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Nanoelectronic detection of dynamic cell functions

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As the current follows solely or largely on the surface, the conductance of the semiconducting nanomaterials is highly sensitive to the electrochemical perturbation induced by the interacting biomolecules or by biological activities of the interacting cells. Taking advantage of this, nanoelectronic biosensors based on these nanostructured materials have been developed, promising novel applications for fundamental studies, diagnosis, and drug screening. This presentation briefly reviews our works on the nanoelectronics-biology interface. More specifically, we have developed and used nanoelectronic field-effect transistors based on carbon nanotubes, graphene, or silicon nanowires to electrically detect the presence of biomolecules or dynamic activities of live cells (secretion of biomolecules or chemicals, ion channel activities, metabolic activities), with high sensitivity, high temporal resolution, and high throughput.

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GOx detection based on amperometric response of electrochemical glucose biosensor using hydrothermal sol-gel synthesized ZnO nanorods

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This paper describes the fabrication of a glucose sensing biosensor. The working principle is based on the electrochemical reaction taking place between immobilized glucose oxidase adsorbed by the ZnO nanorods, and the electrolyte glucose. Zinc oxide (ZnO) nanorods were synthesized on indium titanium oxide coated glass substrate using the hydrothermal sol-gel growth technique. Characterization of the ZnO nanorods is performed using the absorption spectroscopy, micro-Raman spectroscopy and scanning electron microscopy. A blue shift is observed in the optical band gap due to increased particle size and density of the ZnO nanorods compared to bulk ZnO. The two-electrode system is employed to measure current for sensing the glucose concentration inside an electrochemical cell. Nafion/GOx/ZnO nanorods/ITO is used as the working electrode, and platinum plate as the reference electrode. Amperometric response for clinical range of blood glucose concentration from 0.25–20 mM is measured at 0.8 V. The response time for the proposed biosensor is identified to be less than 3 s. For a linear range of glucose concentration from 0.25–7.5 mM the analyzed sensitivity is 51.3 $\mu A/cm^2\ mM^{-1}$ and the lower detection limit is 5 µM. The electrochemical characterization of the biosensor is performed using the cyclic voltammetry method for a voltage range from -0.2-1 V at a scan rate of 0.1 V/s. The achieved results indicate that ZnO nanorods based working electrode demonstrate much higher current response, excellent stability, reusability, and faster response time than previously reported enzymatic electrochemical biosensors.

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