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BIOCHEMICAL DETECTOR BASED ON THE CONTROLLED TUNNELING BETWEEN DETECTOR NANOSTRUCTURES AND ANALYTE

Abstract

Current biochemical sensors are typically based on detection of optical or electrical changes after capture of an analyte molecule at the detector surface. There is an intrinsic tradeoff between specificity, which is increased by functionalization of the detector surface, and the range of detected molecules that can be detected, when these detection methods are employed. Present will be results on development of a high sensitivity high selectivity biochemical sensor based on charge transfer between detector semiconductor nanostructures and analyte molecules that are to be detected. The sensor is based on an original concept that relies on the tunneling between an analyte molecule and the discrete energy levels of the detector nanostructures. The energy levels in the detector nanostructures, which depend on quantum confinement and external effects, are tailored to mimic the energy levels of the analyte to be detected. Charge tunneling between the detector's nanostructures and the analyte will occur only if the analyte has the energy levels matching the energy levels of the detector's nanostructures. This completely new concept for biochemical sensors, which leverages the unique properties of nanostructured materials and design and optimization of nanomaterials, may potentially lead to label free detection and identification of a wide range of analytes with single molecule sensitivity. It will allow for continuous, instantaneous real time, high selectivity, high sensitivity, miniature, in situ characterization device that could be implemented in various applications. The sensor may be a standalone unit or it can serve as a part of an instrument, enhancing selectivity and sensitivity of that device. Discussed will be modeling of the optoelectronic properties of nanoscale materials and QDs for realistic QD detector ensembles, including the study of collective effects and external electrical field on the energy level spectra, charge transfer processes between nanostructures, and interaction of the light with nanostructures. In addition to the theoretical result that were important for our experimental research and production of the sensor components presented will be also sensor prototype design.