SOLAR ENERGY AND HEAT SOURCE

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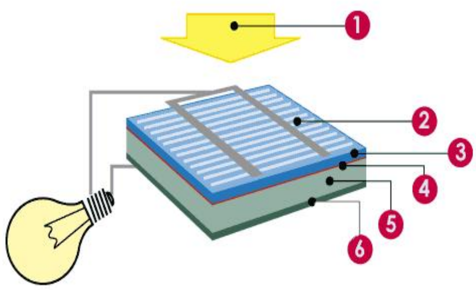
Annotation: Technologies for the production of solar batteries and panels are constantly being developed and improved. Manufacturers and researchers are constantly looking for ways to increase the efficiency of solar panels, increase the amount of energy produced per unit area, improve their performance at different levels of light and temperature, and increase their resistance to environmental factors.

Keywords: solar energy, alternative energy sources, electricity, photovoltaics, solar cell, monocrystalline and polycrystalline silicon, cascade elements, amorphous silicon, solar module.

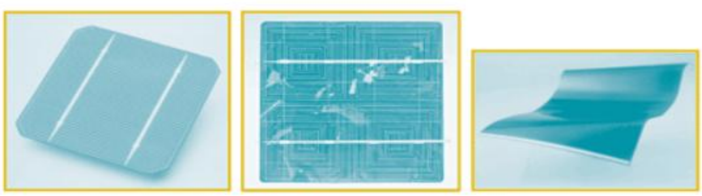
Solar cells (SCs) are made from materials that directly convert sunlight into electricity. Most of the currently commercially produced solar cells are made of silicon (chemical symbol Si). Silicon is a semiconductor. It is widely found on earth in the form of sand, which is silicon dioxide (SiO2), also known as quartzite. Another application of silicon is in electronics, where silicon is used to produce semiconductor devices and chips.

First of all, the solar cell has a back contact and 2 layers of silicon of different conductivity. On top there is a grid of metal contacts and an anti-reflective anti-reflective coating, which gives the solar cell a characteristic blue tint. There are solar cells with p- and n-type junctions. The former are cheaper and more common nowadays. The latter are a little more expensive, but have greater efficiency, and are used in new types of solar cells (for example, PERC).



Silicon solar cell structure 1. light (photons) 2. front contact 3. negative layer 4. transition layer 5. positive layer 6. back contact

Silicon solar cells can be of the following types: monocrystalline, polycrystalline and amorphous (thin film). There are also heterostructural cells that combine crystalline and amorphous solar cells (see below). The difference between these forms is how the silicon atoms are organized in the crystal. Different solar cells have different efficiency of converting light energy. Mono- and polycrystalline cells have higher efficiency than solar cells made from amorphous silicon.



Monocrystalline, polycrystalline and amorphous solar cells.

In recent years, new types of materials for solar cells have been developed. For example, thin-film photovoltaic cells made of copper indium diselenide and CdTe (cadmium telluride). These SCs have also recently been commercially used. Technologies for their production are constantly developing; over the last decade, the efficiency of thin-film elements has increased by approximately 2 times. One of the latest technologies for solar modules made from amorphous silicon is tandem solar modules, which have increased efficiency.

Recent technologies use hybrid methods. This is how elements appeared that have both a crystalline transition and a thin translucent amorphous transition located above the crystalline one. Since crystals and amorphous silicon most efficiently convert only part of the light spectrum, and these spectra are slightly different, the use of such hybrid cells can improve the overall efficiency of the solar cell. In Russia, such solar cells are produced by the Hevel plant.

Manufacturers of solar cells are constantly improving them, which leads to an increase in their efficiency and power generation per peak watt. Modern technologies of solar cells and modules are described in our article Modern solar cells and modules . PERC, HJT, IBC, Bi-facial, TopCon and other new promising technologies are now being used for crystalline silicon cells, which have made it possible to achieve solar cell efficiency of 25 percent or more (see solar cell efficiency map on the right).

The figure shows a graph of changes in the efficiency of solar cells over the past decades. As we can see, laboratories have already obtained results approaching 45%. Of course, such technologies will not reach mass commercial use soon, but work to reduce the cost of manufacturing solar cells is constantly being carried out all over the world. As you can see, the maximum efficiency is obtained with multijunction elements and concentrated lighting.

Unlike crystalline material, there is no structured arrangement of atoms. Therefore, amorphous silicon has worse semiconductor properties and, therefore, lower light conversion efficiency. However, much less silicon is needed to produce cells and it can be applied to almost any surface - glass, metal or other material. The efficiency of amorphous silicon elements with one layer is about 6%. The market share of amorphous silicon modules is insignificant.

CSG (Crystalline Silicon on Glass) look like amorphous silicon modules, but are actually crystalline. A special technological process allows you to apply a thin layer of crystalline silicon (about 2 microns) directly onto the glass (whereas the thickness of a regular photovoltaic cell is 200-300 microns). Contacts are embedded using laser and screen printing. The first photovoltaic modules produced using this technology had an efficiency of about 7%.

CdTe modules (cadmium-tellurium). This special thin film technology has great potential to reduce the cost of photovoltaic modules. The efficiency of the modules reaches 18%. The cadmium content in the module is less than in a conventional AA battery, and manufacturers promise to accept for recycling all used modules they produce.

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