, SS	-	-	Al ₂ O ₃ , BeO	-	Metal reacts quickly in air.
Lithium Bromide	LiBr	550		3.46	-	-	~500	-	Ni	-	-	-	RF	n = 1.78
Lithium Chloride	LiCl	605		2.07	-	-	400	-	Ni	-	-	-	RF	Preheat gently to outgas. n = 1.66
Lithium Fluoride	LiF	845		2.64	875	1020	1180	G	Ni, Ta, Mo, W	-	-	Al ₂ O ₃	RF	Rate control important for optical films. Preheat gently to outgas. n = 1.39
Lithium Iodide	LiI	449		4.08	-	-	400	-	Mo, W	-	-	-	RF	n = 1.96
Lithium Oxide	Li ₂ O	>1700		2.01	-	-	850	-	Pt, Ir	-	-	-	RF	n = 1.64
Lutetium	Lu	1663		9.84	-	-	1300	Ex	Ta	-	-	Al ₂ O ₃	RF, DC	-
Lutetium Oxide	Lu ₂ O ₃	-		9.42	-	-	1400	-	Ir	-	-	-	RF	Decomposes.

* influenced by composition	G = good
** Cr-plated rod or strip	F = fair
***All metals alumina coated	P = poor
C = carbon	S = sublimes
Gr = graphite	D = decomposes
Q = quartz	RF = RF sputtering is effective
Incl = Inconel	RF-R = reactive
VC = vitreous carbon	RF sputter is effective
SS = stainless steel	DC = DC sputtering is effective
Ex = excellent	DC-R = reactive DC sputtering is effective

Material	Symbol	MP (°C)	S/D	g/cm ³	Temp.(°C) for Given Vap. Press. (Torr)			Evaporation Techniques				Sputter	Comments	
					10 ⁻⁸	10 ⁻⁶	10 ⁻⁴	E-Beam	Thermal Sources					
									Boat	Coil	Basket			Crucible
Magnesium	Mg	649	S	1.74	185	247	327	G	W, Mo, Ta, Cb	W	W	Al ₂ O ₃ , VC	DC, RF	Extremely high rates possible.
Magnesium Aluminate	MgAl ₂ O ₄	2135		3.6	-	-	-	G	-	-	-	-	RF	Natural spinel. n = 1.72
Magnesium	MgBr ₂	700		3.72	-	-	~450	7 -	Ni	-	-	-	RF	Decomposes.

Bromide								8						
Magnesium Chloride	MgCl ₂	714		2.32	-	-	400	-	Ni	-	-	-	RF	Decomposes. n = 1.67
Magnesium Fluoride	MgF ₂	1261		2.9-3.2	-	-	1000	Ex	Mo, Ta	-	-	Al ₂ O ₃	RF	Rate control and substrate heat important for optical films. Reacts with tungsten. Excellent with molybdenum. n = 1.38
Magnesium Iodide	MgI ₂	<637	D	4.43	-	-	200	-	Ir	-	-	-	RF	-
Magnesium Oxide	MgO	2852		3.58	-	-	1300	G	-	-	-	C, Al ₂ O ₃	RF, RF-R	Evaporates in 10 ⁻³ Torr oxygen for stoichiometry. Tungsten gives volatile oxides. n~1.7
Manganese	Mn	1244	S	7.20	507	572	647	G	W, Ta, Mo	W	W	Al ₂ O ₃ , BeO	DC, RF	-
Manganese Bromide	MnBr ₂	-	D	4.39	-	-	500	-	Incl	-	-	-	RF	-
Manganese Chloride	MnCl ₂	650		2.98	-	-	450	-	Incl	-	-	-	RF	-
Manganese (III) Oxide	Mn ₂ O ₃	1080		4.50	-	-	-	-	-	-	-	-	-	-
Manganese (IV) Oxide	MnO ₂	535		5.03	-	-	-	P	W	-	W	-	RF-R	Loses oxygen at 535°C.
Manganese Sulfide	MnS	-	D	3.99	-	-	1300	-	Mo	-	-	-	RF	Decomposes. n = 2.70
Mercury	Hg	-39		13.55	-68	-42	-6	-	-	-	-	-	-	-
Mercury Sulfide	HgS	584	S	8.10	-	-	250	-	-	-	-	Al ₂ O ₃	RF	Decomposes. n = 2.85, 3.20
Molybdenum	Mo	2610		10.2	1592	1822	2117	Ex	-	-	-	-	DC, RF	Films smooth, hard. Careful degas required.
Molybdenum Boride	MoB ₂	2100		7.12	-	-	-	P	-	-	-	-	RF, DC	-
Molybdenum Carbide	Mo ₂ C	2687		8.9	-	-	-	F	-	-	-	-	RF, DC	Evaporation of Mo(CO) ₆ yields Mo ₂ C.
Molybdenum Disulfide	MoS ₂	1185		4.80	-	-	~50	-	-	-	-	-	RF	-
Molybdenum Oxide	MoO ₃	795	S	4.69	-	-	~900	-	Mo, Pt	-	Mo	Al ₂ O ₃ , BN	RF	Slight oxygen loss. n = 1.9
Molybdenum Silicide	MoSi ₂	2050		6.31	-	-	-	-	W	-	-	-	RF	Decomposes.
Neodymium	Nd	1021		7.01	731	871	1062	Ex	Ta	-	-	Al ₂ O ₃	DC, RF	Low tantalum solubility.
Neodymium Fluoride	NdF ₃	1410		6.5	-	-	~900	G	Mo, W	-	Mo, Ta	Al ₂ O ₃	RF	Very little decomposition. n = 1.6
Neodymium Oxide	Nd ₂ O ₃	~1900		7.24	-	-	~1400	G	Ta, W	-	-	ThO ₂	RF, RF-R	Loses oxygen, films clear. E-beam preferred. n = 1.79
Nichrome IV	Ni/Cr	1395		8.50	847	987	1217	Ex	***	W	W, Ta	Al ₂ O ₃ , VC, BeO	DC, RF	Alloys with refractory metals.
Nickel	Ni	1455		8.90	927	1072	1262	Ex	W	W	W	Al ₂ O ₃ , BeO, VC	DC, RF	Alloys with refractory metals. Forms smooth adherent films.
Nickel Bromide	NiBr ₂	963	S	5.10	-	-	362	-	Incl	-	-	-	RF	-
Nickel Chloride	NiCl ₂	1001	S	3.55	-	-	444	-	Incl	-	-	-	RF	-
Nickel Oxide	NiO	1984		6.67	-	-	~1470	-	-	-	-	Al ₂ O ₃	RF-R	Dissociates on heating. n = 2.18
Niobium	Nb	2468		8.57	1728	1977	2287	Ex	W	-	-	-	DC, RF	Attacks tungsten

													9	source. n = 1.80	
Niobium Boride	NbB ₂	2900(?)		6.97	-	-	-	-	-	-	-	-	RF, DC	-	
Niobium Carbide	NbC	3500		7.6	-	-	-	F	-	-	-	-	RF, DC	-	
Niobium Nitride	NbN	2573		8.4	-	-	-	-	-	-	-	-	RF, RF-R	Reactive. Evaporates niobium in 10 ⁻³ Torr nitrogen.	
Niobium (II) Oxide	NbO	-		7.30	-	-	1100	-	Pt	-	-	-	RF	-	
Niobium (III) Oxide	Nb ₂ O ₃	1780		7.5	-	-	-	-	W	-	W	-	RF, DC, RF-R	-	
Niobium (V) Oxide	Nb ₂ O ₅	1485		4.47	-	-	-	-	W	-	W	-	RF, RF-R	n = 1.95	
Niobium Telluride	NbTe _x	-		7.6	-	-	-	-	-	-	-	-	RF	Composition variable.	
Niobium-Tin	Nb ₃ Sn	-		-	-	-	-	Ex	-	-	-	-	RF, DC	Co-evaporate from two sources.	
Osmium	Os	2700		22.48	2170	2430	2760	F	-	-	-	-	DC, RF	-	
Osmium Oxide	Os ₂ O ₃	-	D	-	-	-	-	-	-	-	-	-	-	Deposits osmium in 10 ⁻³ Torr oxygen.	
Palladium	Pd	1554	S	12.02	842	992	1192	Ex	W	W	W	Al ₂ O ₃ , BeO	DC, RF	Alloys with refractory metals. Rapid evaporation suggested.	
Palladium Oxide	PdO	870		9.70	-	-	575	-	-	-	-	Al ₂ O ₃	RF-R	Decomposes.	
Parylene	C ₈ H ₈	300-400		1.1	-	-	-	-	-	-	-	-	-	Vapor-depositable plastic.	
Permalloy	Ni/Fe	1395		8.7	947	1047	1307	G	W	-	-	Al ₂ O ₃ , VC	DC	F, Film low in nickel.	
Phosphorus	P	44.1		1.82	327	361	402	-	-	-	-	Al ₂ O ₃	-	Material reacts violently in air. n = 2.14	
Phosphorus Nitride	P ₃ N ₅	-		2.51	-	-	-	-	-	-	-	-	RF, RF-R	-	
Platinum	Pt	1772		21.45	1292	1492	1747	Ex	W	W	W	C, ThO ₂	DC, RF	Alloys with metals. Films soft, poor adhesion.	
Platinum Oxide	PtO ₂	450		10.2	-	-	-	-	-	-	-	-	RF-R	-	
Plutonium	Pu	641		19.84	-	-	-	-	W	-	-	-	-	Toxic, radioactive.	
Polonium	Po	254		9.4	117	170	244	-	-	-	-	Q	-	Radioactive.	
Potassium	K	63		0.86	23	60	125	-	Mo	-	-	Q	-	Metal reacts rapidly in air. Preheat gently to outgas.	
Potassium Bromide	KBr	734		2.75	-	-	~450	-	Ta, Mo	-	-	Q	RF	Preheat gently to outgas. n = 1.559	
Potassium Chloride	KCl	770	S	1.98	-	-	510	G	Ta, Ni	-	-	-	RF	Preheat gently to outgas. n = 1.49	
Potassium Fluoride	KF	858		2.48	-	-	~500	-	-	-	-	Q	RF	Preheat gently to outgas. n = 1.363	
Potassium Hydroxide	KOH	360		2.04	-	-	~400	-	Pt	-	-	-	-	Preheat gently to outgas.	
Potassium Iodide	KI	681		3.13	-	-	~500	-	Ta	-	-	-	RF	Preheat gently to outgas. n = 1.677	
Praseodymium	Pr	931		6.77	800	950	1150	G	Ta	-	-	-	RF, DC	-	
Praseodymium Oxide	Pr ₂ O ₃	-	D	7.07	-	-	1400	G	Ir	-	-	ThO ₂	RF, RF-R	Loses oxygen.	
Radium	Ra	700		5 (?)	246	320	416	-	-	-	-	-	-	-	
Rhenium	Re	3180		20.53	1928	2207	2571	P	-	-	-	-	DC, RF	Fine wire will self-evaporate.	
Rhenium Oxide	ReO ₃	-	D	~7	-	-	-	-	-	-	-	-	RF	Evaporate rhenium in 10 ⁻³ Torr	
Rhodium	Rh	1966		12.4	1277	1472	1707	G 9	W	W	W	ThO ₂ , VC	DC, RF	E-beam gun preferred.	

Rubidium	Rb	39		1.48	-3	37	111	10	-	-	-	-	Q	DC, RF	-
Rubidium Chloride	RbCl	718		2.09	-	-	~550	-	-	-	-	-	Q	RF	n = 1.493
Rubidium Iodide	RbI	647		3.55	-	-	~400	-	-	-	-	-	Q	RF	n = 1.647
Ruthenium	Ru	2310		12.3	1780	1990	2260	P	W	-	-	-	-	DC, RF	-

<p>* influenced by composition ** Cr-plated rod or strip ***All metals alumina coated C = carbon Gr = graphite Q = quartz Incl = Inconel VC = vitreous carbon SS = stainless steel Ex = excellent</p>	<p>G = good F = fair P = poor S = sublimes D = decomposes RF = RF sputtering is effective RF-R = reactive RF sputter is effective DC = DC sputtering is effective DC-R = reactive DC sputtering is effective</p>
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Material	Symbol	MP (°C)	S/D	g/cm ³	Temp.(°C) for Given Vap. Press. (Torr)			Evaporation Techniques				Sputter	Comments	
					10 ⁻⁸	10 ⁻⁶	10 ⁻⁴	E-Beam	Thermal Sources					
									Boat	Coil	Basket			Crucible
Samarium	Sm	1074		7.52	373	460	573	G	Ta	-	-	Al ₂ O ₃	RF, DC	-
Samarium Oxide	Sm ₂ O ₃	2350		8.35	-	-	-	G	Ir	-	-	ThO ₂	RF, RF-R	Loses oxygen. Films smooth, clear.
Samarium Sulfide	Sm ₂ S ₃	1900		5.73	-	-	-	G	-	-	-	-	-	-
Scandium	Sc	1541		2.99	714	837	1002	Ex	W	-	-	Al ₂ O ₃ , BeO	RF	Alloys with tantalum.
Scandium Oxide	Sc ₂ O ₃	2300		3.86	-	-	~400	F	-	-	-	-	RF, RF-R	-
Selenium	Se	217		4.81	89	125	170	G	W, Mo	W, Mo	W, Mo	Al ₂ O ₃ , VC	RF, DC	Toxic. Bad for vacuum systems.
Silicon	Si	1410		2.32	992	1147	1337	F	W, Ta	-	-	BeO, Ta, VC	DC, RF	Alloys with tungsten; use heavy tungsten boat. SiO produced above 4 x 10 ⁻⁶ Torr. E-beam best.
Silicon Boride	SiB ₆	-		-	-	-	-	P	-	-	-	-	RF	-
Silicon Carbide	SiC	~2700	S, D	3.22	-	-	1000	-	-	-	-	-	RF	Sputtering preferred. n = 2.654, 2.697
Silicon Nitride	Si ₃ N ₄	1900		3.44	-	-	~800	-	-	-	-	-	RF, RF-R	-
Silicon (II) Oxide	SiO	>1702	S	2.13	-	-	850	F	Ta	W	W	Ta	RF, RF-R	For resistance evaporation, use baffle box and low rate. n = 1.6
Silicon (IV) Oxide	SiO ₂	1610		~2.65	*	*	1025*	Ex	-	-	-	Al ₂ O ₃	RF	Quartz excellent in E-beam. n = 1.544, 1.553
Silicon Selenide	SiSe	-		-	-	-	550	-	-	-	-	Q	RF	-
Silicon Sulfide	SiS	940	S	1.85	-	-	450	-	-	-	-	Q	RF	n = 1.853
Silicon Telluride	SiTe ₂	-		4.39	-	-	550	-	-	-	-	Q	RF	-
Silver	Ag	962		10.5	847	958	1105	Ex	W	Mo	Ta, Mo	Al ₂ O ₃	W	DC, RF
Silver Bromide	AgBr	432	D	6.47	-	-	~380	-	Ta	-	-	Q	RF	n = 2.253
Silver Chloride	AgCl	455		5.56	-	-	~520	-	Mo, Pt	-	Mo	Q	RF	n = 2.07
Silver Iodide	AgI	558		6.01	-	-	~500	-	Ta	-	-	-	RF	n = 2.21
Sodium	Na	98		0.97	74	124	192	-	Ta, SS	-	-	Q	-	Preheat gently to outgas. Metal reacts quickly in air. n = 4.22
Sodium Bromide	NaBr	747		3.20	-	-	~400	-	-	-	-	Q	RF	Preheat gently to outgas. n = 1.641

Sodium Chloride	NaCl	801		2.17	-	-	530	11 G	Ta, W, Mo	-	-	Q	RF	Copper oven, little decomposition. Preheat gently to outgas. n = 1.544
Sodium Cyanide	NaCN	564		-	-	-	~550	-	Ag	-	-	-	RF	Preheat gently to outgas. n = 1.452
Sodium Fluoride	NaF	993		2.56	-	-	~1000	G	Mo, Ta, W	-	-	BeO	RF	Preheat gently to outgas. No decomposition. n = 1.336
Sodium Hydroxide	NaOH	318		2.13	-	-	~470	-	Pt	-	-	-	-	Preheat gently to outgas. n = 1.358
Spinel	MgO ₃ 5Al ₂ O ₃	-		8.0	-	-	-	G	-	-	-	-	RF	n = 1.72
Strontium	Sr	769		2.6	239	309	403	P	W, Ta, Mo	W	W	VC	RF, DC	Wets but does not alloy with refractory metals. May react in air.
Strontium Chloride	SrCl ₂	875		3.05	-	-	-	-	-	-	-	-	-	n = 1.650
Strontium Fluoride	SrF ₂	1473		4.24	-	-	~1000	-	-	-	-	Al ₂ O ₃	RF	n = 1.442
Strontium Oxide	SrO	2430	S	4.7	-	-	1500	-	Mo	-	-	Al ₂ O ₃	RF	Reacts with molybdenum and tungsten. n = 1.810
Strontium Sulfide	SrS	>2000		3.70	-	-	-	-	Mo	-	-	-	RF	Decomposes. n = 2.107
Sulfur	S ₈	113		2.07	13	19	57	P	W	-	W	Q	-	Bad for vacuum systems. n = 1.957
Supermalloy	Ni/Fe/Mo	1410		8.9	-	-	-	G	-	-	-	-	RF, DC	Sputtering preferred; or co-evaporate from two sources, permalloy and molybdenum.
Tantalum	Ta	2996		16.6	1960	2240	2590	Ex	-	-	-	-	DC, RF	Forms good films.
Tantalum Boride	TaB ₂	3000(?)		11.15	-	-	-	-	-	-	-	-	RF, DC	-
Tantalum Carbide	TaC	3880		13.9	-	-	~2500	-	-	-	-	-	RF, DC	-
Tantalum Nitride	TaN	3360		16.30	-	-	-	-	-	-	-	-	RF, RF-R, DC	Evaporates tantalum in 10 ⁻³ Torr nitrogen.
Tantalum Pentoxide	Ta ₂ O ₅	1872		8.2	1550	1780	1920	G	Ta	W	W	VC	RF, RF-R	Slight decomposition. Evaporates in 10 ⁻³ Torr oxygen. n = 2.6
Tantalum Sulfide	TaS ₂	>1300		-	-	-	-	-	-	-	-	-	RF	-
Technetium	Tc	2200		11.5	1570	1800	2090	-	-	-	-	-	-	-
PTFE	PTFE	330		2.9	-	-	-	-	W	-	-	-	RF	Baffled source. Film structure doubtful.
Tellurium	Te	452		6.25	157	207	277	P	W, Ta	W	W, Ta	Al ₂ O ₃ , Q	RF	Toxic. Wets without alloying. n = 1.002
Terbium	Tb	1356		8.23	800	950	1150	Ex	Ta	-	-	Al ₂ O ₃	RF	-
Terbium Fluoride	TbF ₃	1172		-	-	-	~800	-	-	-	-	-	RF	-
Terbium Oxide	Tb ₂ O ₃	2387		7.87	-	-	1300	-	Ir	-	-	-	RF	Partially decomposes.
Terbium Peroxide	Tb ₄ O ₇	-	D	-	-	-	-	-	Ta	-	-	-	RF	Films TbO.
Thallium	Tl	304		11.85	280	360	470	P	W, Ta	-	W	Al ₂ O ₃ , Q	DC	Very toxic. Wets freely.
Thallium Bromide	TlBr	480	S	7.56	-	-	~250	-	Ta	-	-	Q	RF	Toxic. n = 2.4 - 2.8
Thallium Chloride	TlCl	430	S	7.00	-	-	~150	-	Ta	-	-	Q	RF	n = 2.247
Thallium Iodide	TlI	440	S	7.1	-	-	~250	-	-	-	-	Q	RF	n = 2.78
Thallium Oxide	Tl ₂ O ₂	717		10.19	-	-	350	-	-	-	-	-	RF	Disproportionates at 850°C to Tl ₂ O.
Thorium	Th	1875		11.7	1430	1660	1925	Ex	W, Ta, Mo	W	W	-	-	Toxic, radioactive.
Thorium	ThBr ₄	610	S	5.67	-	-	-	1†	Mo	-	-	-	-	Toxic. n=2.47

Bromide								12						
Thorium Carbide	ThC ₂	2655		8.96	-	-	~2300	-	-	-	-	C	RF, DC	Radioactive.
Thorium Fluoride	ThF ₄	>900		6.32	-	-	~750	F	Mo	-	W	VC	RF	Radioactive.
Thorium Oxide	ThO ₂	3220		9.86	-	-	~2100	G	W	-	-	-	RF, RF-R	Radioactive.
Thorium Oxyfluoride	ThOF ₂	900		9.1	-	-	-	-	Mo, Ta	-	-	-	-	Radioactive. n = 1.52
Thorium Sulfide	ThS ₂	1925		7.30	-	-	-	-	-	-	-	-	RF	Sputtering preferred; or co-evaporate from two sources.
Thulium	Tm	1545	S	9.32	461	554	680	G	Ta	-	-	Al ₂ O ₃	DC	-
Thulium Oxide	Tm ₂ O ₃	-		8.90	-	-	1500	-	Ir	-	-	-	RF	Decomposes.
Tin	Sn	232		7.28	682	807	997	Ex	Mo	W	W	Al ₂ O ₃	DC, RF	Wets molybdenum. Use tantalum liner in E-beam guns.
Tin Oxide	SnO ₂	1630	S	6.95	-	-	~1000	Ex	W	W	W	Q, Al ₂ O ₃	RF, RF-R	Films from tungsten are oxygen deficient, oxidize in air. n = 2.0
Tin Selenide	SnSe	861		6.18	-	-	~400	G	-	-	-	Q	RF	-
Tin Sulfide	SnS	882		5.22	-	-	~450	-	-	-	-	Q	RF	-
Tin Telluride	SnTe	780	D	6.48	-	-	~450	-	-	-	-	Q	RF	-
Titanium	Ti	1660		4.5	1067	1235	1453	Ex	W	-	-	TiC	DC, RF	Alloys with refractory metals; evolves gas on first heating.
Titanium Boride	TiB ₂	2900		4.50	-	-	-	P	-	-	-	-	RF, DC	-
Titanium Carbide	TiC	3140		4.93	-	-	~2300	-	-	-	-	-	RF, DC	-
Titanium Nitride	TiN	2930		5.22	-	-	-	G	Mo	-	-	-	RF, RF-R, DC	Sputtering preferred. Decomposes with thermal evaporation.
Titanium (II) Oxide	TiO	1750		4.93	-	-	~1500	G	W, Mo	-	-	VC	RF	Preheat gently to outgas. n = 2.2
Titanium (III) Oxide	Ti ₂ O ₃	2130	D	4.6	-	-	-	G	W	-	-	-	RF	Decomposes.
Titanium (IV) Oxide	TiO ₂	1830		4.26	-	-	~1300	F	W, Mo	-	W	-	RF, RF-R	Suboxide, must be reoxidized to rutile. Tantalum reduces TiO ₂ to TiO and titanium. n = 2.616, 2.903
Tungsten	W	3410		19.35	2117	2407	2757	G	-	-	-	-	RF, DC	Forms volatile oxides. Films hard and adherent.
Tungsten Boride	WB ₂	~2900		10.77	-	-	-	P	-	-	-	-	RF	-
Tungsten Carbide	W ₂ C	2860		17.15	1480	1720	2120	Ex	C	-	-	-	RF, DC	-
Tungsten Disulfide	WS ₂	1250	D	7.5	-	-	-	-	-	-	-	-	RF	-
Tungsten Oxide	WO ₃	1473	S	7.16	-	-	980	G	W, Pt	-	-	-	RF-R	Preheat gently to outgas. Tungsten reduces oxide slightly. n = 1.68
Tungsten Selenide	WSe ₂	-		9.0	-	-	-	-	-	-	-	-	RF	-
Tungsten Silicide	WSi ₂	>900		9.4	-	-	-	-	-	-	-	-	RF, DC	-
Tungsten Telluride	WTe ₃	-		9.49	-	-	-	-	-	-	-	Q	RF	-
Uranium	U	1132		19.05	1132	1327	1582	G	Mo, W	W	W	-	-	Films oxidize.
Uranium Carbide	UC ₂	2350		11.28	-	-	2100	-	-	-	-	C	RF	Decomposes.
Uranium Fluoride	UF ₄	960		6.70	-	-	300	-	Ni	-	-	-	RF	-

Uranium (III) Oxide	U ₂ O ₃	1300	D	8.30	-	-	-	13	W	-	W	-	RF-R	Disproportionates at 1300°C to UO ₂ .
Uranium (IV) Oxide	UO ₂	2878		10.96	-	-	-	-	W	-	W	-	RF	Tantalum causes decomposition.
Uranium Phosphide	UP ₂	-		8.57	-	-	1200	-	Ta	-	-	-	RF	Decomposes.
Uranium (II) Sulfide	US	>2000		10.87	-	-	-	-	-	-	-	-	-	-
Uranium (IV) Sulfide	US ₂	>1100		7.96	-	-	-	-	W	-	-	-	RF	Slight decomposition.
Vanadium	V	1890		5.96	1162	1332	1547	Ex	W, Mo	-	-	-	DC, RF	Wets molybdenum. E-beam-evaporated films preferred. n = 3.03
Vanadium Boride	VB ₂	2400		5.10	-	-	-	-	-	-	-	-	RF, DC	-
Vanadium Carbide	VC	2810		5.77	-	-	~1800	-	-	-	-	-	RF, DC	-
Vanadium Nitride	VN	2320		6.13	-	-	-	-	-	-	-	-	RF, RF-R, DC	-
Vanadium (IV) Oxide	VO ₂	1967	S	4.34	-	-	~575	-	-	-	-	-	RF, RF-R	Sputtering preferred.
Vanadium (V) Oxide	V ₂ O ₅	690	D	3.36	-	-	~500	-	-	-	-	Q	RF	n = 1.46, 1.52, 1.76
Vanadium Silicide	VSi ₂	1700		4.42	-	-	-	-	-	-	-	-	RF	-
Ytterbium	Yb	819	S	6.96	520	590	690	G	Ta	-	-	-	DC, RF	-
Ytterbium Fluoride	YbF ₃	1157		-	-	-	~800	-	Mo	-	-	-	RF	-
Ytterbium Oxide	Yb ₂ O ₃	2346	S	9.17	-	-	~1500	-	Ir	-	-	-	RF, RF-R	Loses oxygen.
Yttrium	Y	1522		4.47	830	973	1157	Ex	W, Ta	W	W	Al ₂ O ₃	RF, DC	High tantalum solubility.
Yttrium Aluminum Oxide	Y ₃ Al ₅ O ₁₂	1990		-	-	-	-	G	-	W	W	-	RF	Films not ferroelectric.
Yttrium Fluoride	YF ₃	1387		4.01	-	-	-	-	-	-	-	-	RF	-
Yttrium Oxide	Y ₂ O ₃	2410		5.01	-	-	~2000	G	W	-	-	C	RF, RF-R	Loses oxygen, films smooth and clear. n = 1.79
Zinc	Zn	420		7.14	127	177	250	Ex	Mo, W, Ta	W	W	Al ₂ O ₃ , Q	DC, RF	Evaporates well under wide range of conditions.
Zinc Antimonide	Zn ₃ Sb ₂	570		6.33	-	-	-	-	-	-	-	-	RF	-
Zinc Bromide	ZnBr ₂	394		4.20	-	-	~300	-	W	-	-	C	RF	Decomposes. n = 1.545
Zinc Fluoride	ZnF ₂	872		4.95	-	-	~800	-	Pt, Ta	-	-	Q	RF	-
Zinc Nitride	Zn ₃ N ₂	-		6.22	-	-	-	-	Mo	-	-	-	RF	Decomposes.
Zinc Oxide	ZnO	1975		5.61	-	-	~1800	F	-	-	-	-	RF-R	n = 2.008, 2.029
Zinc Selenide	ZnSe	>1100		5.42	-	-	660	-	Ta, W, Mo	W, Mo	W, Mo	Q	RF	Preheat gently to outgas. Evaporates well. n = 2.89
Zinc Sulfide	ZnS	1700	S	3.98	-	-	~800	G	Ta, Mo	-	-	-	RF	Preheat gently to outgas. Films partially decompose. Sticking coefficient varies with substrate temperature. n = 2.356
Zinc Telluride	ZnTe	1239		6.34	-	-	~600	-	Mo, Ta	-	-	-	RF	Preheat gently to outgas. n = 3.56
Zirconium	Zr	1852		6.49	1477	1702	1987	Ex	W	-	-	-	RF, DC	Alloys with tungsten. Films oxidize readily.
Zirconium Boride	ZrB ₂	~3200		6.09	-	-	-	G	-	-	-	-	RF, DC	-
Zirconium Carbide	ZrC	3540		6.73	-	-	~2500	-	-	-	-	-	RF, DC	-
Zirconium								13					RF, RF-	Reactively evaporates in

Nitride	ZrN	2980		7.09	-	-	-	14	-	-	-	-	R, DC	10 ⁻³ Torr nitrogen.
Zirconium Oxide	ZrO ₂	~2700		5.89	-	-	~2200	G	W	-	-	-	RF, RF-R	Films oxygen deficient, clear and hard. n = 2.13, 2.19, 2.20
Zirconium Silicate	ZrSiO ₄	2550		4.56	-	-	-	-	-	-	-	-	RF	n = 1.92 - 1.96; 1.97 - 2.02
Zirconium Silicide	ZrSi ₂	1700		4.88	-	-	-	-	-	-	-	-	RF, DC	-

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