

Development of novel CdS/organic and Si/organic hybrid heterostructures for photovoltaic applications

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A recent new branch in photovoltaics is aimed at development of hybrid photovoltaic cells composed of organic and inorganic components. The objective of hybrid photovoltaics is to combine useful properties of organic materials, such as a relative cheapness, plasticity, flexibility, processibility, easy chemical tailoring of the structure, and useful properties of inorganic materials, such as a broad range of light absorption, effective transport of charge carriers, firmness, hardness, thermostability, in a single device. The use of inorganic materials in the form of nanoparticles allows one to further extend variation of the useful properties, since the absorption edge of semiconductor nanoparticles can be controlled by change of the particle size, and the nanoparticles can also be processed in the thin-film structure.

Our activity in the above branch of photovoltaics is directed to search for and development of novel combinations of organic and inorganic materials for photovoltaic applications. Now this activity unites two main groups, one from the Institute of Semiconductor Physics and the other from the Institute of Bioorganic Chemistry and Petrochemistry (Dr.A.A.Pud et al.), as well as our collaborator Prof. W. Salaneck from Linköping University, Sweden, and Prof. Dr. S. Schrader from University of Applied Sciences Wildau, Germany, and this activity fulfils in the frame of the Science and Technology Center in Ukraine (project #3746).

In our studies of hybrid heterostructures, we follow the concept of two types of devices. The first one, the **A type** device is based on a combination of a wide-gap semiconductor that plays the role of a window to transmit the solar light, and an organic film that is the main absorber in this structure. The second type of devices, the **B type** device is based on a combination of a narrow-gap semi-conductor that absorbs a major part of the solar spectrum, and an organic film that plays the role of a selective contact to draw off electrons or holes and further transmit them to the respective electrode. According to the above concept, we have found and developed hybrid bilayer heterojunctions which are based on combinations of inorganic *CdS*, on the one hand, and Si semiconductor, on the other hand, and various organic materials, such as conductive polymers and low-weight organic molecules, respectively. Our best hybrid organic-inorganic structures based on silicon showed the power conversion efficiency up to 5.6 %. The devices based on *CdS*, although displaying acceptable open-circuit voltages, possess lower efficiencies, so our current trends are to reduce the *CdS* film thickness by using vacuum evaporation and nanotechnology techniques, and adjust a proper dopant and electrode for the film to increase the photocurrent. The aim of the above researches is, on the one hand, to disclose the underlying physics of the processes at the organic/inorganic interface which are responsible for the photo-generated charge carrier separation, and, on the other hand, to create photovoltaic cells with acceptable efficiency-to-cost ratio. Our further activity is directed to development of the improved morphology of the inorganic counterpart of the hybrid cell by modification of the crystal surfaces, use of inorganic nanoparticles, synthesis of nanorods and complex nanorod/nanoparticle systems.

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