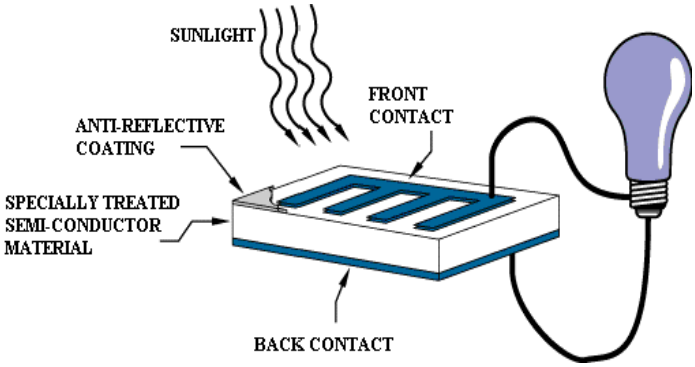
PHOTOVOLTAIC CELLS

Solar Decathlon 2013: We are using silicon photovoltaic panels donated by Bosch. Bosch is known for their commitment to sustainable technology, with 40% of sales and 50% of research going towards technology designed to minimize environmental impact. In addition to donating the photovoltaic panels, they are also providing energy-efficient appliances. The house will include 28 rooftop panels that will supply all the electricity for the competition.

Courtesy of 2013 team



upload.wikimedia.org/wikipedia/commons/7/7d/Operation_of_a_basic_photovoltaic_cell.gif

The Semiconductor: Silicon

Silicon is extremely abundant, but it requires an extensive manufacturing process to be useful. Quartz sand is heated to a high temperature to ensure purity before it is formed into ingots and cut into small wafers. There is a high fuel cost associated with the heating process, which produces carbon monoxide, and nearly half the original silicon is lost as waste in the wafering process.

Those who mine silicon can develop silicosis, stemming from excess exposure to silica dust; however, with precautions, this is preventable. Over 94% of PV panels contain silicon since it is practical and effective.

The Electrodes: Indium Tin Oxide

Solar panel electrodes must be transparent to avoid blocking incoming light, so options are limited. Indium tin oxide is preferred for its conductivity and transparency, but it is extremely rare and the process to extract it from other metals is difficult. Some scientists predict that reserves might run out in ten years or less. Improperly discarded electrodes can leach toxic chemicals into landfills.

The Doping Agents: Phosphorus and Boron

Silicon wafers must be doped with an electrically conductive material to allow electrons to flow easily. Most panels contain phosphorus and boron to create an interaction between positive (p-type) silicon and negative (n-type) silicon. The phosphorus mining process leaves behind heavy metals which can contaminate ecosystems and water sources. The main concern from using boron is the high energy cost of purification.

The Alternatives

- **Carbon nanotubes:** Carbon is abundant, and can be formed into nanotubes to serve as a semiconductor. Currently this process is too labor-intensive to be practical.
- **Germanium and gallium arsenide:** While these create panels that are much more efficient than those made with silicon, they are much more expensive. They are most commonly found in space technology.
- **Graphene:** Currently in development, these carbon-based electrodes are nontoxic, but they lag behind in conductivity and performance.