Comparative study of several fullerene based bulk heterojunctions

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The use of bulk heterojunction based on organic semiconductors is a promising method of the organic nanophotonics, particularly for the creation of an organic solar cells [1]. The bulk heterojunction can be created in a form of inter-penetrating network of donor and acceptor materials, which can be used to increase the efficiency of converting solar energy in the photocell.

Organic heterostructures with thickness of 100 - 1000 nm were obtained by vacuum deposition technology in the quasi-equilibrium conditions. It's a novel method of creation a nanocomposite material consisting of organic and inorganic semiconductors with a composition gradient for the realization of a bulk heterojunction. The structure, composition and electrical properties of composite thin films of organic semiconductors C_{60} and *Me*TPP (tetraphenylporphyrin *Me*, where *Me* = Zn, Cu, or a complex of FeCl), as well as the C_{60} films with the addition of an inorganic n-type semiconductor CdS were analysed. Structural properties of the films were investigated by AFM, Raman and x-ray spectroscopy. The electrical properties of sandwich-structures on ITO-glass and Si (111) substrates were investigated. In such structures C_{60} acts as an acceptor, porphyrin or CdS molecules acts as an donor center [2].

Current-voltage characteristics of this composite heterostructures have a diode character for the different pairs of C_{60}-*Me*TPP, as well as for C_{60}-CdS. The rectification factor depend on the composition and structure of the film, as well as the composition gradient. For the structures glass/ITO/C_{60}/mixtureC_{60}-CdS containing CdS about 1 at.%, the direct to reverse current ratio at 1 V is about 10^3. It's the record value for the organic diode structures. The increase of CdS concentration to 30 at.% leads to a decrease in this ratio. Direct and reverse I-U curves can be satisfactorily described in a model of hopping conductivity and non-ideal heterojunction; relative contribution of these mechanisms is determined by the composition of the sample.

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