

Melting and Boiling Points of Halides

data source: www.webelements.com

Element	Halide	Melting Point (°C)	Boiling Point (°C)
Aluminum	AlF ₃	1290	1275
	AlCl ₃	192.6	180
	(AlBr ₃) ₂	97.5	255
Antimony	SbF ₃	290	345
	SbF ₅	8.3	141
	SbCl ₃	73.4	223
	SbCl ₅	4	140
	SbBr ₃	96	288
Chromium	CrF ₂	894	1300
	CrCl ₂	815	1120
	CrBr ₂	842	-
Germanium	GeF ₄	-15 (triple point)	-36.5
	GeCl ₄	-49.5	87
	GeBr ₄	26	186
Gold	AuF ₃	> 300	-
	AuCl	decomposes > 289	-
	(AuCl ₃) ₂	decomposes > 200	-
	AuBr	decomposes > 165	-
Hafnium	HfF ₄	>970	-
	HfCl ₄	432 (triple point)	-
	HfBr ₄	425	420
Indium	InF ₃	1170	> 1200
	InCl	211	608
	InCl ₃	583	-
	InBr	285	656
	InBr ₃	435	371
Molybdenum	MoF ₅	67	213
	MoF ₆	17.4	34
	MoCl ₄	170	-
	MoCl ₆	254	-
	MoBr ₃	977	-

Nickel	NiF ₂	1450	1000
	NiCl ₂	1001	993
	NiBr ₂	965	sublimes
Niobium	(NbF ₅) ₄	79	234
	NbCl ₅	205	254
	NbBr ₅	254	360
Palladium	PdF ₂	952	-
	PdCl ₂	decomposes 936	600
	PdBr ₂	250	-
Platinum	PtF ₄	600	-
	PtCl ₄	decomposes 370	-
	PtBr ₄	decomposes 250	-
Selenium	SeF ₄	-10	101
	(SeCl ₄) ₄	sublimes 305	196
	(SeBr ₄) ₄	decomposes 75	-
Silicon	SiF ₄	-90	-86
	SiCl ₄	-69	58
	SiBr ₄	5.4	154
Silver	AgF	435	1150
	AgCl	455	1550
	AgBr	434	1533
Strontium	SrF ₂	1477	2460
	SrCl ₂	874	1250
	SrBr ₂	657	2045
Tantalum	TaF ₅	97	229
	TaCl ₅	210	233
	TaBr ₅	280	345
Tellurium	TeF ₄	129	194
	TeF ₆	-38	-39
	TeCl ₂	208	328
	(TeCl ₄) ₄	223	390
	TeBr ₂	210	339
	(TeBr ₄) ₄	388	414

Tin	SnF ₂	213	850
	SnF ₄	-	705
	SnCl ₂	247	623
	SnCl ₄	-33	114
	SnBr ₂	216	620
	SnBr ₄	31	202
Titanium	TiF ₄	284	-
	TiCl ₄	-30	136.5
	TiBr ₄	38	234
Tungsten	WF ₆	2	19.5
	WCl ₆	275	337
	WBr ₅	286	333
	WBr ₆	309	sublimes 327
Zirconium	ZrF ₄	932 (triple point)	912
	ZrCl ₄	437 (25 atm, tr. point)	331
	ZrBr ₄	450	350

Use of thermal properties of halides in plasma etching:

The main etch gas should show the lowest possible melting and boiling points among the halides of the material to be etched. In order to achieve anisotrope etching, a sidewall passivation forming gas needs to be added. This could be a gas forming halides with high boiling and melting point temperatures or oxide and or nitride forming gases.