SCH4U1

**The Solid State - Overview**

Almost all substances can exist is the solid state. Some substances, such as the noble gas helium, must be cooled almost to -272oC (1 K) to exist as a solid. Other substances such diamond (a form of pure carbon) melts at 4000 K! It is the types of attractive forces or bonds in these substances that account for the properties of various solids.

**Types of Bonds**

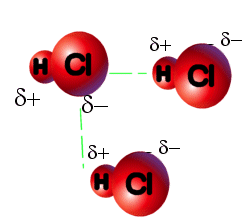




|  |  |  |
| --- | --- | --- |
| **Intramolecular** | **Metallic** | **Intermolecular** |
| **1. Ionic bonds**  **2. Covalent**  **(Polar and Non-polar)** | **Metallic bonds** | **1. van der Waals forces (“London forces”)**  **2. Dipole-dipole forces**  **3. Hydrogen bonds** |

**strong bonds weak bonds**

***increasing bond strength***



**Types of Solids**

**1. Atomic**

**2. Molecular a) Non-polar**

**b) Polar Covalent**

**3. Metallic**

**4. Network Covalent**

**5. Ionic**

**Properties of Solids**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type** | **Examples** | **Intramolecular**  **Bonds** | **Intermolecular**  **Bonds** | **Relative Melting Point** |
| **Atomic** | He, Ar | van der Waals | | - very low |
| **Molecular** | Cl2, HCl, H2O | covalent bonds (polar or non-polar) | van der Waals,  dipole-dipole and hydrogen bonds | - low |
| **Metallic** | Cu, Mg, Fe  (metals) | metallic bonds | | - moderate-high |
| **Network** | quartz (SiO2)  diamond (C) | covalent bonds | | - very high |
| **Ionic** | NaCl  NaNO3  (metal + non-metal) | ionic bonds | | - high |

**Types of Solids formed by Elements**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***H2*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ***He*** |
| ***Li*** | ***Be*** |  |  |  |  |  |  |  |  |  |  | ***B*** | ***C*** | ***N2*** | ***O2*** | ***F2*** | ***Ne*** |
| ***Na*** | ***Mg*** |  |  |  |  |  |  |  |  |  |  | ***Al*** | ***Si*** | ***P8*** | ***S4*** | ***Cl2*** | ***Ar*** |
| ***K*** | ***Ca*** | ***Sc*** | ***Ti*** | ***V*** | ***Cr*** | ***Mn*** | ***Fe*** | ***Co*** | ***Ni*** | ***Cu*** | ***Zn*** | ***Ga*** | ***Ge*** | ***As*** | ***Se*** | ***Br2*** | ***Kr*** |
| ***Rb*** | ***Sr*** | ***Y*** | ***Zr*** | ***Nb*** | ***Mo*** | ***Tc*** | ***Ru*** | ***Rh*** | ***Pd*** | ***Ag*** | ***Cd*** | ***In*** | ***Sn*** | ***Sb*** | ***Te*** | ***I2*** | ***Xe*** |
| ***Cs*** | ***Ba*** | ***La-***  ***Lu*** | ***Hf*** | ***Ta*** | ***W*** | ***Re*** | ***Os*** | ***Ir*** | ***Pt*** | ***Au*** | ***Hg*** | ***Tl*** | ***Pb*** | ***Bi*** | ***Po*** | ***At2*** | ***Rn*** |
| ***Fr*** | ***Ra*** | ***Ac-***  ***Lw*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |