

Property	Bond Type			
	Ionic (Electrostatic)	Covalent (Electron-shared)	Metallic	Van der Waals (Residual)
Bond Strength	Strong	Very strong	Variable strength, generally moderate	Weak
Mechanical	Hardness moderate to high, depending on interionic distance and charge; brittle	Hardness great Brittle	Hardness low to moderate; gliding common; high plasticity; sectile, ductile, malleable	Crystals soft and somewhat plastic
Electrical	Poor conductors in the solid state; melts and solutions conduct by ion transport	Insulators in solid state and melt	Good conductors; conduction by electron transport	Insulators in both solid and liquid state
Thermal (melting point = m.p.; coefficient of thermal expansion = coef.)	m.p. moderate to high depending on interionic distance and charge; low coef.	m.p. high; low coef.; atoms and molecules in melt	Variable m.p. and coef.; atoms in melt	Low m.p.; high coef.; liquid crystal molecules in melt
Solubility	Soluble in polar solvents to yield solutions containing ions	Very low solubilities	Insoluble, except in acids or alkalis by chemical reaction	Soluble in organic solvents to yield solutions
Structural	Nondirected; gives structures of high coordination and symmetry	Highly directional; gives structures of lower coordination and symmetry	Nondirected; gives structures of very high coordination and symmetry	Nondirected; symmetry low because of shape of molecules
Examples	Halite, NaCl; Calcite, CaCO ₃ ; Fluorite, CaF ₂ ; most minerals	Diamond, C; Sphalerite, ZnS; molecules of O ₂ ; organic molecules; graphite (strong bond)	Copper, Cu; Silver, Ag; Gold, Au; Ectrum, (Au,Ag); most metals	Iodine, I ₂ ; organic compounds; graphite (weak bond).

Impact of Interionic Distance and Charge on Melting Point

Compound	Interionic Distance (Å)	Melting Point (°C)
NaF	2.31	988
NaCl	2.81	801
NaBr	2.98	755
NaI	3.23	651
MgO	2.10	2800
CaO	2.40	2580
SrO	2.57	2430
BaO	2.76	1923

Impact of Interionic Distance and Charge on Hardness

Compound	Interionic Distance (Å)	Hardness (Mohs)
BeO	1.65	9.0
MgO	2.10	6.5
CaO	2.40	4.5
SrO	2.57	3.5
BaO	2.76	3.3
Na ⁺ F ⁻	2.31	3.2
Mg ²⁺ O ²⁻	2.10	6.5
Sc ³⁺ N ³⁻	2.23	7-8
Ti ⁴⁺ C ⁴⁻	2.23	8-9

Impact of Atomic Weight on Specific Gravity

Mineral	Composition	Atomic Weight of Cation	Specific Gravity
Aragonite	CaCO ₃	40.08	2.95
Strontianite	SrCO ₃	87.62	3.76
Witherite	BaCO ₃	137.34	4.29
Cerussite	PbCO ₃	207.19	6.55

Impact of Structure on Specific Gravity

Composition	Mineral	Hardness	Specific Gravity
C	Diamond	10	3.52
	Graphite	1	2.23
FeS ₂	Pyrite	6	4.99
	Marcasite	6	4.85
SiO ₂	low quartz (rhombo.)	7	2.65
	Coesite	7.5	3.01
	Stishovite		4.30

SOME COLORED MINERALS AND THEIR PROBABLE CAUSES

Mineral	Gem	Color	“Cause”
Corundum	Ruby	red	Cr^{3+}
	Sapphire	blue	Ti^{4+}
Garnet	Almandine	dark red	Fe^{2+}
Beryl	Emerald	deep green	Cr^{3+}
	Aquamarine	blue-green	Mn^{2+}
Quartz	Amethyst	violet	Fe
Olivine	Peridot	green	Cr^{3+}
Kyanite		blue	Ti^{4+}