Slides
Condensed Matter Physics
Lecture 4

Type of Bonding	Description	Typical of which compounds	Typical Properties
Ionic	Electron is transferred from one atom to another, and the resulting ions attract each other	Binary compounds made of constituents with very different electronegativity: Ex, group 1-7 such as NaCl or group 2-7 compounds.	• Hard, Very Brittle • High Melting Temperature • Electrical Insulator • Water Soluble
Covalent	Electron is shared equally between two atoms forming a bond. Energy lowered by delocalization of wavefunction	Compounds made of constituents with similar electronegativities (ex, 3-5 compounds such as GaAs), or solids made of one element only such as Diamond (C)	• Very Hard (Brittle) • High Melting Temperature • Electrical Insulators or Semiconductors
Metallic Bonds	Electrons delocalized throughout the solid forming a glue between positive ions.	Metals. Left and Middle of Periodic Table.	• Ductile, Maleable (due to non-directional nature of bond. Can be hardened by preventing dislocation motion with impurities) • Lower Melting Temperature • Good electrical and thermal conductors.
Molecular (van der Waals or Fluctuating Dipole)	No transfer of electrons. Dipole moments on constituents align to cause attraction. Bonding strength increases with size of molecule or polarity of constituent.	Nobel Gas Solids, Solids made of Non-Polar (or slightly polar) Molecules Binding to Each Other (Wax)	• Soft, Weak • Low Melting Temperature • Electrical Insulators
Hydrogen	Involves Hydrogen ion bound to one atom but still attracted to another. Special case because H is so small.	Important in organic and biological materials	• Weak Bond (stronger than VdW though) • Important for maintaining shape of DNA and proteins

Table 4.1: Types of Bonds in Solids. This table should be thought of as providing rough rules. Many materials show characteristics intermediate between two (or more!) classes.