### Ionic, H-bonding, Dipole, or London?

<table>
<thead>
<tr>
<th>Details</th>
<th>Bond</th>
<th>Molecule</th>
<th>IMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \text{EN} = 0 - 0.5$</td>
<td>nonpolar</td>
<td>nonpolar</td>
<td>London</td>
</tr>
<tr>
<td>$\Delta \text{EN} = 0.5 - 1.7$</td>
<td>polar</td>
<td>polar</td>
<td>dipole-dipole*</td>
</tr>
<tr>
<td>$\Delta \text{EN} = 1.7 - 3.2$</td>
<td>ionic</td>
<td>ionic</td>
<td>ionic</td>
</tr>
<tr>
<td>H + N, O, F</td>
<td>polar</td>
<td>polar</td>
<td>H-bonding*</td>
</tr>
<tr>
<td>Symmetrical molecule (any $\Delta \text{EN}$)</td>
<td>--</td>
<td>nonpolar</td>
<td>London</td>
</tr>
</tbody>
</table>

*Since all compounds have London forces. London forces are also present. However, their affect is minor and overshadowed by the stronger forces present. Note: the term “polar” is used interchangeable with “polar covalent”. Likewise, “nonpolar” and “nonpolar covalent” mean the same thing.

### Network solids (covalent crystals)

- There are some compounds that do not have molecules, but instead are long chains of covalent bonds (E.g. diamond)

- This happens in 3 dimensions, creating a crystal
- Because there are only covalent bonds, network solids are extraordinarily strong

### Metallic crystals

- Metals normally occur as solids (high melting points).
- Thus, there must be strong bonds between the atoms of metals causing them to bond
- Bonding in metals and alloys is different from in other compounds: positive nuclei exist in a sea of electrons (this explains why metals conduct electricity)

### Crystal types

- There are 6 types of intermolecular forces
- These forces are associated with certain crystal types. By comparing solids we have a common frame of reference.
- The crystal types and their basic units are:
  1. Network (covalently bonded atoms)
  2. Ionic (electrostatic attraction of ions),
  3. Metallic (positive nuclei in electron sea),
  4. Molecular (electrostatic attraction of dipoles in molecules)
    a) Polar (dipole-dipole and H-bonding)
    b) Non-polar (London forces)

### Properties of crystals

- Boiling and melting occur when the forces between molecules are overcome and a change of state occurs
- The higher the force of attraction between molecules (IMF) the higher the melting/bubbling point (see previous slide for order)
- Only metallic crystals conduct electricity in solid state (they also conduct in liquid state)
- Ionic crystals will conduct electricity in molten state or dissolved because ions are free to move to positive and negative poles

### Solubility of crystal types

- Solute = what is dissolving (e.g. salt)
- Solvent = what it is dissolving in (e.g. water)
- Strong attractions between the basic units of covalent crystals cause them to be insoluble.
- Metallic crystals are likewise insoluble
- The solubility of other crystals depends on solute and solvent characteristics
- We will see that polar/ionic solutes dissolve in polar/ionic solvents and non-polar solutes dissolve in non-polar solvents
- This is known as the like-dissolves-like rule

### Attraction and randomness

- The reason why some substances mix and others do not has to do with …
  1) Intermolecular forces
  2) the tendency for randomness due to random molecular motion
- Reference: 499 (starting from “A tendency toward randomness”) to 502 (ending right before “How Soaps and Detergents work”)

### Mixing oil and water

- Let’s take a look at why oil and water don’t mix (oil is non-polar, water is polar)

- The dipoles of water attract, pushing the oil (with no partial charge) out of the way: attractions win out over the tendency toward randomness