CREATION OF COMPOSITE MATERIALS FOR PHOTOVOLTAIC CONVERTERS WITH HIGH EFFICIENCY

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Overview

Today, in scientific world there are research developments aimed at creating fundamentally new photovoltaic converters. It is customary to distinguish three generations of photovoltaic converters:

- Photovoltaic converters of the first generation: monocrystalline (mc-Si), multilayer (m-Si), GaAs-based, ribbon-based (EFG, S-web), thin-layer polysilicon (Apex).

- Photovoltaic converters of the second generation are based on the use of thin epitaxial semiconductor batteries: amorphous silicon (a-Si), micro- and nano-silicon (mc-Si/nc-Si), silicon on glass (CSG), cadmium telluride (CdTe), copper-(indium-)gallium (di)selenide (CI(G)S).

- Photoelectric converters of the third generation on the basis of organic and inorganic materials. The third generation of photovoltaic cells is significantly different from the previous two. It is represented by quantum dots (fragments of a conductor or semiconductor, limited in all three spatial dimensions containing electrons, they are so small that quantum effects can be realized) and devices with built-in carbon nanotubes. Their efficiency at the start of large-scale production is projected to reach 45%.

Methods

The limiting theoretical efficiency for photovoltaic converters, determined only by thermodynamic losses, can reach 85%, and for real systems values of 45-55% are quite attainable. For example, tandem and multicascade photovoltaic converters based on compounds of the type $A^{III}B^{V}$ (gallium arsenide, AlGaAs systems, AlGaInAs, etc.) already have efficiency in the laboratory conditions of more than 40%.

To date, research and developments on the creation of polymer-fullerene photocells, polymer photocells, low-molecular photocells, tandem photocells, hybrid photocells, cells sensitized with organic dye, striped nanorods, etc. are underway. All developments have their advantages, features and disadvantages.

Results

Inorganic photocells of CTZSS type are technologies of thin-film photocells. CTZSS it is a material made of an alloy based on the composition of copper, tin, zinc, selenium and sulfur. Thin-film solar panels CTZSS showed an efficiency of 11.1%. These photocells are less susceptible to a drop in efficiency with an increase in temperature, which for silicon photocells achieves a half-percent for each degree above 25 °C. It is possible to achieve an efficiency of 20% in the laboratory and 12% in the field conditions. Despite the price of selenium, the simplicity of the technology of manufacturing new solar batteries already now allows them to compete with silicon ones.

Conclusions

To date, most solar cells are based on crystalline silicon, zinc oxide, titanium, but their characteristics leave much to be desired. Devices based on thin films and devices with high efficiency and low cost are of increasing interest. Creating some of them requires the use of nanostructures. The well-chosen geometry of such structures can shorten the path that the charge carrier must pass, and, accordingly, increase efficiency. Thus, it is needed research studies on the creation and further commercial use of fundamentally new photovoltaic converters based on the latest structures with an efficiency of up to 40%.

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