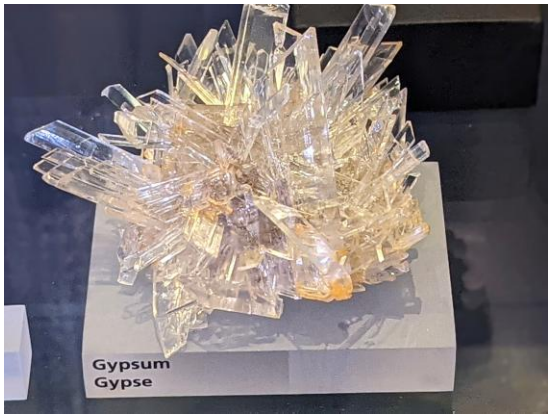
Crystallography
PHY312

Insulators (high bandgap)

Rocksalt

E_g = 3.1 eV



Gypsum

E_g = 5-7 eV

Diamond

E_g = 5.47 eV

Calcite

E_g = 6 eV

Magnesite

E_g = 5.4 eV

Insulators (lower bandgap)

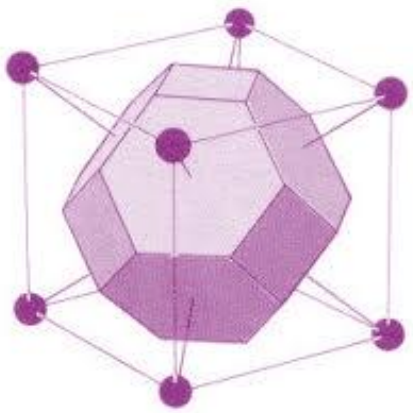
E_g = 2.3 eV

Metals

Semiconductors

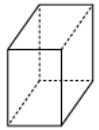
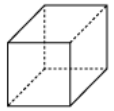
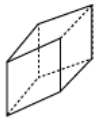
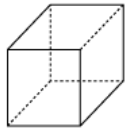
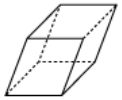
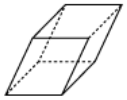
GaP, 2.26 eV

Silicon, 1.1 eV

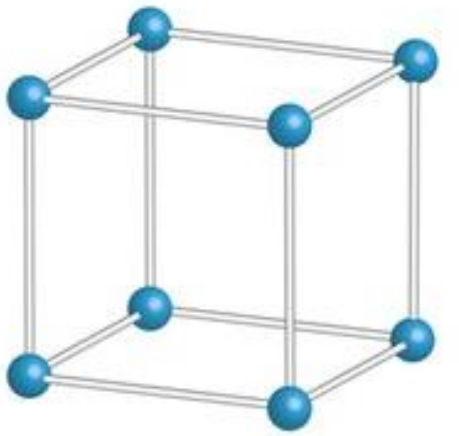


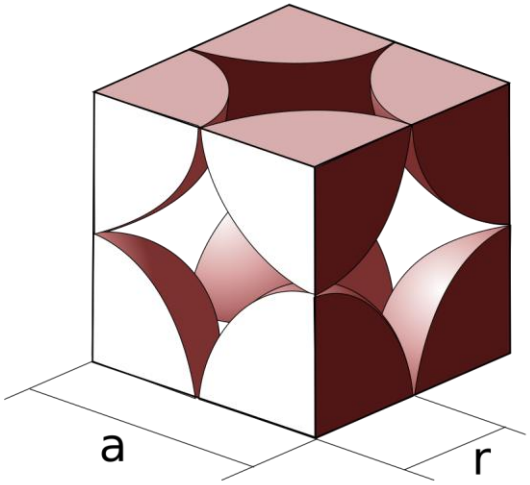
Wigner seitz cell (3D)

Crystal System Table

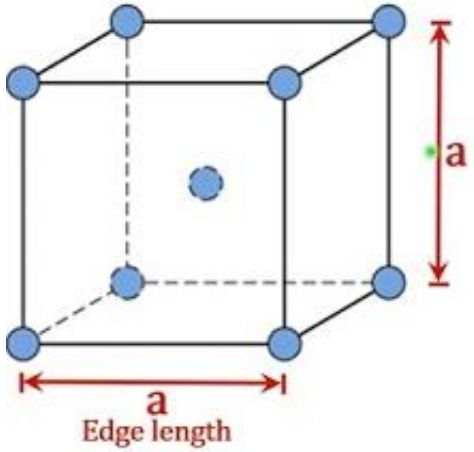
System	Axial length	Axial Angle	Unit Cell Geometry
Cubic	a = b = c	$\alpha = \beta = \gamma = 90^o$	
Tetragonal	a = b ≠ c	$\alpha = \beta = \gamma = 90^o$	
Orthorhombic	a ≠ b ≠ c	$\alpha = \beta = \gamma = 90^o$	
Rhombohedral	a = b = c	$\alpha = \beta = \gamma \neq 90^o$	
Hexagonal	a = b ≠ c	$\alpha = \beta = 90^o$, $\gamma = 120^o$	
Monoclinic	a ≠ b ≠ c	$\alpha = \gamma = 90^o$, $\beta \neq 90^o$	
Triclinic	a ≠ b ≠ c	$\alpha \neq \beta \neq \gamma$	

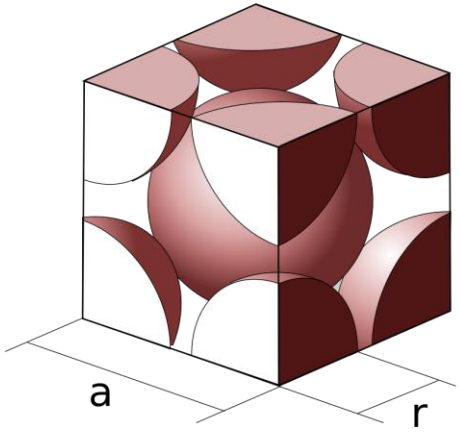
Simple cubic



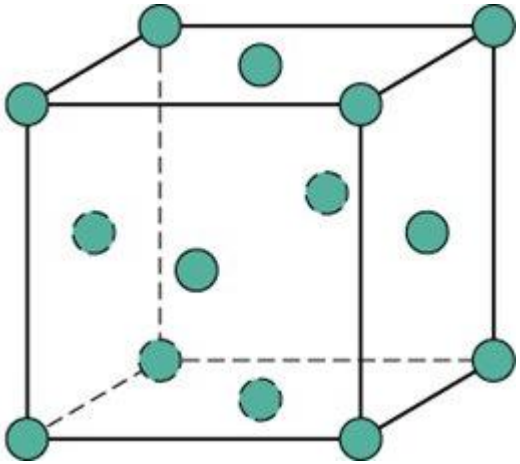


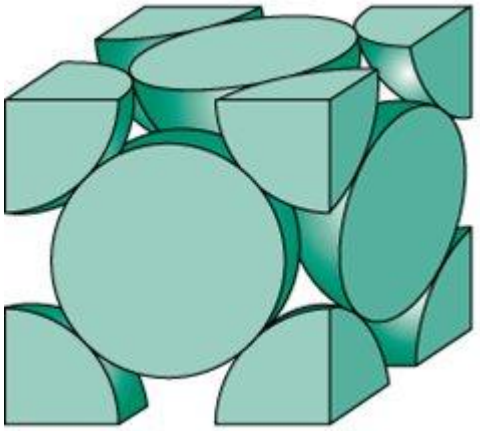
Body centered cubic



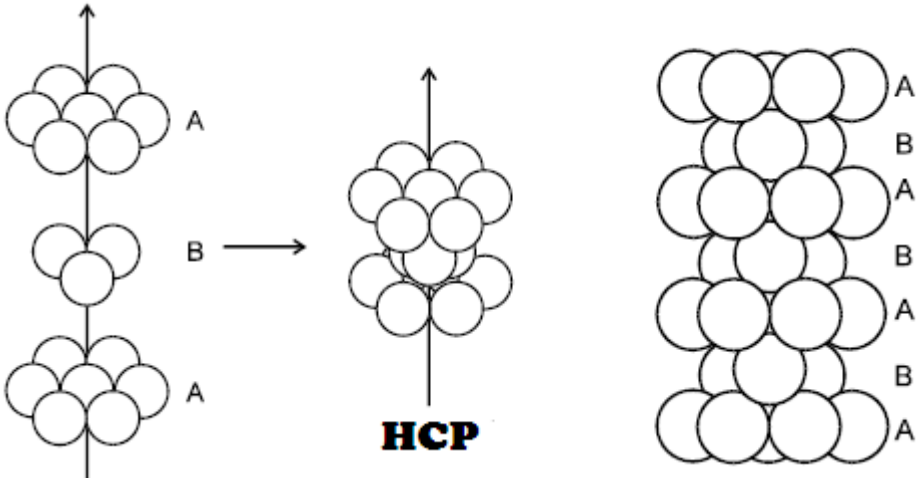


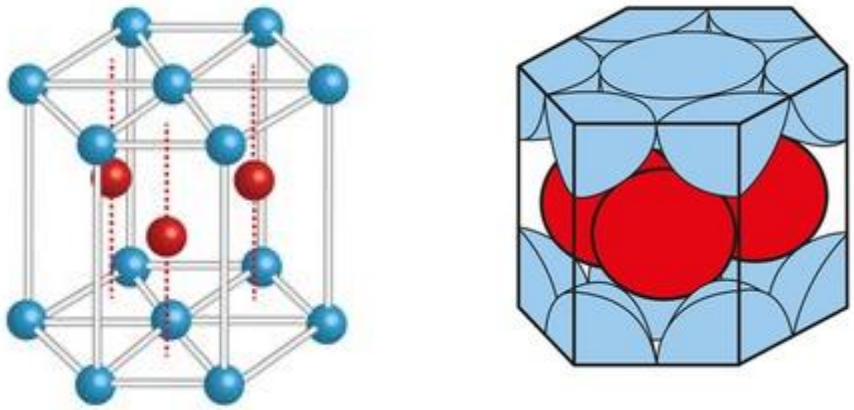
Face centered cubic



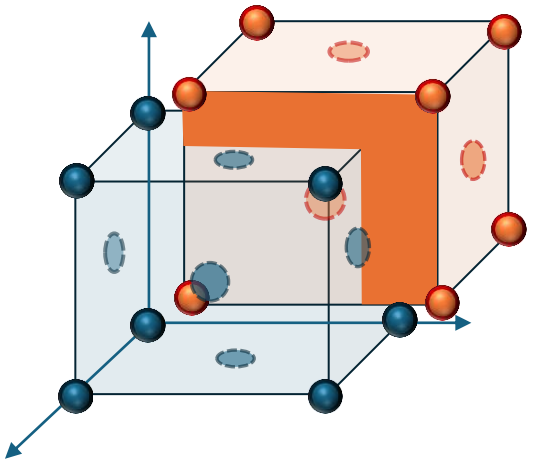


Hexagonal closed pack structure





Interpenetrating FCC structure



B sub-lattice

A sub-lattice

Co-ordinates

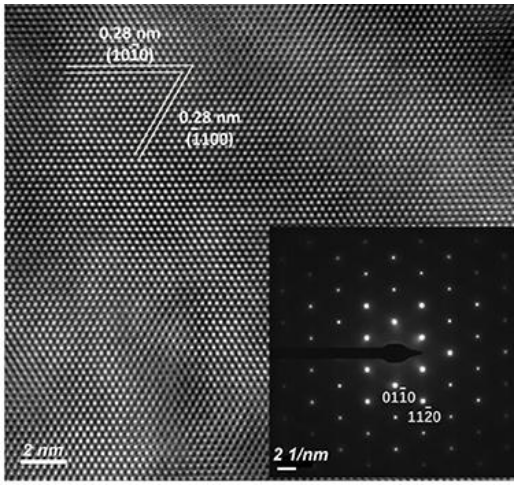
A-sublattice (0 0 0)

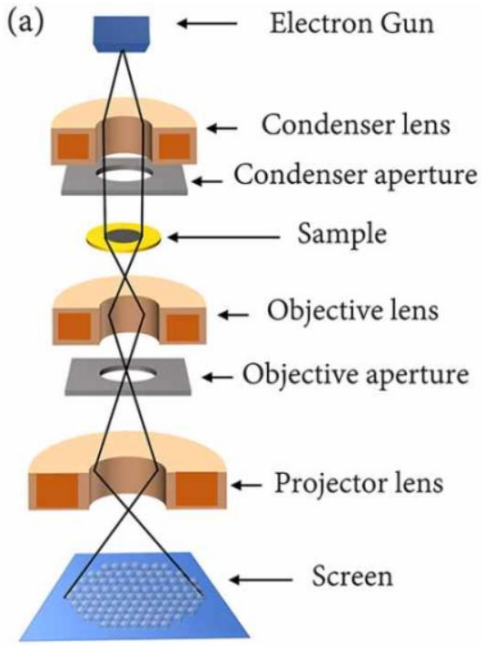
B-Sublattice (¼ ¼ ¼)

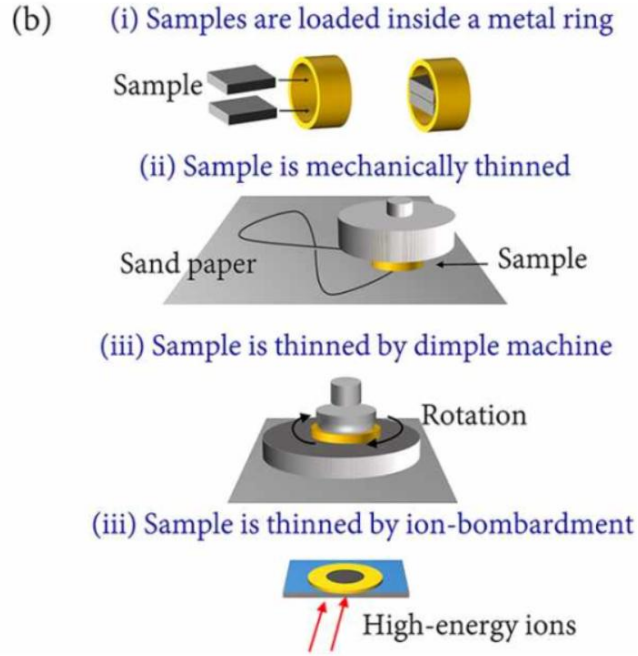
A = B, Diamond structure

A ≠ B, Zinc-Blende (ZnS) structure

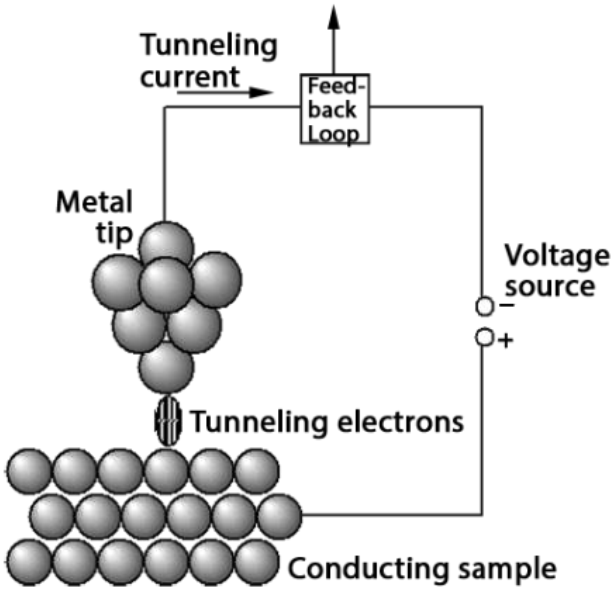
Transmission electron microscopy

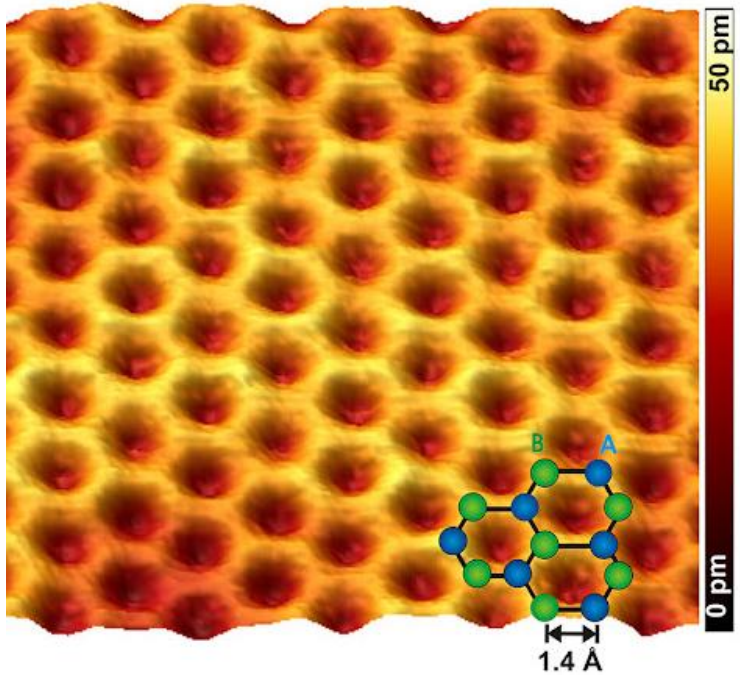






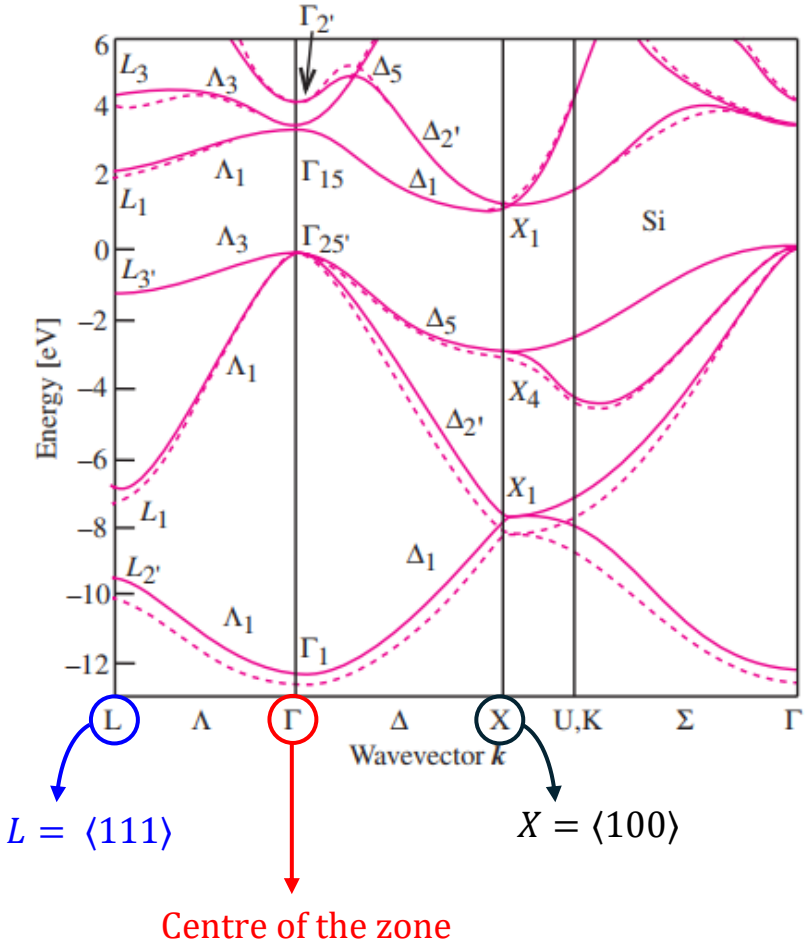
Scanning Tunnelling Microscopy



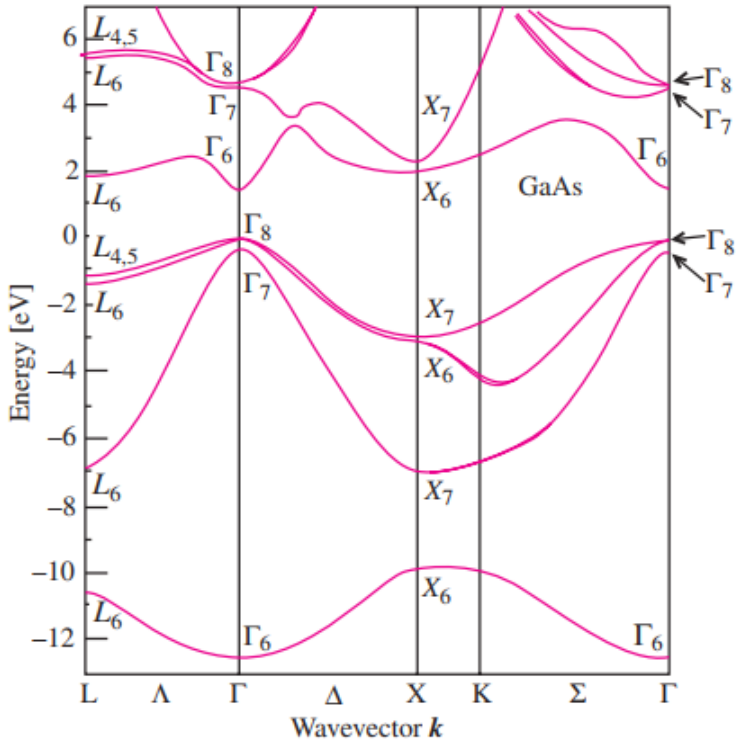


Bandstructure:

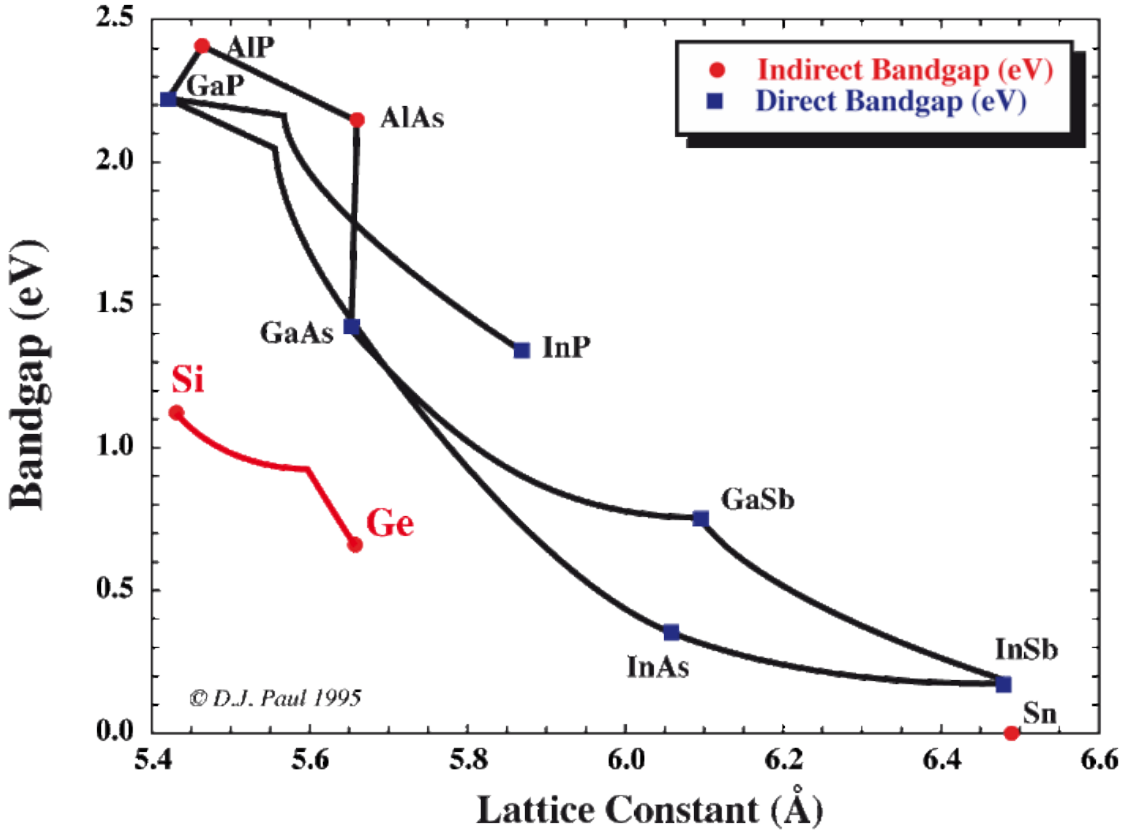
Silicon

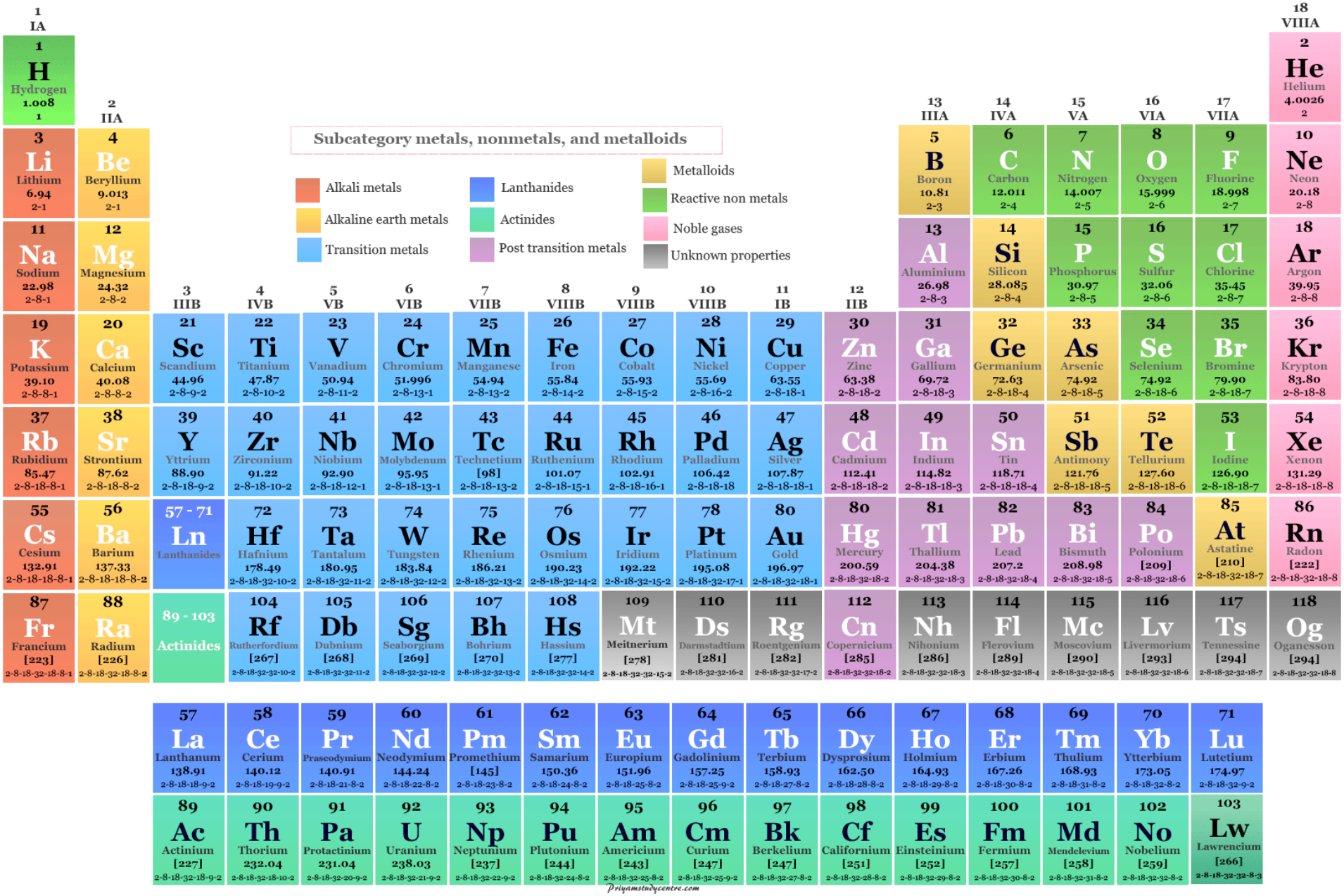


GaAs



Bandgap for different semiconductors:




Subcategory metals, nonmetals, and metalloids
Alkali metals
Alkaline earth metals
Transition metals
Lanthanides
Actinides
Post transition metals
Metalloids
Reactive non metals
Noble gases
Unknown properties
1 IA
2 IIA
3 IIIB
4 IVB
5 VB
6 VIB
7 VIIB
8 VIIIB
9 VIIIB
10 VIIIB
11 IB
12 IIB
13 IIIA
14 IVA
15 VA
16 VIA
17 VIIA
18 VIIIA
1 H Hydrogen 1.008 1
2 He Helium 4.0026 2
3 Li Lithium 6.94 2-1
4 Be Beryllium 9.013 2-1
5 B Boron 10.81 2-3
6 C Carbon 12.011 2-4
7 N Nitrogen 14.007 2-5
8 O Oxygen 15.999 2-6
9 F Fluorine 18.998 2-7
10 Ne Neon 20.18 2-8
11 Na Sodium 22.98 2-8-1
12 Mg Magnesium 24.32 2-8-2
13 Al Aluminium 26.98 2-8-3
14 Si Silicon 28.085 2-8-4
15 P Phosphorus 30.97 2-8-5
16 S Sulfur 32.06 2-8-6
17 Cl Chlorine 35.45 2-8-7
18 Ar Argon 39.95 2-8-8
19 K Potassium 39.10 2-8-8-1
20 Ca Calcium 40.08 2-8-8-2
21 Sc Scandium 44.96 2-8-9-2
22 Ti Titanium 47.87 2-8-10-2
23 V Vanadium 50.94 2-8-11-2
24 Cr Chromium 51.996 2-8-13-1
25 Mn Manganese 54.94 2-8-13-2
26 Fe Iron 55.84 2-8-14-2
27 Co Cobalt 55.93 2-8-15-2
28 Ni Nickel 55.69 2-8-16-2
29 Cu Copper 63.55 2-8-18-1
30 Zn Zinc 63.38 2-8-18-2
31 Ga Gallium 69.72 2-8-18-3
32 Ge Germanium 72.63 2-8-18-4
33 As Arsenic 74.92 2-8-18-5
34 Se Selenium 74.92 2-8-18-6
35 Br Bromine 79.90 2-8-18-7
36 Kr Krypton 83.80 2-8-18-8
37 Rb Rubidium 85.47 2-8-18-8-1
38 Sr Strontium 87.62 2-8-18-8-2
39 Y Yttrium 88.90 2-8-18-9-2
40 Zr Zirconium 91.22 2-8-18-10-2
41 Nb Niobium 92.90 2-8-18-12-1
42 Mo Molybdenum 95.95 2-8-18-13-1
43 Tc Technetium [98] 2-8-18-13-2
44 Ru Ruthenium 101.07 2-8-18-15-1
45 Rh Rhodium 102.91 2-8-18-16-1
46 Pd Palladium 106.42 2-8-18-18
47 Ag Silver 107.87 2-8-18-18-1
48 Cd Cadmium 112.41 2-8-18-18-2
49 In Indium 114.82 2-8-18-18-3
50 Sn Tin 118.71 2-8-18-18-4
51 Sb Antimony 121.76 2-8-18-18-5
52 Te Tellurium 127.60 2-8-18-18-6
53 I Iodine 126.90 2-8-18-18-7
54 Xe Xenon 131.29 2-8-18-18-8
55 Cs Cesium 132.91 2-8-18-18-8-1
56 Ba Barium 137.33 2-8-18-18-8-2
57 - 71 Ln Lanthanides
72 Hf Hafnium 178.49 2-8-18-32-10-2
73 Ta Tantalum 180.95 2-8-18-32-11-2
74 W Tungsten 183.84 2-8-18-32-12-2
75 Re Rhenium 186.21 2-8-18-32-13-2
76 Os Osmium 190.23 2-8-18-32-14-2
77 Ir Iridium 192.22 2-8-18-32-15-2
78 Pt Platinum 195.08 2-8-18-32-17-1
80 Au Gold 196.97 2-8-18-32-18-1
80 Hg Mercury 200.59 2-8-18-32-18-2
81 Tl Thallium 204.38 2-8-18-32-18-3
82 Pb Lead 207.2 2-8-18-32-18-4
83 Bi Bismuth 208.98 2-8-18-32-18-5
84 Po Polonium [209] 2-8-18-32-18-6
85 At Astatine [210] 2-8-18-32-18-7
86 Rn Radon [222] 2-8-18-32-18-8
87 Fr Francium [223] 2-8-18-32-18-8-1
88 Ra Radium [226] 2-8-18-32-18-8-2
89 - 103 Actinides
104 Rf Rutherfordium [267] 2-8-18-32-32-10-2
105 Db Dubnium [268] 2-8-18-32-32-11-2
106 Sg Seaborgium [269] 2-8-18-32-32-12-2
107 Bh Bohrium [270] 2-8-18-32-32-13-2
108 Hs Hassium [277] 2-8-18-32-32-14-2
109 Mt Meitnerium [278] 2-8-18-32-32-15-2
110 Ds Darmstadtium [281] 2-8-18-32-32-16-2
111 Rg Roentgenium [282] 2-8-18-32-32-17-2
112 Cn Copernicium [285] 2-8-18-32-32-18-2
113 Nh Nihonium [286] 2-8-18-32-32-18-3
114 Fl Flerovium [289] 2-8-18-32-32-18-4
115 Mc Moscovium [290] 2-8-18-32-32-18-5
116 Lv Livermorium [293] 2-8-18-32-32-18-6
117 Ts Tennessine [294] 2-8-18-32-32-18-7
118 Og Oganesson [294] 2-8-18-32-32-18-8
57 La Lanthanum 138.91 2-8-18-18-9-2
58 Ce Cerium 140.12 2-8-18-19-9-2
59 Pr Praseodymium 140.91 2-8-18-21-8-2
60 Nd Neodymium 144.24 2-8-18-22-8-2
61 Pm Promethium [145] 2-8-18-23-8-2
62 Sm Samarium 150.36 2-8-18-24-8-2
63 Eu Europium 151.96 2-8-18-25-8-2
64 Gd Gadolinium 157.25 2-8-18-25-9-2
65 Tb Terbium 158.93 2-8-18-27-8-2
66 Dy Dysprosium 162.50 2-8-18-28-8-2
67 Ho Holmium 164.93 2-8-18-29-8-2
68 Er Erbium 167.26 2-8-18-30-8-2
69 Tm Thulium 168.93 2-8-18-31-8-2
70 Yb Ytterbium 173.05 2-8-18-32-8-2
71 Lu Lutetium 174.97 2-8-18-32-9-2
89 Ac Actinium [227] 2-8-18-32-18-9-2
90 Th Thorium 232.04 2-8-18-32-18-10-2
91 Pa Protactinium 231.04 2-8-18-32-20-9-2
92 U Uranium 238.03 2-8-18-32-21-9-2
93 Np Neptunium [237] 2-8-18-32-22-9-2
94 Pu Plutonium [244] 2-8-18-32-24-8-2
95 Am Americium [243] 2-8-18-32-25-8-2
96 Cm Curium [247] 2-8-18-32-25-9-2
97 Bk Berkelium [247] 2-8-18-32-27-8-2
98 Cf Californium [251] 2-8-18-32-28-8-2
99 Es Einsteinium [252] 2-8-18-32-29-8-2
100 Fm Fermium [257] 2-8-18-32-30-8-2
101 Md Mendelevium [258] 2-8-18-32-31-8-2
102 No Nobelium [259] 2-8-18-32-32-8-2
103 Lw Lawrencium [266] 2-8-18-32-32-8-3
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