Despite significant development of the photovoltaic (PV) industry over the past decades, the efficient and cost-effective conversion of solar energy into electricity through PV cells remains constantly actual. Current annual solar energy usage is well below 1% of total energy consumption, while fossil fuels account for over 90% of the energy consumption. Before the large-scale use of solar energy, more efficient PV systems at reduced costs must be developed.

A major problem limiting the conversion efficiency of solar cells (SC) is their insensitivity to a full solar spectrum. The solar spectrum reaching the Earth surface consists of photons with wide wavelengths ranging from ultraviolet (about 250 nm) to infrared (~2500 nm). But current SCs, in particular most popular silicon ones, use only a relatively small fraction of these solar photons (Fig.1).

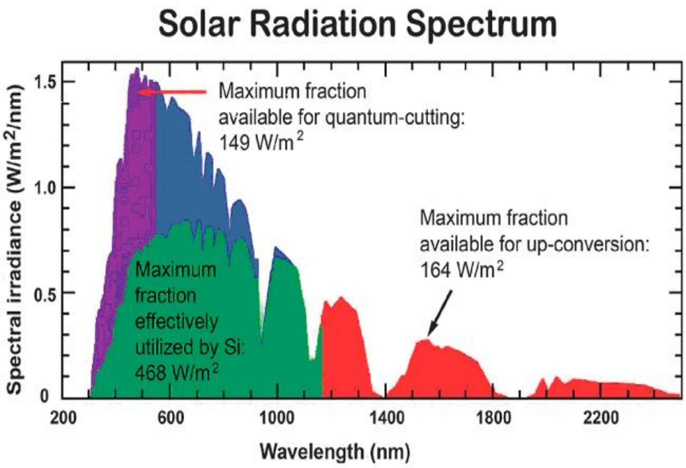

Fig. 1.

Luminescence techniques for solar spectrum modification allowing conversion of high-energy photons (250-550 nm) and low-energy photons (1100-2500 nm) to the middle range of maximal SCs sensitivity are at the scene to solve this problem. One of such techniques is down-conversion (quantum cutting) which allows to cut one high energy photon into two lower energy ones. Theoretical calculations show that the down-converting layer placed on the front side of silicon SC (like in Fig. 2) allows to increase the efficiency limit of the cell from 31% to about 37%. In spite of this the luminescence techniques for solar spectrum modification are not used in practice yet.

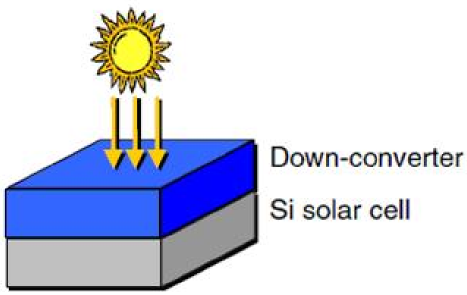

Fig. 2.

One of the main problems that prevent routinely usage of such luminescence techniques for solar cells enhancement is lack of appropriate materials and engineering solutions to apply this technique. The research project proposed deals exactly with this problem.

The project is devoted to investigation of the down-conversion phenomena as it is, study of new materials that can be applicable to silicon solar cells as well as development of some engineering solutions that can be useful for this purpose.

In particular, in frames of the project proposed number of novel luminescent materials in the form of nanopowders, polymer-based nanocomposites, crystalline layers and glasses will be studied. To increase the absorption and luminescence efficiency of the down-converting layers even more, novel approaches such as nanophotonic structures will be investigated as well.

The project implementation should provide an answer on possible efficiency enhancement in practice of existent solar cells using the solar spectrum modification technique that is widely discussed nowadays on theoretical level. If such a possibility will be confirmed experimentally, in frames of the project proposed, particular technical approaches allowing efficiency enhancement of real solar cells will be proposed. This undoubtedly will be a result of high quality owing to the modern development and implementation of PV energy sources into everyday usage.