POSSIBILITIES TO INCREASE THE EFFICIENCY OF PHOTOVOLTAIC CELLS

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1. INTRODUCTION

The present article deals with improving the efficiency photovoltaic conversion of solar radiation. Nowadays, when more and more points to the need for renewable energy is necessary to find, refine and exploit opportunities for photovoltaic conversion of sunlight into electricity.

Many studies are dealing the problem of photovoltaic conversion. Especially in recent years there has been restoration of Materials Research, whose aim is find new ways to improve the efficiency of photovoltaic cells. Also ongoing research into new non-traditional materials aimed at increasing their efficiency while reducing production costs.

2. REPLACEMENT CIRCUIT OF PHOTOVOLTAIC CELL

Internal connection of photovoltaic cell, we can express with the equivalent circuit. Frequently introduce as the current source connected parallel to the diode with an internal serial and parallel resistance. To achieve the highest output power it is necessary to maximize generated current I_{FV}, minimize series resistance R_S and achieve the highest possible "leakage" resistance of R_p.

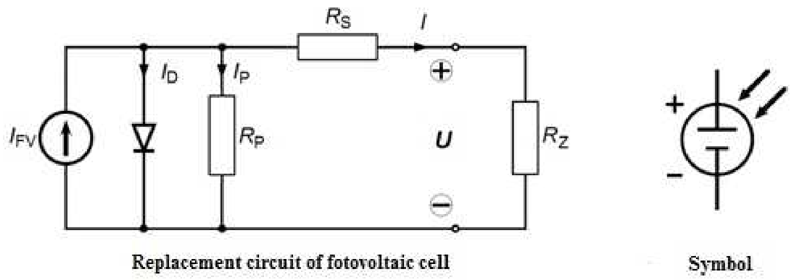

Figure 1 – Replacement circuit of photovoltaic cell

3. POSSIBILITIES TO INCREASE EFFICIENCY OF PHOTOVOLTAIC CELLS

The replacement scheme under the basic ways of improving the efficiency of photovoltaic cells. As the first option seems to be increasing the generated power. In practice, using methods of collecting grid electrode to maximize the collection area with as little masking of article. Beginning to be implemented fully transparent electrodes based on metal oxides. At large areas of cells however on these transparent electrodes applied collecting electrode.

Latest step in this direction is introduction of PERC. Its essence is the incorporation of the failures layer over PN junction exact locations under the metal collecting contact. Because uninterrupted material has a much lower resistance the charge carriers are trying to cross this defective place where they are divert by the shortest route. By decreasing recombination losses and it is theoretically possible to achieve 35%.

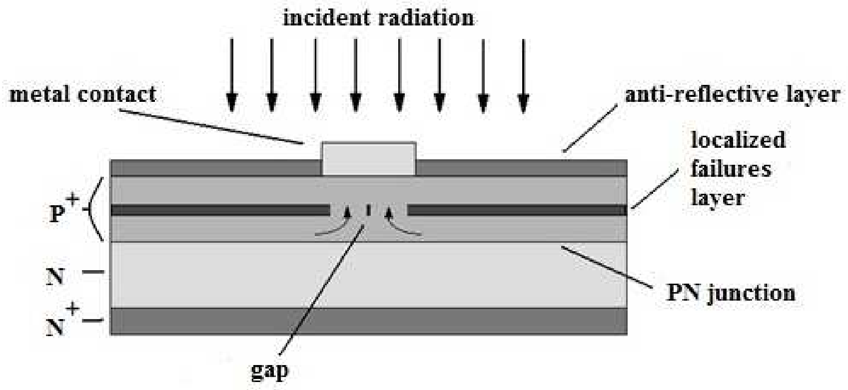

Figure 2 – Photovoltaic cell with a localized layer of fault

Step that will significantly increase the amount of generated charge carriers has been to create an anti-reflective coating on the cell surface by etching solutions. The resulting structure is called PEARL. Monocrystalline cells with PEARL reaches efficiencies of 24%, opposite monocrystalline cells without PEARL achieve 16-18% efficiency.

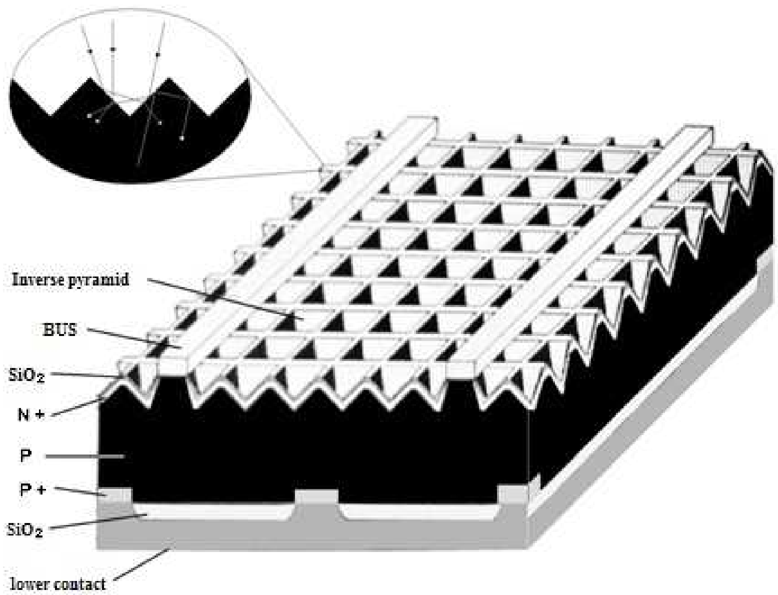

Figure 3 – Texturisation surface of the structure PEARL

Other ways of increasing the efficiency of photovoltaic cells are include concentrator systems which are divided into two basic types:

- Low concentration ratio
- High concentration ratio

Species with low concentration ratio is mainly use planar mirrors for concentration. For higher concentrations are used parabolic mirrors or Fresnel lenses with the degree of concentration c = 10 – 30. At such high concentrations already there is a significant warming of photovoltaic cells therefore used GaAs-based panels who is at high temperatures much more favorable electrical properties.

At high concentration cells shall have the meaning used nested contacts which reduces the shaded area, reduces the series resistance and improves the article collection of charge carriers.

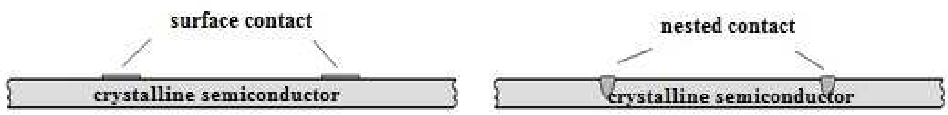

Figure 4 – The shape of nested and surface contact

3.1. Methods "quantum dots"

They use special nanostructures that allow you to control the width of the forbidden zone. Their attraction is that one high energy photon can produce two to three free electrons that after the release of the excess energy is not converted to heat but to take advantage of the excitation another electron. Theoretical calculations suggest to a twofold increase conversion efficiency of sunlight into electricity.

3.2. New methods of increasing the absorption of photovoltaic cells

With the advent of nanomaterials created new possibilities for surface texturisation of photovoltaic cells for example using carbon nano tubes. This technology begins to cause a minor revolution because they have already been tested in laboratory conditions. Because the tubes are only 50-150 nm large have completely different optical properties. Absorb the light incident at angle and they can accurately focus the radiation energy to the points.

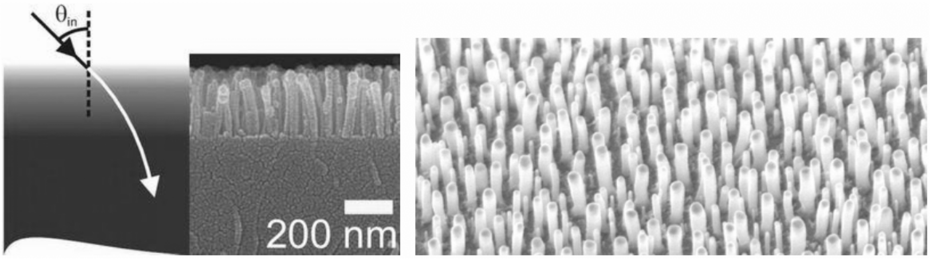

Figure 5 – Surface structure of the nanotubes article

3.3. Method of high energy electrons

Current photovoltaic cells are able to convert solar energy into electricity to use only a certain range of radiation. If they have the highest sensitivity in the red spectrum so the impact of radiation generated only electrons with this tipe of energy. If to this article incidence photon with higher energy (blue part of the spectrum) that produces high-energy electron, the so-called hot electron. he, however, its energy very rapidly converted into heat. This phenomenon occurs even before the electron leaves the photovoltaic cell and converted to electricity. In the experiments, was constructed article 15 nm thick. This fact causes the electrons are divert quickly and do not cools down. Higher energy of the incident radiation causes a higher generated current. Since the article is extremely thin, yet managed to capture only 3% of incident radiation. Scientists suggest improvements using carbon-based nanomaterials.

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