Chapter 7

Performance Analysis of FET-Based Nanoiosensors by Computational Method

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ABSTRACT

Human body has a hierarchy of structures. There are many organs which are affected much earlier by a disease when it is detected. Most modern sensors can detect anomalies when its concentration in the body fluid reaches to millimolar range. But more sensitive biosensors should detect disease from much lower concentration like femtomolar range. So, extremely sensitive biosensors are needed for early detection of fatal diseases at their early stage. It should detect the target molecule from a very low concentration of analyte. Also, molecules which we often need to detect are too small in size. So Nanotechnology and biotechnology should shake hand to detect nanosized particles from an extremely low concentration solution. Hence we are in a real need of a biosensor. Here we are interested in charged biomolecules and will discuss the performance of Field-Effect Transistor based biosensors by computational method.

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INTRODUCTION

Recalling Moor’s law, it is the real picture that an IC chip now contains billions of transistors. But simultaneous idea of lab on a chip is the real challenge of a nanobiosensor so that it can monitor our whole physiological process as we require. Also, it should direct us for personalised medicine. Now people are trying to develop sophisticated and intelligent nanobiosensors. Nanowire, nanosphere sensors, nanocantilever sensors, field-effect transistor (FET) type sensors, array sensors are some of the models of newly developed sensors.

There are several processes to detect biomolecules from solution depending on their mass, charge, redox potential and even optical index. A biosensor is an analytical sensing device that converts a biological response into an electrical signal to sense materials like antibody, protein, enzyme etc. Detection of disease, quality of food estimation, monitoring environmental condition, agriculture, and pharmaceutical uses are some of the essential applications of biosensor. There are some types of biosensors like potentiometric, amperometric and calorimetric paper biosensor which are commonly used nowadays. With the progress of nanoscience nanotechnology, a tremendous breakthrough can be expected in near future. A sensor must be accurate, sensitive, have very low response time and should be reproducible and it is must be free from electrical noise. Besides, it should be cheap, portable and easy to use.

In every aspect of biosensing, the label-free approach using FET nanobiosensors are proving their superiority regarding target specificity, cost effectiveness, the ease of use and portability than the existing label-based enzyme-linked immunosorbent assay (ELISA) biosensing technique. As the various studies on biosensors are still in the developing stage, so simulation studies now have greater importance. Here we have done a detail analysis of various level free biosensors like flexure FET sensor, double gate FET pH sensor and extended gate FET pH sensor. Many of their important characteristics are studied in detail.

BACKGROUND

The following review briefly describes the progress of biosensing technology until now including both experimental and computational contributions.

Experimentally there are many literatures which address the development of various nanobiosensors which are based on diverse principles of detection and produce different types of devices. Nanoparticles, carbon nanotubes (CNTs), nanowire, magnetic particles, metallic platelets and graphene sheets are some of the candidates found to be used for this purpose. Not only in nanomedicine, biosensors are used in finding food pathogens, environment pollutants and in bioterrorism. Lee and Fauchet
Nanorevolution and Professionalizing University Education: Opportunities and Obstacles
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