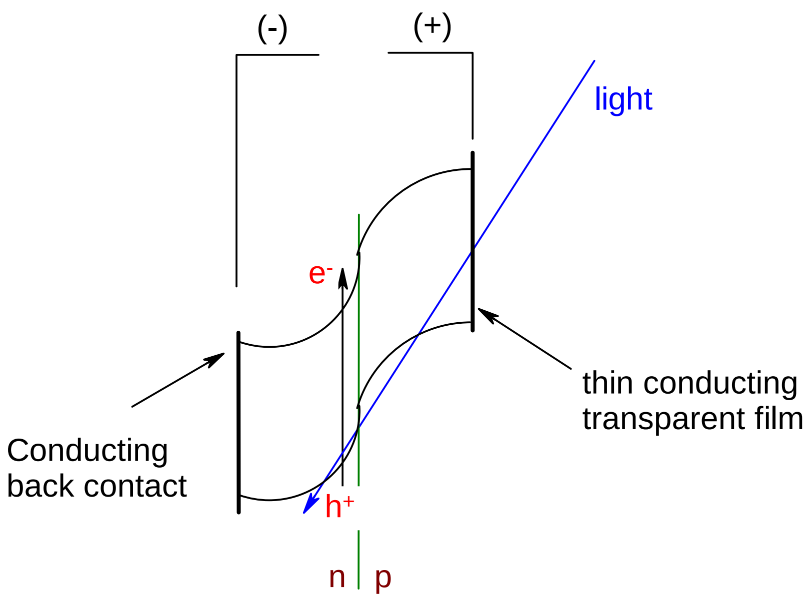
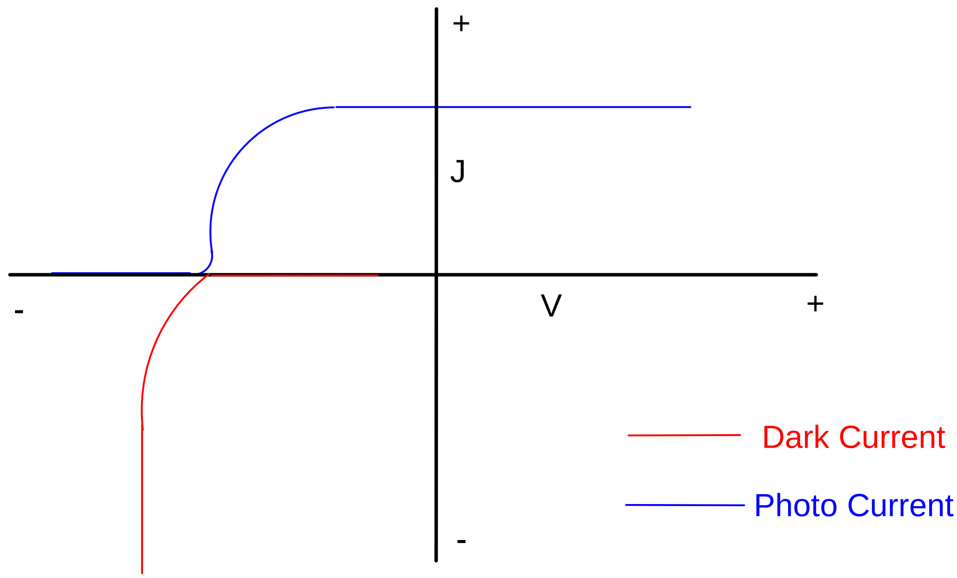


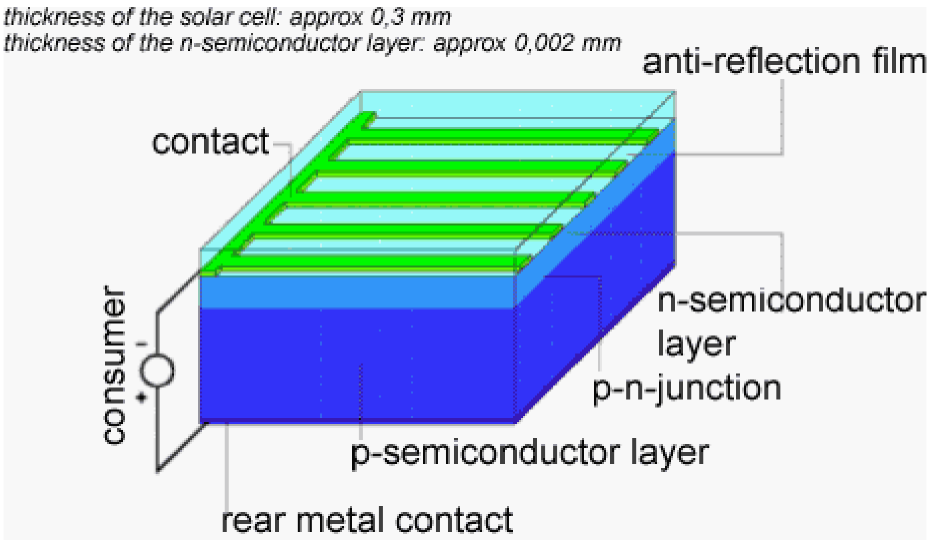
light to electricity in p-n junctions



Typical plots of current vs. applied potential in PEC operations

How Does a Solar Cell Work?

Solar cells are composed of various semiconducting materials. Semiconductors are materials, which become electrically conductive when supplied with light or heat, but which operate as insulators at low temperatures.
Over 95% of all the solar cells produced worldwide are composed of the semiconductor material Silicon (Si). As the second most abundant element in earth`s crust, silicon has the advantage, of being available in sufficient quantities, and additionally processing the material does not burden the environment. To produce a solar cell, the semiconductor is contaminated or "doped". "Doping" is the intentional introduction of chemical elements, with which one can obtain a surplus of either positive charge carriers (p-conducting semiconductor layer) or negative charge carriers (n-conducting semiconductor layer) from the semiconductor material. If two differently contaminated semiconductor layers are combined, then a so-called p-n-junction results on the boundary of the layers.



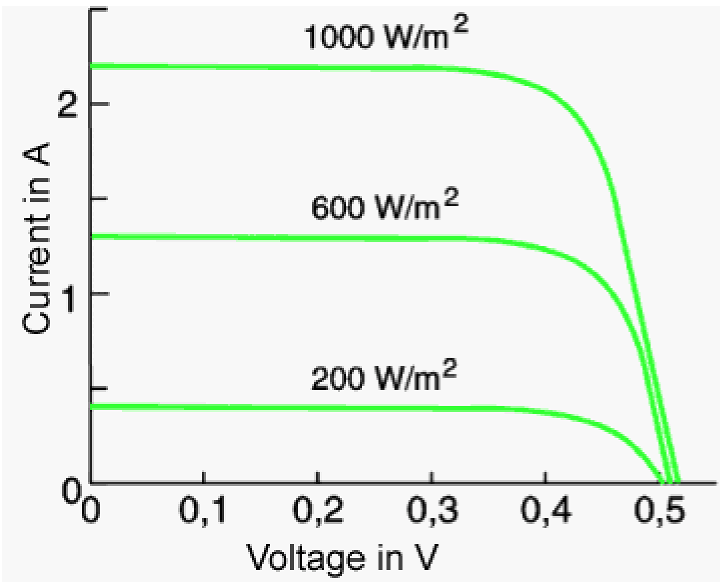
model of a crystalline solar cell

At this junction, an interior electric field is built up which leads to the separation of the charge carriers that are released by light. Through metal contacts, an electric charge can be tapped. If the outer circuit is closed, meaning a consumer is connected, then direct current flows.

Silicon cells are approximately 10 cm by 10 cm large (recently also 15 cm by 15 cm). A transparent anti-reflection film protects the cell and decreases reflective loss on the cell surface.

Characteristics of a Solar Cell

The usable voltage from solar cells depends on the semiconductor material. In silicon it amounts to approximately 0.5 V. Terminal voltage is only weakly dependent on light radiation, while the current intensity increases with higher luminosity. A 100 cm² silicon cell, for example, reaches a maximum current intensity of approximately 2 A when radiated by 1000 W/m².



current-voltage line of a si-solar cell

The output (product of electricity and voltage) of a solar cell is temperature dependent. Higher cell temperatures lead to lower output, and hence to lower efficiency. The level of efficiency indicates how much of the radiated quantity of light is converted into useable electrical energy.

Polymer solar cell

From Wikipedia, the free encyclopedia

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Polymer solar cells are a type of solar cell: they produce electricity from sunlight. A relatively novel technology, they are being researched by universities, national laboratories and several companies around the world.

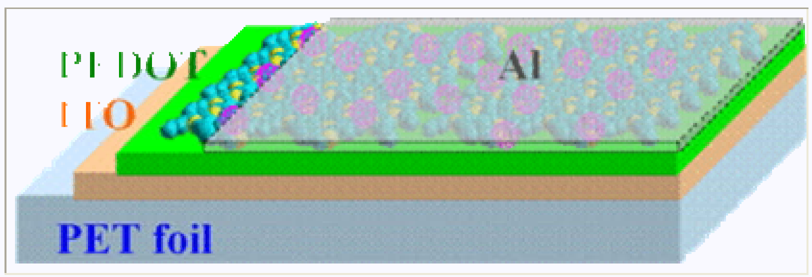

Fig. 1. The scheme of plastic solar cells. PET - PolyEthyleneTerephtalate, ITO - Indium Tin Oxide, PEDOT - Poly(3,4-EthyleneDiOxyThiophene), Al - Aluminium.]]

Currently, many solar cells in the world are made from a refined, highly purified silicon crystal, similar to those used in the manufacture of integrated circuits and computer chips. The high cost of these silicon solar cells and their complex production process has generated interest in developing alternative photovoltaic technologies.

Advantages of organic solar cells:

Compared to silicon-based devices, polymer solar cells are lightweight (which is important for small autonomous sensors), disposable, inexpensive to fabricate, flexible, designable on the molecular level, and have little potential for environmental impact.

It was shown in the 90s that the plastic solar cell can be successfully realized as "bulk heterojunctions" between an organic polymer and organic molecule as electron acceptor. Fullerene embedded into conjugated polymer are usually used for such purposes (see Fig. 1). Plastic solar cell technology appeared to be easy to mass-produce and its cost is roughly one-third of that of traditional silicon solar cell technology, because the polymers and fullerene used in its construction are commercially available.

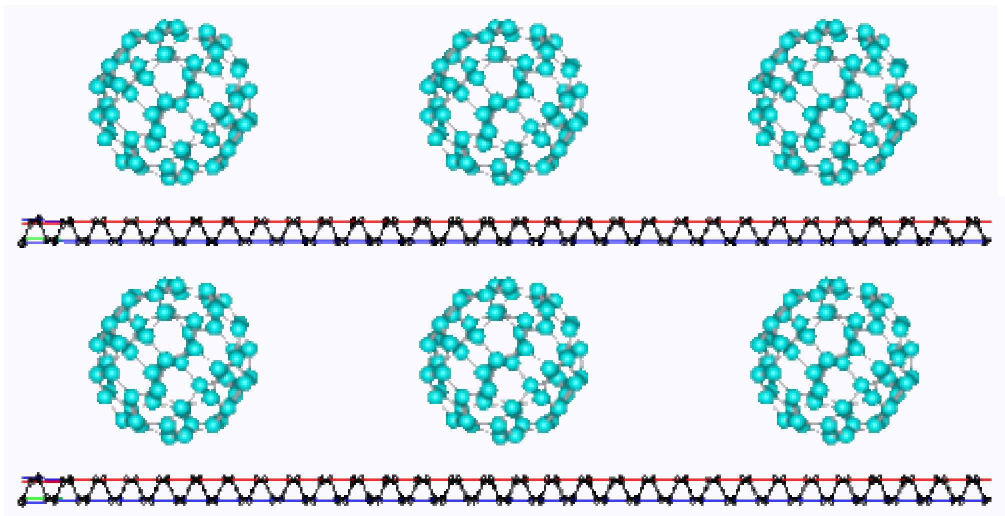

Fig. 2. Polymer chain with diffunding polaron surrounded with rotating fulleren molecules

Ultimately solar energy conversed by polymer solar cells can be extensively used in both the commercial and private sectors. There are such a wide variety of potential applications, e.g. cars equipped with solar energy engine instead of diesel and gas ones, handy TV, phones, etc.

At the moment, an open question is to what degree polymer solar cells can commercially compete with silicon solar cells. Now the silicon solar cell industry has the important industrial advantage of being able to leverage the general silicon infrastructure developed for the computer industry. Besides, the present efficiency of polymer solar cells lies near 5 percent. However, it can be doubled in a very short period of time and reach ca. 15 - 20 percent within a 15–20 years, typical for large-sized high-quality silicon modules with the same lifespan. Polymer solar cells also suffer from huge degradation effects: the efficiency is decreased over time due to environmental effects. Good protective coatings are still to be developed. It is clear that in the future the plastic solar cells can be as low-cost alternative electricity source with any shape and size produced by using an appropriate technology.

The illumination of the polymer/fulleren system by visible light leads to electron transfer from a polymer chain to a fullerene molecule. This is accompanied by the formation of photoinduced quasiparticle - polaron P^+ - on a polymer chain and fullerene ion-radical C_{60}^- (Fig. 2). Polaron is characterized by high in-chain rate, so fast charge separation occurs in the system. Both the polaron and ion-radical possess spin S= ½, so the charge photoinduction and separation processes can be controlled by the Electron Paramagnetic Resonance method. There are different dynamics processes in the polymer/fullerene system (see Fig. 2), namely the polaron motion along and between polymer chain, the superslow macromolecular libration and the rotation of a fullerene around own main molecular axis. studying these processes one can to optimize electronic properties of the polymer solar cell, including its efficiency and stability.