NANOPHOTONIC SENSORS FOR BIOMEDICAL AND ECOLOGICAL APPLICATION

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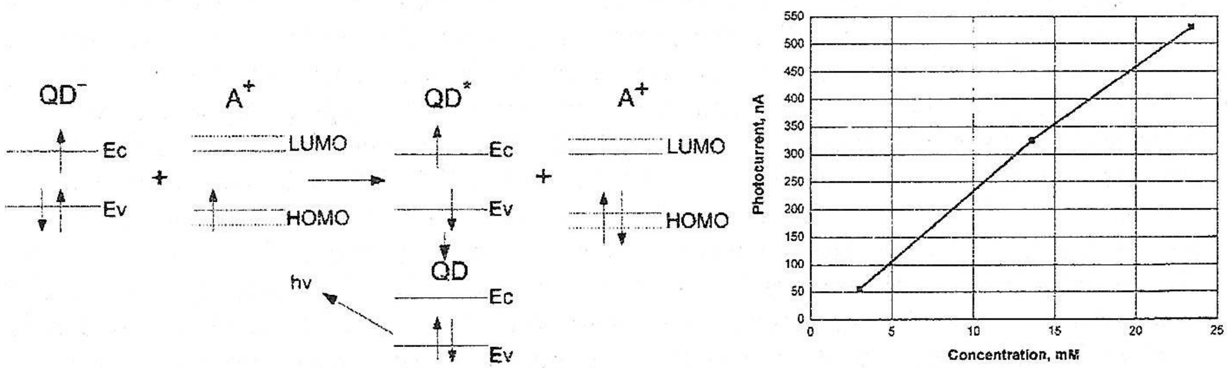
There is an ever-increasing need to enhance the capability of sensor technology for health, structural and environmental monitoring. One area of great concern is new strains of microbial organism and the spread of infectious diseases that requires rapid identification and detection in vivo and in vitro. Another area of major concern, worldwide, is the threat of chemical and biological terrorism. This points out onto necessity of improovement of existing and development of novel detection technologies based on nanomaterials [1]. Nanophotonics-based sensors utilizing nanostructured multiple probes provide the ability for simultaneous detection of different biomedical and ecological objects as well as the ability for remote sensing where necessary. A useful future approach can utilize nanoscale optoelectronics with hybrid detection methods involving both photonics and electronics.

In this abstract we discuss the development and study of nanophotonic sensors for early diagnostics of tuberculosis and for the determination of hazardous carcinogens and metabolites in biological liquids and environment water developed in the frameworks of STCU projects № 4495 and 5067.

The modern tendency of novel sensors development is the miniaturization of the electrodes and their modification with nanostructure materials in particular with semiconductor nanoparticles, nanocrystals, nanoclusters and quantum dots. Construction concept of nanophotonic sensor is selection of suitable nanomaterials, in our case, semiconductor quantum dots (QDs) and their plotting on the sensor's working electrode surface by appropriate nanotechnology.

At the core of nanophotonic sensor is the process of QDs transfer to ionic forms in a consequence of electrochemical processes and reactions with oppositely charged ionic forms of the analyte, resulting in the emission of an analytical optical signal (Fig. 1, a). The number of quanta emitted at the given period of time is the measure of analyte content.



(a) (b)

Fig. 1. Scheme of the process for polycyclic aromatic hydrocarbons detection: Ec – QD's conduction band; Ev – QD's valence band; LUMO – lowest unoccupied molecular orbital, HOMO – highest occupied molecular orbital (a); concentration dependence of photocurrent of the model tryptophan solution (b).

One of the results of tuberculosis markers study is the detection of tryptophan aminoacid as a potential marker of open form of pulmonary tuberculosis by nanophotonic sensor using semiconductor CdTe QDs with diameters of 3 nm (Fig. 1, b).

1. P. N. Prasad, Nanophotonics. – New Jersey: John Wiley & Sons, Inc., 2004.