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Increased Sensitivity of Biosensors using Evolutionary Algorithm for Bio-Medical Applications[1]

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Abstract—The use of bio-medical applications and bio-inspired computing facilitates the diagnosis of human health. The main work of bio-medical applications relies mostly over the biosensors. Biosensor construction are based on piezoelectric, chemical, optical or electronic principles. Field Effect Transistor (FET) based biosensors gain popularity because of some distinct advantages like compact, fast measurement and portable instrumentation. Due to their small size, FET based biosensors are considered as potential candidates for point of care testing. In this paper, we have investigated the sensitivity of FET biosensors based on Evolutionary Algorithm for Bio-Medical (EABM) applications. We have also discussed major limitations in FET based biosensors like inability to detect neutral charged biomolecules and lesser sensitivity. Current mechanism in tunnel FET is based on band to band tunneling and this property is explored to enhance sensitivity of the device. In this paper, sensing is modeled with drain current, while as effect of variation in biomolecule concentration is based on changes in doping concentration and use high dielectric constant materials. The proposed EABM algorithm shows that the optimized value of drain current (sensitivity) is obtained with increase in doping concentrations or dielectric constant at the gate. The results also depict that the proposed EABM approach outperforms existing FET models.

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1. INTRODUCTION

Biosensors are devices used to convert biological response into electrical signal. They determine the concentration of substance by interaction of biological element with analyzer. Various types of biosensors are typically based on electronic, electrochemical, optical or piezoelectric principles.

For instance, piezoelectric biosensors are based on principle of electrical voltage change with applied stress on crystal. While as, in case of electrochemical biosensors, change in electrical quantity like voltage or current is sensed and interpreted. Semiconductor based biosensors have witnessed substantial growth due to the development in Semiconductor Technology and its application in various fields. FET based (Field Effect Transistor) sensor was developed in 1970.

Clark and Lyon [1] introduced biosensors in 1962, and since then they have found applications in industrial, biomedical and healthcare applications. Among various available biosensing devices, FET biosensors are found attractive because of their sensitivity, easy operation, low cost, mass production, high speed and requirement of minute samples for testing. Bergveld [2] initially reported principle of ion-sensitive biosensor (ISFET) based on conventional MOSFET (Metal Oxide Semiconductor Field Effect Transistor) in 1970. Janata and Moss [3] used this concept for study of enzyme by FETs. Caras and Janata [4] showed the first practical use of FET biosensor for penicillin use in 1980. Various other papers are demonstrated the capabilities of FET biosensor with different molecular targets [5], like amino acids [6], nucleotides and cells [7].

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