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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Group IUPAC: 5 VB</p> <p>Symbol: Ta</p> <p>Element Name: Tantalum</p> <p>Melting Point (°C): 3017 180.948</p> <p>Boiling Point (°C): 5458 16.654</p> <p>Atomic Number: 73</p> <p>Atomic Mass: 180.948</p> <p>Density (g/cm³): 16.654</p> </div> <div style="width: 45%;"> <p>Metals</p> <ul style="list-style-type: none"> ● Alkali Metals ● Alkaline-earth Metals ● Transition Metals ● Lanthanide Series ● Actinides Series ● Other Metals </div> <div style="width: 45%;"> <p>Nonmetals</p> <ul style="list-style-type: none"> ● Hydrogen ● Semiconductors ● Halogens ● Noble Gases ● Other Nonmetals </div> </div>																		<table border="1" style="width: 100%; text-align: center;"> <tr> <th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>18</th> </tr> <tr> <th>IIIA</th><th>IVA</th><th>VA</th><th>VIA</th><th>VIIA</th><th>VIIIA</th> </tr> <tr> <td>B 5</td><td>C 6</td><td>N 7</td><td>O 8</td><td>F 9</td><td>Ne 10</td> </tr> <tr> <td>Boron</td><td>Carbon</td><td>Nitrogen</td><td>Oxygen</td><td>Fluorine</td><td>Neon</td> </tr> <tr> <td>2075 4000</td><td>10.806 2.34</td><td>12.009 2.62</td><td>14.006 1.2506</td><td>18.998 1.429</td><td>20.180 0.901</td> </tr> <tr> <td>Al 13</td><td>Si 14</td><td>P 15</td><td>S 16</td><td>Cl 17</td><td>Ar 18</td> </tr> <tr> <td>Aluminum</td><td>Silicon</td><td>Phosphorus</td><td>Sulfur</td><td>Chlorine</td><td>Argon</td> </tr> <tr> <td>660.32 2519</td><td>28.084 2.329</td><td>30.974 1.82</td><td>32.059 2.07</td><td>35.446 3.214</td><td>39.948 1.784</td> </tr> <tr> <td>K 19</td><td>Ca 20</td><td>Sc 21</td><td>Ti 22</td><td>V 23</td><td>Cr 24</td><td>Mn 25</td><td>Fe 26</td><td>Co 27</td><td>Ni 28</td><td>Cu 29</td><td>Zn 30</td><td>Ga 31</td><td>Ge 32</td><td>As 33</td><td>Se 34</td><td>Br 35</td><td>Kr 36</td> </tr> <tr> <td>Potassium</td><td>Calcium</td><td>Scandium</td><td>Titanium</td><td>Vanadium</td><td>Chromium</td><td>Manganese</td><td>Iron</td><td>Cobalt</td><td>Nickel</td><td>Copper</td><td>Zinc</td><td>Gallium</td><td>Germanium</td><td>Arsenic</td><td>Selenium</td><td>Bromine</td><td>Krypton</td> </tr> <tr> <td>63.5 759</td><td>39.098 0.862</td><td>44.956 2.989</td><td>47.867 4.54</td><td>50.942 5.8</td><td>51.996 7.19</td><td>54.938 7.43</td><td>55.845 7.86</td><td>58.933 8.9</td><td>58.693 8.902</td><td>63.546 8.96</td><td>65.38 7.133</td><td>69.723 5.907</td><td>72.630 5.323</td><td>74.922 5.72</td><td>78.971 4.79</td><td>79.901 3.119</td><td>83.798 3.74</td> </tr> <tr> <td>Rb 37</td><td>Sr 38</td><td>Y 39</td><td>Zr 40</td><td>Nb 41</td><td>Mo 42</td><td>Tc 43</td><td>Ru 44</td><td>Rh 45</td><td>Pd 46</td><td>Ag 47</td><td>Cd 48</td><td>In 49</td><td>Sn 50</td><td>Sb 51</td><td>Te 52</td><td>I 53</td><td>Xe 54</td> </tr> <tr> <td>Rubidium</td><td>Strontium</td><td>Yttrium</td><td>Zirconium</td><td>Niobium</td><td>Molybdenum</td><td>Technetium</td><td>Ruthenium</td><td>Rhodium</td><td>Palladium</td><td>Silver</td><td>Cadmium</td><td>Indium</td><td>Tin</td><td>Antimony</td><td>Tellurium</td><td>Iodine</td><td>Xenon</td> </tr> <tr> <td>85.468 688</td><td>87.62 1.532</td><td>88.906 4.469</td><td>91.224 6.49</td><td>92.906 8.57</td><td>95.95 10.22</td><td>97 11.5</td><td>101.07 12.2</td><td>102.91 12.41</td><td>106.42 12.02</td><td>107.87 10.5</td><td>112.41 8.65</td><td>114.82 7.31</td><td>118.71 7.31</td><td>121.76 6.684</td><td>127.6 6.24</td><td>126.904 4.93</td><td>131.29 5.8971</td> </tr> <tr> <td>Cs 55</td><td>Ba 56</td><td>La 57</td><td>Hf 72</td><td>Ta 73</td><td>W 74</td><td>Re 75</td><td>Os 76</td><td>Ir 77</td><td>Pt 78</td><td>Au 79</td><td>Hg 80</td><td>Tl 81</td><td>Pb 82</td><td>Bi 83</td><td>Po 84</td><td>At 85</td><td>Rn 86</td> </tr> <tr> <td>Cesium</td><td>Barium</td><td>Lanthanum</td><td>Hafnium</td><td>Tantalum</td><td>Tungsten</td><td>Rhenium</td><td>Osmium</td><td>Iridium</td><td>Platinum</td><td>Gold</td><td>Mercury</td><td>Thallium</td><td>Lead</td><td>Bismuth</td><td>Polonium</td><td>Astatine</td><td>Radon</td> </tr> <tr> <td>132.91 671</td><td>137.33 3.51</td><td>138.91 6.7</td><td>178.49 13.2</td><td>180.95 16.654</td><td>183.84 19.3</td><td>186.21 21.02</td><td>190.23 22.4</td><td>192.22 22.5</td><td>195.08 21.45</td><td>196.97 19.32</td><td>200.59 13.456</td><td>204.38 11.85</td><td>207.2 11.34</td><td>208.98 9.8</td><td>209 9.4</td><td>210 340</td><td>222 -61.7</td> </tr> <tr> <td>Fr 87</td><td>Ra 88</td><td>Ac 89</td><td>Rf 104</td><td>Db 105</td><td>Sg 106</td><td>Bh 107</td><td>Hs 108</td><td>Mt 109</td><td>Ds 110</td><td>Rg 111</td><td>Cn 112</td><td>Nh 113</td><td>Fl 114</td><td>Mc 115</td><td>Lv 116</td><td>Ts 117</td><td>Og 118</td> </tr> <tr> <td>Francium</td><td>Radium</td><td>Actinium</td><td>Rutherfordium</td><td>Dubnium</td><td>Seaborgium</td><td>Bohrium</td><td>Hassium</td><td>Meitnerium</td><td>Darmstadtium</td><td>Roentgenium</td><td>Copernicium</td><td>Nihonium</td><td>Flerovium</td><td>Moscovium</td><td>Livermorium</td><td>Tennesine</td><td>Oganesson</td> </tr> <tr> <td>223.0 677</td><td>226.025 1140</td><td>227.0 10.07</td><td>267.12</td><td>270.13</td><td>271.13</td><td>270.13</td><td>270.13</td><td>278.16</td><td>281.17</td><td>281.17</td><td>285.18</td><td>286.18</td><td>289.19</td><td>290.20</td><td>293.20</td><td>293.21</td><td>294.21</td> </tr> <tr> <td>Ce 58</td><td>Pr 59</td><td>Nd 60</td><td>Pm 61</td><td>Sm 62</td><td>Eu 63</td><td>Gd 64</td><td>Tb 65</td><td>Dy 66</td><td>Ho 67</td><td>Er 68</td><td>Tm 69</td><td>Yb 70</td><td>Lu 71</td> </tr> <tr> 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36	Potassium	Calcium	Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc	Gallium	Germanium	Arsenic	Selenium	Bromine	Krypton	63.5 759	39.098 0.862	44.956 2.989	47.867 4.54	50.942 5.8	51.996 7.19	54.938 7.43	55.845 7.86	58.933 8.9	58.693 8.902	63.546 8.96	65.38 7.133	69.723 5.907	72.630 5.323	74.922 5.72	78.971 4.79	79.901 3.119	83.798 3.74	Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54	Rubidium	Strontium	Yttrium	Zirconium	Niobium	Molybdenum	Technetium	Ruthenium	Rhodium	Palladium	Silver	Cadmium	Indium	Tin	Antimony	Tellurium	Iodine	Xenon	85.468 688	87.62 1.532	88.906 4.469	91.224 6.49	92.906 8.57	95.95 10.22	97 11.5	101.07 12.2	102.91 12.41	106.42 12.02	107.87 10.5	112.41 8.65	114.82 7.31	118.71 7.31	121.76 6.684	127.6 6.24	126.904 4.93	131.29 5.8971	Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86	Cesium	Barium	Lanthanum	Hafnium	Tantalum	Tungsten	Rhenium	Osmium	Iridium	Platinum	Gold	Mercury	Thallium	Lead	Bismuth	Polonium	Astatine	Radon	132.91 671	137.33 3.51	138.91 6.7	178.49 13.2	180.95 16.654	183.84 19.3	186.21 21.02	190.23 22.4	192.22 22.5	195.08 21.45	196.97 19.32	200.59 13.456	204.38 11.85	207.2 11.34	208.98 9.8	209 9.4	210 340	222 -61.7	Fr 87	Ra 88	Ac 89	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111	Cn 112	Nh 113	Fl 114	Mc 115	Lv 116	Ts 117	Og 118	Francium	Radium	Actinium	Rutherfordium	Dubnium	Seaborgium	Bohrium	Hassium	Meitnerium	Darmstadtium	Roentgenium	Copernicium	Nihonium	Flerovium	Moscovium	Livermorium	Tennesine	Oganesson	223.0 677	226.025 1140	227.0 10.07	267.12	270.13	271.13	270.13	270.13	278.16	281.17	281.17	285.18	286.18	289.19	290.20	293.20	293.21	294.21	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71	Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium	140.12 3443	140.91 6.77	144.24 7.007	145.0 6.475	150.36 7.54	151.96 5.259	157.25 7.895	158.93 8.27	162.50 8.536	164.93 8.54	167.26 8.795	168.93 9.321	173.05 6.98	174.97 9.85	Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103	Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium	232.04 4788	231.04 -4000	238.03 4131	237.048 3900	244.0 3228	243 2011	247 3100	247 1050	251 860	252 860	257 1527	258 827	259 827	262 1627
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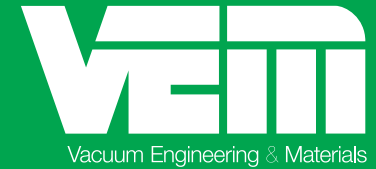
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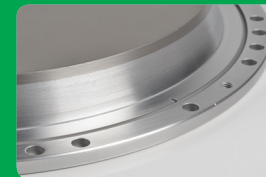
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VEM Quick Reference Thin Film Evaporation Guide

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Element	Symbol	Melting Point °C	Density (bulk, g/cm3)	Z-ratio	Temperature °C at Vapor Pressure (Torr)			Evaporation Method	Crucible Liner	Remarks
					10 ⁸	10 ⁶	10 ⁴			
Aluminum	Al	660	2.7	1.08	677	821	1010	ebeam (excellent)	TiB2-TiC, TiB2-BN, Si3N4-BN, BN	High deposition rates possible. Al wets IMCs.
Aluminum Oxide (Alumina)	Al2O3	2045	3.97	0.336	–	–	1550	ebeam (excellent)	W, graphite	Swept beam with low dep rates (< 3 Å/sec).
Chromium	Cr	1907	7.19	0.305	837	977	1157	ebeam (good)	W, graphite	Films are very adherent. High dep rates possible, but uniformity can be an issue.
					Sublimes					
Copper	Cu	1085	8.96	0.437	727	857	1017	ebeam (excellent)	Al2O3, Mo, Ta, graphite	Poor adhesion on most substrates. Use thin adhesion layer of Cr or Ti.
Germanium	Ge	938	5.32	0.516	812	957	1167	ebeam (excellent)	Al2O3, quartz, graphite, Ni	Uniform films achieved with slow power ramp and swept beam.
Gold	Au	1064	19.32	0.381	807	947	1132	ebeam (excellent)	W, Al2O3, graphite, BN	Metal spitting can be an issue. Mitigate by slow power ramp with swept beam and low carbon content in source material.
Indium	In	157	7.31	0.841	487	597	742	ebeam (excellent)	Mo, graphite, Al2O3	Wets Cu and W. Mo liner is preferred.
Iron	Fe	1538	7.86	0.349	858	998	1180	ebeam (excellent)	Al2O3, BeO, graphite	Molten Fe will attack and adhere to graphite, severely limiting crucible liner life.
Nickel	Ni	1455	8.91	0.331	927	1072	1262	ebeam (excellent)	Al2O3, BeO, W, graphite	Differential thermal expansion between Ni and graphite can cause graphite crucible liners to crack on cooling.
Palladium	Pd	1555	12.02	–	842	992	1192	ebeam (excellent)	W, Al2O3, graphite	Susceptible to metal spitting. Mitigate with slow power ramp and longer soak before deposition.
Platinum	Pt	1768	21.45	0.245	1292	1492	1747	ebeam (excellent)	W, Al2O3, graphite	Low dep rates (< 5 Å/sec) preferred for film uniformity. Carbon contamination with graphite liners is possible at high power.
Silicon	Si	1414	2.33	0.712	992	1147	1337	ebeam (fair)	Ta, graphite, BeO	High dep rates possible. Molten Si can attack graphite liners limiting crucible liner life.
Silicon Dioxide	SiO2	1610-1710	2.2-2.7	1	–	–	~1025	ebeam (excellent)	Al2O3, Ta, graphite, W	Swept beam is critical to avoid hole drilling, since the source material will have a shallow melt pool.
					influenced by composition					
Silver	Ag	962	10.49	0.529	847	958	1105	ebeam (excellent)	W, Al2O3, Ta, Mo, graphite	Swept beam during melt and focused beam during deposition is recommended for higher dep rates.
Tantalum	Ta	3017	16.6	–	1960	2240	2590	ebeam (excellent)	graphite	High melting point of Ta limits crucible liner selection. High vacuum is required to mitigate oxygen incorporation in films.
Tantalum Pentoxide	Ta2O5	1800	8.74	–	1550	1780	1920	ebeam (good)	graphite, Ta	Swept beam to avoid hole drilling. A thin Ti layer will improve adhesion to the substrate.
Tin	Sn	232	7.75	0.724	682	807	997	ebeam (excellent)	Al2O3, Ta, graphite, W	High dep rates possible, but uniformity may suffer. Slow power ramp to mitigate cavitation of melt pool.
Titanium	Ti	1660	4.5	0.628	1067	1235	1453	ebeam (excellent)	W, graphite, TiC	Films are very adherent to almost any substrate.
Yttrium	Y	1522	4.48	–	830	973	1157	ebeam (excellent)	W, Al2O3	
Zinc	Zn	419	7.14	0.514	127	177	250	ebeam (excellent)	W, Al2O3, quartz, graphite	Evaporates well under a wide range of conditions.



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