FIELDS OF APPLICATION OF PHOTOVOLTAIC CELLS BASED ON ORGANIC MATERIALS

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Abstract: *Solar energy is a branch of alternative energy based on the direct use of solar radiation to produce energy in one form or another. Solar energy uses renewable energy sources and is "ecologically clean", i.e. does not emit harmful emissions during the active phase of use.*

Keywords: *organic materials, solar cell, cathode, anode, catalyst, quantum dot, electron, colloidal quantum dots, wavelength, spectral properties, photostability property, silicon solar cells, heterostructure, tandem photocells.*

Introduction

Recently, solar cells based on organic materials have attracted increasing interest from researchers and solar cell companies. Although the photoconversion efficiency of organic solar cells seems to be relatively modest compared to inorganic solar cells, these devices have a number of positive properties that make them real competitors to inorganic elements [1-5]. These properties include low consumption and low cost of materials, their environmental safety and cheap disposal, very low production costs, flexibility of modules and the associated ease of transportation and installation (Figure 1).

However, the disadvantages of photovoltaic cells based on organic materials, in addition to the low photoconversion efficiency, are the problem of stability of the properties inherent in composite polymers.

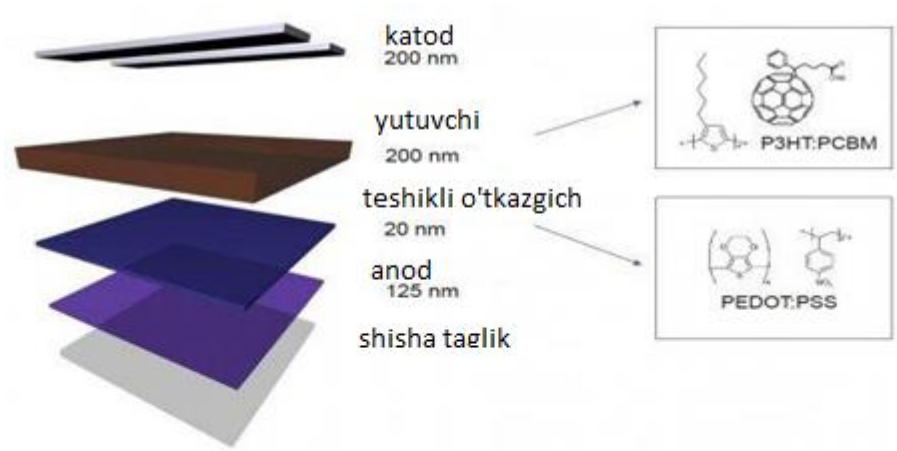

Figure 1. Design of a single organic solar cell and the materials used to create it

The efficiency of photovoltaic cells based on organic materials is not high, up to 7-8%, but all this is due to the fact that the above-mentioned organic materials do not absorb light in the entire wavelength range (Fig. 2). On the one hand, this problem requires the development of more complex schemes with two combined panels, that is, tandem solar cells, or simply making the panel transparent and gluing it to glass. This solution eliminates the above-mentioned drawback and increases the efficiency of photovoltaic cells based on organic materials [6-9].

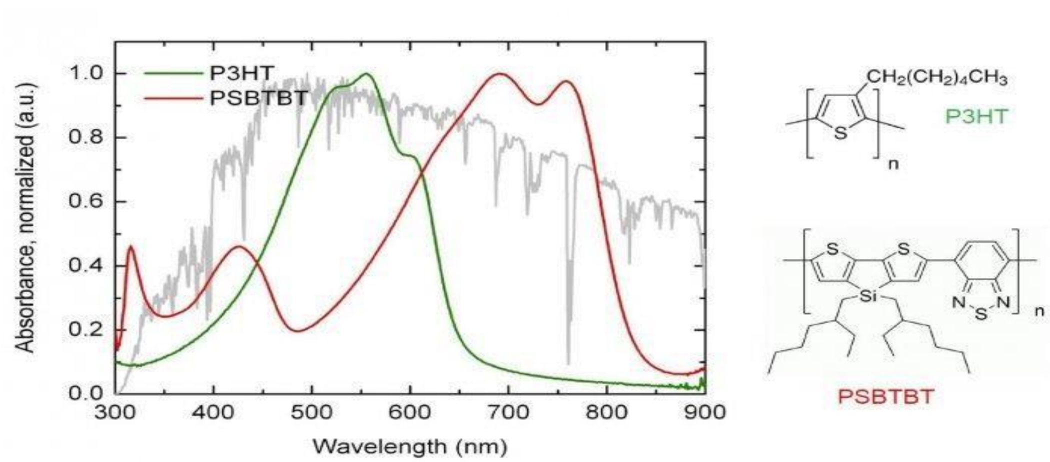

Figure 2. Example of absorption spectra of two organic materials used in the production of tandem solar cells

Liquid solar cells are also a class of thin-film solar cells. This type of solar cell was invented in 1991 by the Swiss scientist Gratzel and is therefore also called a "Gratzel cell". The first Gratzel cell consisted of a highly porous nanocrystalline titanium dioxide anode (10 μm thick), the surface of which was coated with a monomolecular dye layer and formed on a glass substrate covered with a transparent conductive oxide layer [9-12]. The porous anode was impregnated with a liquid iodine electrolyte, while the cathode was made of platinum (Figure 3).

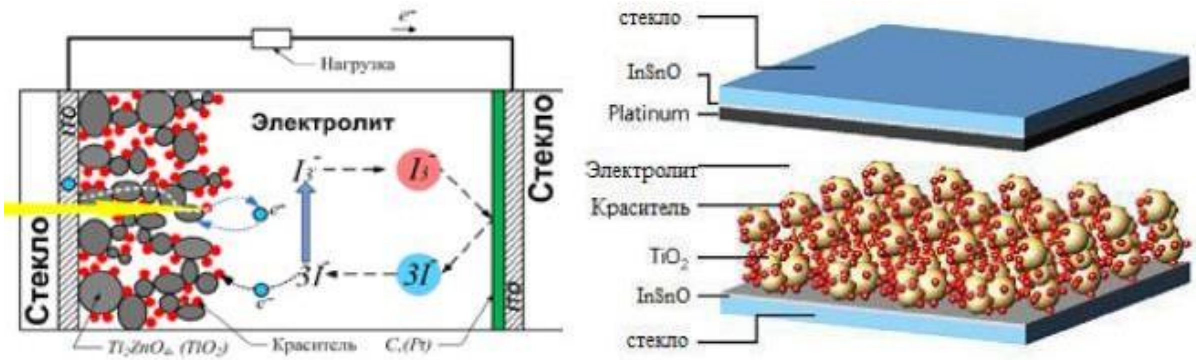

Figure 3. Structure of a solar panel based on paint and electrolyte

The figure shows a typical design of a photosensitive solar panel: two electrodes and an electrolyte. The disadvantages of the Gretzel cell are the high corrosiveness of the electrolyte and the high cost of platinum [13-15]. However, these problems are not fatal and effective solutions can be found for them. For example, the use of CoS instead of Pt has already been proposed, and less aggressive organic electrolytes have also been proposed. Given the low cost of the materials used and the simplicity of the technology, these solar cells are widely available. Research is constantly being conducted to find new cheaper or more effective materials that will allow us to increase the efficiency of these structures [16-19].

A quantum dot is a region of a conductor or semiconductor that contains electrons that are confined and conductive in all three spatial dimensions. The dot must be so small that quantum effects are noticeable [20-22].

A three-dimensional representation of another heterostructure, similar to a pyramid, is shown in Figure 4.

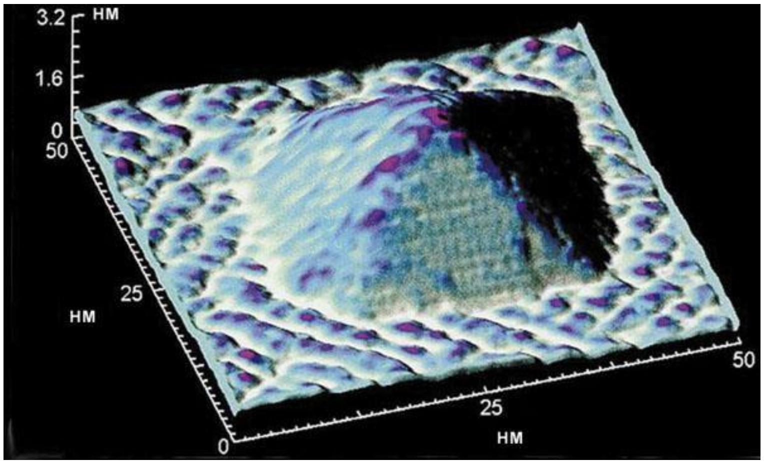

Figure 4. Three-dimensional image of a quantum dot, a pyramid of germanium atoms spontaneously formed on a silicon substrate

Quantum dots are similar in their properties to nano-sized atoms – “artificial atoms”. Electrons in atoms jump from one orbit to another, emitting a quantum of light with a strictly defined frequency [23-25]. However, unlike real atoms, which cannot change their internal structure and emission spectrum, the parameters of quantum dots depend on them (Figure 5).

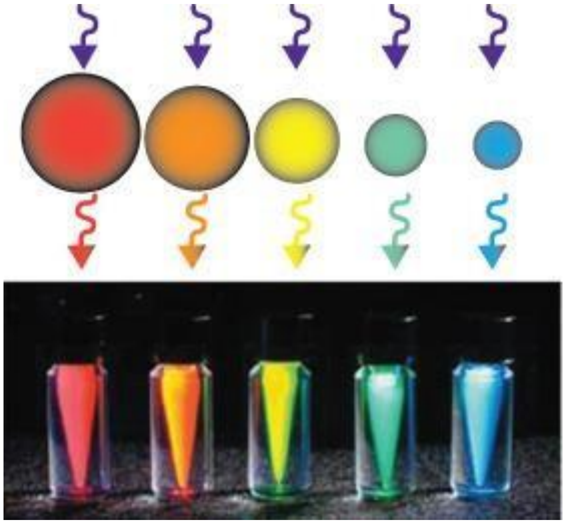

Figure 5. The color of quantum dots depends on their size

Colloidal quantum dots for creating solar panels are characterized by the following properties: the ability to control the effective band gap, that is, the ability to tune the spectral properties of quantum dots by changing their size to the desired wavelengths; the high photostability of inorganic materials, the solubility of which allows the formation of sol, which allows quantum dots to be easily controlled.

Conclusion

Organic solar cells have several advantages over traditional, commercially produced silicon-based solar cells. These advantages include not only that organic solar cells are much thinner and more flexible than silicon solar cells, but also that they are easier and cheaper to manufacture industrially. Organic solar cells are easier to adapt to both everyday electronic devices that power them, as well as devices and systems that are not always used. In the long term, organic solar cells could reduce our dependence on panels, batteries, and electrical cables.

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