Other Solids: Polymers, Nanomaterials, Foams, etc.

Skills to Develop

- Describe some of the properties and/or characteristics of polymers and nanomaterials

There are many other types of solids, or other important qualities that distinguish solids, like catalysis, porosity, etc. We haven't described minerals or ceramics very well, or superconductors, magnetic materials, etc. For now, we'll just describe two more types: polymers and nanomaterials. Polymers are familiar and important from life, because we use them for almost everything. Nanomaterials are less familiar, but are starting to be used in commercial products although we don't always understand them too well.

Polymers

Polymers are also called **macromolecules**, which means big molecules. Polymers are usually long chains made of small molecules covalently bonded together. The important properties of the polymer come from the "intermolecular" or non-covalent forces that determine how the polymer chains fold up or tangle together. Most important biomolecules (like DNA, proteins and starch) are polymers. We also make a wide variety of polymers, usually starting with hydrocarbon molecules from oil, that are used in clothing, plastics, construction materials, etc. Many different molecules and reactions can be used to make polymers. The properties of the polymer will often depend on the structure, which is usually amorphous or disorganized. If the macromolecules are more orderly and rigid, the structure may be more crystalline and less flexible, with a higher melting point (because the molecules can pack together well with relatively strong intermolecular forces). If the macromolecules are very different sizes and have irregular shapes, then the polymer might be more flexible. Sometimes covalent bonds are added between the molecules, which can also make the material tougher. (For example, rubber is made by stronger by heating with sulfur, which can connect the chains together.)

Nanomaterials

Nanomaterials are very small solids, like extremely fine powders only smaller. They have dimensions measured in nanometers, or 10^{-9} meters. At this scale, they are too small to have all the normal properties of solids, because they have so much edge. For example, nanomaterials have bigger band gaps than the same material in bigger chunks. The smaller the particles, the bigger the band gap. (Molecules have bigger HOMO/LUMO gaps than solid materials; nanoparticles are in between molecules and normal solids.) People are pretty excited about nanoparticles (they're popular!) but it's good to remember that we don't really know much about their health effects yet, except to say that they are complicated and need more study. I don't recommend running out and buying the new nano-shampoo or nano-silver handwipes or whatever you might encounter unless it's noticeably superior to the non-nano alternative.

Nanostructures and nanoparticles can be natural or manufactured. For example, most birds that look blue don't have blue pigment, they have nanostructures on their feathers that scatter light. These days, most electronic devices are based on nanostructures also: each individual transistor in a computer chip is nanosized, and it may not be possible to make them much smaller than they are now without too many size-based complications.

Outside Link

- CrashCourse Chemistry: Polymers (10 min)

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