Synthesis and application of hybrid polymer-polymer and polymer-inorganic semiconductor nanocomposites

Alexander A. Pud
Institute of Bioorganic Chemistry and Petrochemistry of NAS of Ukraine, 50 Kharkivske shose, 02160, Kyiv, Ukraine, echoc@mail.kar.net

The high technology and smart possibilities, which are inherent to different hybrid semiconductor nanostructures, have motivated us, as well as a lot of other researchers and companies, to synthesize and study such materials. It is expected that these nanocomposites due to synergetic combination of their components will effectively work in photovoltaic, optoelectronic and sensor devices, catalytic and membrane systems, etc.

As one of the possible useful components of the hybrid composite materials we suggest to use a common transparent polymer with high environmental stability. We hope that this additive can impart to these materials easier modification, variability, better processibility, low cost, higher stability, etc. as compared to traditional materials. However, additional work with optimization of morphology and compatibility of these materials should be performed. Specifically, in case of BHJ photovoltaic devices the conditions (solvent or melt, temperature, concentration etc.) should be found, which allow formation of interpenetrating charge-transporting networks of donor and acceptor phases in a free volume of amorphous phase of matrix of the common polymer

Among different approaches tried to produce such the materials, we prefer the synthetic approaches allowing chemical/electrochemical synthesis of one component (polythiophene, polyaniline, their derivatives like P3MT, P3HT, POMA etc.) in the presence of other component (nanocrystals of CdSe, CdS, SiC, etc. or particulate/film/dissolved phase of common filmforming polymer) and *vice versa*. The effectiveness of these approaches stems from the fact that an intimate contact among all the system participants is formed during the synthetic process. This way can be especially effective in case of grafting the synthesized component (phase “guest”) to the surface of the “host” one that sometimes results in formation of core-shell structures. As an important practical issue here we consider a possibility of modification of the host component (e.g. inorganic nanocrystals) under chemical pressure of the synthetic medium. Specifically, this can be resulted in change of surface states of this component or in its damage.

We have been developing synthetic methods to form such the semiconductor polymer-common polymer, inorganic semiconductor-semiconductor polymer, inorganic semiconductor-common polymer or ternary nanocomposite materials. A special attention is paid to doping of inorganic semiconductor particles (CdS, CdSe). The properties of the prepared materials (including photovoltaic, photoluminescence, conductivity, sensory, thermostability, morphology, spectral, etc.) we have been investigating in collaboration with teams of Institute of Semiconductor Physics of NAS of Ukraine, Kyiv, Ukraine (Dr. O.P. Dimitriev, Dr. P.S. Smertenko), Laboratoire de Physique de l’Etat Condense Université du Maine, Le Man, France (Prof. A. Kassiba), Materials Science & Engineering Department, Western Michigan University, Kalamazoo, USA (Prof. V.N. Bliznyuk).