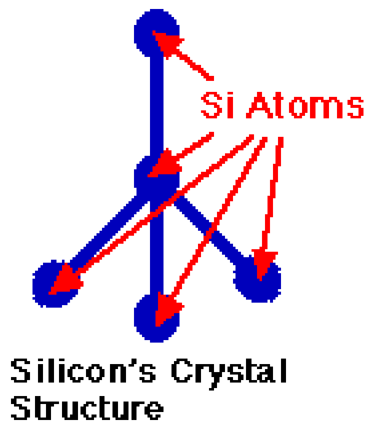
Solar Energy & Chemistry

Whoever said chemistry is the science of the electron was almost correct. Many of the processes that occur in chemistry are dependent on the state of the electrons floating around the outside of the nucleus. The material of solar cells is an elaborate network of electron paths. These paths are what a photon, or an excited electron will move through after approaching a cell. A solar cell is really only a converter that takes the light of the sun and turns it into electricity. The technical name for a solar cell is photovoltaics. When the word photovoltaic is broken into its roots, *photo* meaning light and *volt* meaning electromotive force, the idea of using light to create a force is simply obtained. The forces that occur within the solar cell are inspected at the Solar Physics page.

The manufacture of a solar cell involves changing the surface that electrons come in contact with. The solar cells that are most often sold are made of silicon and some other elements that change the fundamental chemical properties of the silicon and produce electricity. Silicon solar cells come in two different types: Amorphous silicon and Crystalline silicon.

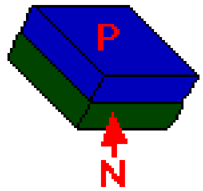
The crystal made by an element is predictable because the same crystal will be produced every time. Crystalline solar cells are made from crystalline silicon and are fragile and break or bend easily. The crystalline struture of silicon can be seen in the following picture:



The breakdown of crystalline silicon over time has been extremely apparent in the Space Industry. Electricity producing modules that power space stations and satelittes must be replaced or left as space waste. The amount of electric current that a crystalline silicon solar cell produces is larger than for amorphous silicon, but still only a small percentage of the total amount of the total sunlight that reaches Earth.

An amorphous solar cell does not have the same definite structure that is predicted for crystalline silicon, and is therefore much more flexible. Usually amorphous cells can be found on handheld calculators or personal organizers. Unfortunately amorphous cells are not as efficient as crystalline cells, meaning the energy production with crystalline silicon is much higher. This kind of solar cell is used on boats, campers, and other modes of transportation because it is so flexible. Crystalline and amorphous silicon solar cells are not the only forms of solar cells available, but because other cells are not as efficient as silicon cells substitutes are not used.

A solar cell is actually a wafer of two layers. The top layer is P-Type Silicon, is the blue or purple part of the cell as seen in pictures, and has a positive charge. N-Type Silicon of negative charge occupies the lower layer and is ususally not visible in pictures of solar cells. The process of adding elements to silicon is called doping. When Boron is added to silicon, P-Type Silicon forms. The addition of Phosphorus or Arsenic creates N-Type Silicon. The wafer formed by combining a level of P-Type and N-Type Silicon is displayed in the picture below. This wafer structure is called a PN Junction. Understanding the electron organization in these atoms illuminates the process of energy conversion in a solar cell.



PN Junction Layer

Several important chemistry concepts are discussed at the next link: Valences & Orbitals. Review the information at this link before reading the rest of this page. One way to illustrate the PN Junction is through Lewis symbols. Each element's symbol is surrounded by dots for each of the eight electrons found in the outer orbitals. Examples of Lewis structures are seen at a special Lewis Structure Page. The absence of an electron is displayed by a hole where an electron is absent. When the complete layer of P-Type or N-Type silicon is illustrated using Lewis structures, a network is created.

The process that converts an excited electron called a photon from the sun's light to energy is described at the Solar Electronics page.

Silicon Solar Cell Production

Pure silicon, element symbol Si, is taken from an impure variety and heated to the melting point of silicon which is 1410 degrees Celsius. After reaching this melting point, the mass of impure silicon is cooled slowly, and the impure silicon is separated from very pure silicon. This separation can occur because the impurities have a slightly different melting point than the very pure silicon. This process is similar to the purification process of gold and other precious metals. The pure silicon forms a crystal as it cools. This crystal is sliced like a piece of sausage into thin wafers. Wafers used for circular silicon cells are usually about four inches in diameter.

Next, the pure silicon wafer is first "doped" (sprinkled) with an small amount of boron, to form the P-type silicon layer. The opposite side of the wafer is doped with some phosphorus to form the N-type silicon layer. The only part of the cell that is needed for it to produce electricity is for wires to be connected to both the negative (N- type silicon) layer, and the positive (P-type silicon) layer that connect to a battery or some other electronic component. Take a quiz on this material to see how much you have learned.

Now study the theory of waves and solar power at Solar Physics.