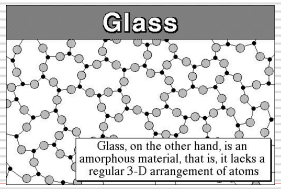
Types of Solids

Amorphous



Safety Glass

- Cars don't use common glass for their windshield because it breaks into dangerous shard when it breaks.
- Instead they use a heat strengthened glass, one that is slowly cooled to a solid to allow for a better arrangement of molecules, so that when it breaks it breaks into less dangerous "dice".

Solids

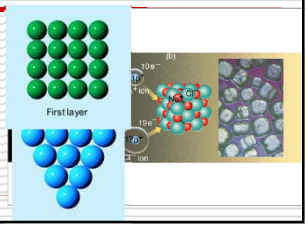
- Crystalline Solids- have a regular repeating arrangement of their particles.
- Salts, Sugars, Metals
- Amorphous Solids- have no regular repeating arrangement of their molecules
- Common glass, several polymers.

Amorphous solids

- Amorphous solids, due to a lack of arrangement of molecules, can actually flow like a liquid, slowly.
- You can also see this effect with silly putty, and other polymers

Glass Safety Glass

Crystalline Structure



Making solids…

- Technically, anything can be made amorphous.
- A rapid cooling from liquid to solid makes it amorphous. The particles just don't have time to arrange themselves in a pattern.
- A slower cooling or heat treatment can make some amorphous solids crystalline.

Back to crystalline solids

- Crystalline solids can be made up of 3 different things
- Ionic Solids –made of ions
- Molecular Solids- made of molecules held together by covalent bonds
- Atomic Solids- Made of atoms

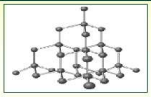
Ionic Compounds

- Ionic Compounds have very high melting points.
- Sodium Chloride melts at 801°C
- That is because every single negative particle is attracted to every single positive particle and vice versa.
- This is in essence a very strong intermolecular force.

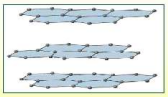
Melts and solutions

- If you melt an ionic compound, then the ions can move. Electrons can now easily move through the substance.
- If you dissolve an ionic compound, the ions are also free to move.
- Therefore, liquid ionic compounds and ionic solutions are good conductors.

Allotropes of Carbon



Diamond
sp^3-hybridized carbon

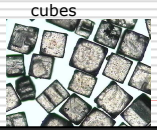


Graphite
sp^2-hybridized carbon

Fullerenes: C_{60}, C_{70}

Ionic Solids

- Ionic solids are brittle. When they break their crystal structure shows, as they break into similar shapes.
- NaCl breaks into cubes
- $CaCl_2$ into spheres.



Molecular Compounds

- Molecular Compounds have much lower melting points.
- Several are liquids (water) or gases (carbon dioxide) at room temperature.
- Molecular compounds are not good conductors of electricity.

Nonmetal Gases

- Noble gases and diatomic elements (except bromine, and iodine)
- These all have only London dispersion forces.
- These are very weak intermolecular forces.
- They all have very low melting points, obviously since they are gases.
- None are good conductors

Conduction of electricity

- Electricity is a flow of electrons
- Anything that allows electrons to easily pass through will be a good conductor of electricity.
- While solids, electrons can only jump from ion to ion.
- This is a very slow process so solid ionic compounds are not good conductors.

Atomic Solids/Elements

- Solid nonmetals and metalloids commonly form very large molecules.
- A diamond (any size) could actually be viewed as one molecule of all carbon.
- These solids are called network solids.
- They have high melting points and don't conduct electricity.

Bromine and Iodine

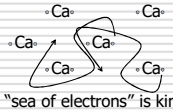
- These act the same as the other diatomic elements but since the atoms are larger the London dispersion forces are greater.
- That is why they are a liquid (bromine) or a solid (iodine) at room temperature.

Metals

- Metals have high melting points and are good conductors of electricity.
- Metals are held together by metallic bonds.
- Similar to ionic bonds these are somewhere in between intramolecular forces and intermolecular forces.

Model of Metallic Bonds

Calcium has 2 valence electrons

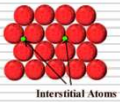


All of the electrons move like this.

The "sea of electrons" is kind of like bees (valence electrons) swarming around a few flowers (rest of the atoms).

Interstitial Alloy

- Steel is an interstitial alloy because the carbon atoms fit into the "holes" between the iron atoms in the crystal structure.



Metallic Bonding

- Bonds between metals
- Metallic bonds only occur with the same metal not with other metals.
- Ca can bond with other Ca atoms, but not Ba.

Properties

- The nuclei inside the "sea of electrons" are movable without breaking the structure.
- This is why metals are malleable and ductile.
- Electrons can easily move through so they are great conductors of electricity.
- Heat is the speed of the particles. If I heat up electrons at one end they quickly hit the slower moving ones and speed them up. So the whole material gets hot. That is why they conduct heat.

Substitutional Alloy

- A substitutional alloy is when a metal atom of similar size replaces the host metal.
- Brass (copper and zinc), sterling silver (silver and copper), white gold (gold, palladium, silver, and copper) are all substitutional alloys.
- This changes the properties of the metal.

Metallic Bond

- In metallic bonds the valence electrons become community property, traveling anywhere they want to throughout the element.
- This "Sea of Electrons" is why metals are such good conductors of electricity and heat.

Alloys

- ~a substance that is mixture of elements and has metallic properties.
- Alloys are mixtures so they can be separated without chemical reactions
- Steel is an alloy. It is made of iron and 0.2-1.5% carbon.
- The carbon makes it harder, stronger, and less malleable than normal iron.
- More carbon makes it stronger.

Both substitutional and interstitial alloys

- Stainless Steel is iron and carbon (interstitial) mixed with chromium and nickel (substitutional).
- It resists corrosion.
- Slightly changing the presence of any of these drastically changes the properties of the final metal.