Abstract

Recently global climatic changes have become of utmost importance, not only for us, but also for future generations. Many research groups all over the world are concerned with renewable energy sources that are expected to improve the status of the natural environment and permit sustainable work of the ecosystem. The effects of toxic side products emitted from the currently used power stations have brought series harmful effects. One of the possible solutions is the photoconversion of sunlight, which seems to be much promising. The currently used inorganic photovoltaic cells have found increasing use, although they are flawed with a number of drawbacks. First of all, their construction is expensive and their application is limited by many restrictions following from their rigidity and mass of constructed panels. In view of the above, much attention has been paid recently to the organic photovoltaic that may offer some solutions. In comparison to the classical solar cells, production of organic solar cells (OSC) is much easier and cheaper, mainly because of easy access to resources of initial precursors, numerous synthetic pathways and the possibility of using low-temperature methods for deposition of layers of organic compounds. OSC are hoped to permit overcoming of all drawbacks of all other types of solar cells, unfortunately, the efficiency of their photoconversion is still unsatisfactory. The most important approach to solve this problem to is design and construct new organic materials of the active layer. Another challenge is designing devices based on organic compounds is to ensure the stability of their work in atmospheric conditions. These problems have inspired us to devise new organic materials that would be characterized by high efficiency of photoconversion, thermal and broadly understood stability as well as effective charge transport within the device. Much promising for this application are polycyclic aromatic hydrocarbons and from among them – perylene derivatives and materials based on perylene diimide (PDI) core. These compounds show strong absorption in a wide range of visible light, high thermal stability and high charge mobility. Moreover, their solubility and tendency to self-assembly through the π-π interactions leading to molecular stacking as well as optoelectronic properties can be easily tuned by the way of chemical modifications.

The aim of the project is first of all to establish correlations between the chemical modifications of the structures and properties of the compounds obtained. A more general aim is to improve the performance of the cathode interlayer that has been devised to improve the contact between inorganic electrodes and organic active material. Our plan is to synthesize the derivatives characterized by high electric conductivity achieved thanks to the stacking interactions, which will permit the use of layers thicker than 10 nm. Hitherto it has been the maximum thickness above which electric resistance at the junction between the electrode-interlayer-active layer would considerably increase. The PDI cores are planned to be equipped in substituents free from mobile counterions and differing in the type and number of polar groups, length of linker and distance between counterions. From among a series of perylene derivatives the compound comprising the most effective anchoring group will be selected. It is also planned to identify the conditions permitting achievement of the best possible conductivity of the interlayer based on PDI. Another objective of the study is to obtain an effective acceptor for the active layer of bulk heterojunction solar cells (BHJ). Our intention is to synthesize new three-dimensional compounds composed of a core linked to spatially oriented perylene structures that at the next step will be used for production of photovoltaic cells. The effectiveness of performance of the cells with different compounds will be tested to establish the core most suitable for the optimum aggregation of aromatic rings. A very important novelty of the project is the use of the interlayer and the acceptor based on PDI, which should ensure excellent contact between the chemically similar layers and thus increase the chances of getting solar cells of high efficiency. The information gained on the correlations between the perylene derivatives' structures and their properties is expected to provide certain guidelines that should bring a considerable contribution to development of OSC technology.