

Structure of Carbon Nanotubes with Post-its

Introduction

This activity is used to introduce the relationship between the mechanical properties of a material and its structure using carbon nanotubes modeled with Post-its.

Material

Post-its

Pencil

Two paper cups

Small weights or pennies



To Do and Notice

Place two paper cups upside down on a flat surface about 2 inches apart. Take a small stack of Post-its and place the Post-its flat on the top of the cups forming a bridge between the two cups. Now try to balance as many pennies or small weights as possible in the center of the stack of Post-its. Record the maximum number of pennies you are able to balance with the Post-its.

Now take the same number of Post-its and individually roll them up using the pencil to form small tubes. The sticky part of the Post-it should be sufficient to hold the tube together. Using the tubes, again form a bridge between the two paper cups and try to balance as many pennies on the bridge as possible. Compare your result with the result for the flat sheet Post-it bridge.

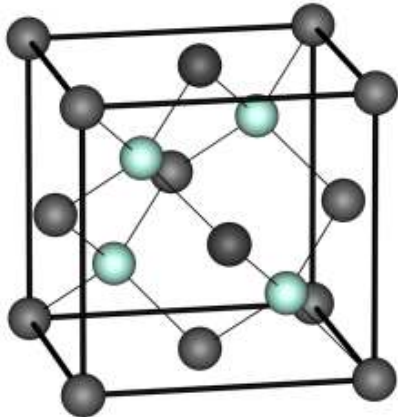
What's going on?

Carbon comes in many forms. Two well-known forms of carbon are graphite and diamond. Graphite and diamond have drastically different mechanical properties such as hardness. Diamond is one of the hardest materials known to man. It can cut through glass. Graphite, on the other hand, is a very soft material, used in pencil lead.

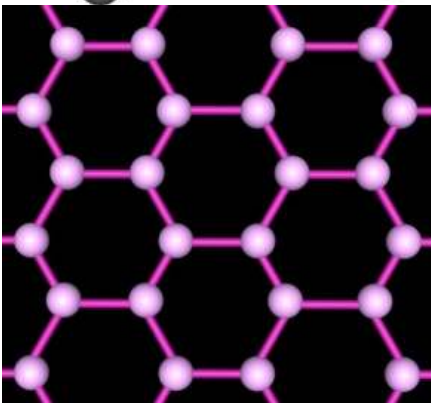
The difference in properties is due to the structure of the atoms and their bonds in the material, also known as the materials crystal structure. Graphite is made up of stacked sheets of hexagons with a carbon atom at each corner of the hexagon, and looks much like chicken wire. These sheets are stacked one on top of the other, but easily slip and slide. Diamond has a tetragonal crystal structure with very few slip planes.

Carbon nanotubes are a fairly new form of carbon. A carbon nanotube structure looks like sheets of graphite that have been rolled up to form small tubes. This small difference in structure leads to a much stronger, stiffer material. Carbon nanotubes have a diameter of 1 to 10 nanometers, yet they are 50 times stronger than steel.

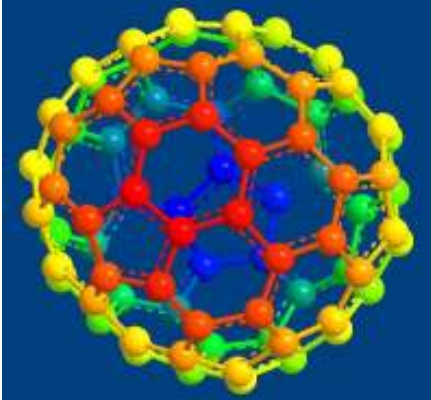
Forms of Carbon



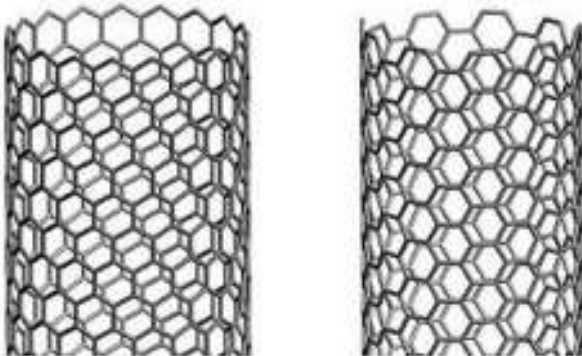
Diamond



Graphite



C₆₀ Buckminsterfullerene



Carbon Nanotube