Polymer Glossary

Amorphous - having no ordered arrangement. Polymers are amorphous when their chains are tangled up in any old way. Polymers are *not* amorphous when their chains are lined up in ordered crystals.

Anion - an atom or molecule which has a negative electrical charge.

Cation - an atom or molecule which has a positive electrical charge

Complex - two or more molecules which are associated together by some type of interaction of electrons, other than a covalent bond.

Copolymer - A polymer made from more than one kind of monomer.

Covalent bond - a joining of two atoms when the two share a pair of electrons.

Crosslinking - crosslinking is when individual polymer chains are linked together by covalent bonds to form one giant molecule.

Crystal - a mass of molecules arranged in a neat and orderly fashion. In polymer crystal the chains are lined up neatly like new pencils in a package. They are also bound together tightly by secondary interactions

Elastomer - rubber. Hot shot scientists say a rubber or elastomer is any material that can be stretched many times its original length without breaking, *and* will snap back to its original size when it is released.

Electrolyte - a molecule that separates into a cation and an anion when its dissolved in a solvent, usually water. For example, salt, NaCl separates into Na^+ and Cl^- in water:

Elongation - how long a sample is stretched when it is pulled. Elongation is usually expressed as the length after stretching divided by the original length.

Emulsion - a mixture in which two immiscible substances, like oil and water, stay mixed together thanks to a third substance called an *emulsifier*. The emulsifier is usually something like a soap, whose molecules have a water-soluble end and an organic-soluble end. The soap molecules form little balls called *micelles*, in which the water-soluble ends point out into the water, and the organic-soluble ends point into the inside of the ball. The oil is stabilized in the water by hiding in the center of the micelle. Thus the water and oil stay mixed.

Entropy - disorder. Entropy is a measure of the disorder of a system.

First order transition - a thermal transition that involves both a latent heat and a change in the heat capacity of the material.

Free radical - an atom or molecule which has at least one electron which is not paired with another electron.

Gel - a crosslinked polymer which has absorbed a large amount of solvent. Crosslinked polymers usually swell a good deal when they absorb solvents.

Gem diol - a diol in which both hydroxy groups are on the same carbon. Gem diols are unstable. Why are they called *gem* diols? It's short for *geminal*, which means "twins". It's related to the word *gemini*.

Glass transition temperature - the temperature at which a polymer changes from hard and brittle to soft and pliable.

Heat capacity - the amount of heat it takes to raise the temperature of one gram of a material one degree Celsius.

Hydrodynamic volume - the volume of a polymer coil when it is in solution. This can vary for a polymer depending on how well it interacts with the solvent, and the polymer's molecular weight.

Hydrogen bond - a very strong attraction between a hydrogen atom which is attached to an electronegative atom, and an electronegative atom which is usually on another molecule. For example, the hydrogen atoms on one water molecule are very strongly attracted to the oxygen atoms on another water molecule.

Ion - an atom or molecule which has a positive or a negative electrical charge.

Latent heat - the heat given off or absorbed when a material melts or freezes, or boils or condenses. For example, when ice is heated, once the temperature reaches 0 ^{o}C, it's temperature won't increase until all the ice is melted. The ice has to absorb heat in order to melt. But even though it's absorbing heat, it's temperature stays the same until all the ice has melted. The heat required to melt the ice is called the *latent* heat. The water will give off the same amount of latent heat when you freeze it.

Le Chatlier's principle - this principle states that if a system is placed under stress, it will act so as to relieve the stress. Applied to chemical reactions, it means that if product or byproduct is removed from the system, the equilibrium will be upset, and the reaction will produce more product to make up for the loss. In polymerizations, this trick is used to make polymerization reactions reach high conversion.

Ligand - an atom or group of atoms which is associated with a metal atom in a complex. Ligands may be neutral or they may be ions.

Living polymerization - a polymerization reaction in which there is no termination, and the polymer chains continue to grow as long as there are monomer molecules to add to the growing chain.

Matrix - in a fiber reinforced composite, the matrix is the material in which the fiber is embedded, the material that the fiber reinforces. It comes from a Latin word which means "mother", interestingly enough.

Modulus - the ability of a sample of a material to resist deformation. Modulus is usually expressed as the ratio of stress exerted on the sample to the amount of deformation. For example, tensile modulus is the ration of stress applied to the elongation which results from the stress.

Monomer - a small molecule which may react chemically to link together with other molecules of the same type to form a large molecule called a polymer.

Olefin Metathesis - a reaction between to molecules, both containing carbon-carbon double bonds. In olefin metathesis, the double bond carbon atoms change partners, to create two new molecules, both containing carbon-carbon double bonds.

Oligomer - a polymer whose molecular weight is too low to really be considered a polymer. Oligomers have molecular weights in the hundreds, but polymers have molecular weights in the thousands or higher.

Plasticizer - a small molecule that is added to polymer to lower its glass transition temperature.

Random coil - the shape of a polymer molecule when its in solution, and it's all tangled up in itself, instead of being stretched out in a line. The random coil only forms when the intermolecular forces between the polymer and the solvent are equal to the forces between the solvent molecules themselves and the forces between polymer chain segments.

Ring-opening polymerization - a polymerization in which cyclic monomer is converted into a polymer which does not contain rings. The monomer rings are opened up and stretched out in the polymer chain, like this:

Secondary interaction - interaction between two atoms or molecules other than a covalent bond. Secondary interactions include hydrogen bonding, ionic interaction, and dispersion forces.

Second order transition - a thermal transition that involves a change in heat capacity, but does not have a latent heat. The glass transition is a second order transition

Soap - a molecule in which one end is polar and water-soluble and the other end is non-polar and organic-soluble, such as sodium lauryl sulfate:

These form micelles in water, little balls in which the polar ends of the molecules point out into the water, and the non-polar ends point inward, away from the water. Water insoluble dirt can hide inside the micelle, so soapy water washes away dirt that plain water can't.

Strain - the amount of deformation a sample undergoes when one puts it under stress. Strain can be elongation, bending, compression, or any other type of deformation

Strength - the amount of stress an object can receive before it breaks.

Stress - the amount of force exerted on an object, divided by the cross-sectional area of the object. The cross-sectional area is the area of a cross-section of the object, in a

plane perpendicular to the direction of the force. Stress is usually expressed in units of force divided by area, such as N/cm^2.

Termination - in a chain growth polymerization, the reaction which causes the growing chain to stop growing. Termination reactions are reactions in which none of the products may react to make a polymer grow.

Thermoplastic - a material that can be molded and shaped when it's heated.

Thermal transition - a change that takes place in a material when you heat it or cool it, such as melting, crystallization, or the glass transition.

Thermoset - a hard and stiff crosslinked material. Thermosets are different from *thermoplastics*, which become moldable when heated. Thermosets are crosslinked, so they don't. Also, they are different from crosslinked *elastomers*. Thermosets are stiff and don't stretch the way elastomers do.

Toughness - a measure of the ability of a sample to absorb mechanical energy without breaking, usually defined as the area underneath a stress-strain curve.

Transesterification - A reaction between an ester and an alcohol in which the -O-R of the ester and the -O-R' group of the alcohol trade places, as shown below.