LABEL FREE DETECTION OF BIOMOLECULES USING TUNNEL FIELD EFFECT TRANSISTORS

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Highly sensitive, fast and inexpensive detection of various biomolecules is a crucial factor for medical diagnostic tools. The CMOS technology has gained a huge attention in the domain of biomedical applications over a last few years. Being a well matured technology driven by continuous dimension scaling ensures the device to detect the biomolecules of equivalent dimensions and even small quantities with high sensitivity. The key advantages offered by field-effect based biosensors are: direct label free detection, high sensitivity and selectivity, electrical signal transduction and time saving. The detection procedure involves monitoring the change in the electrical parameters (i.e. conductance, threshold voltage) due to the binding of the biomolecules to the device surface. The cost effectiveness and scalability of the sensor design can further be enhanced by choosing a less complex fabrication process flow of Junctionless FET [1] for the transducer. A performance based comparison of JL-FET with the counterpart conventional MOSFET design can further reveal the key benefits of JL-FET based transducer design. In addition, it is also important to study the impact of detection environment (dry and fluidic) on the sensitivity. The proposal of a Dielectric Modulated Tunnel Field Effect Transistor (DM-TFET) based biosensor through analytical and simulation based study [2-3] highlighted its advantages in comparison to DM-FET biosensors. One of the most important and crucial step in DM-FET process step is to carve the nanogap cavity but due to process variability, cavity length may change. Another concern is the partial hybridization (PH) of biomolecules due to steric hindrance inside the nanogap cavity as shown in Fig 1(a). Further, the positioning of the probe/receptors on the cavity surface to which target biomolecules bind also brings a change in the device characteristics.

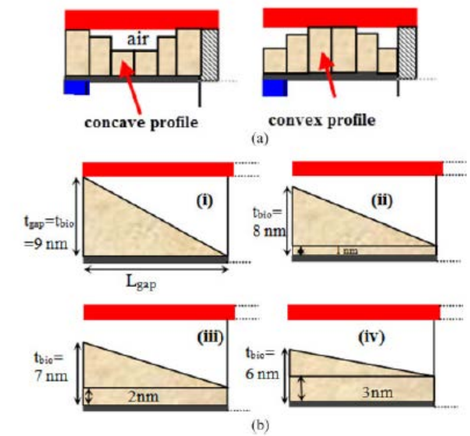

Fig. 1. (a) Non-uniformly partially filled cavity (with step profile) depicting concave and convex profile (b) non-uniformly partially filled cavity with slant profile [4].

The above mentioned effects have been investigated [4] to ascertain the suitability of TFET architecture for biosensing applications. In this talk, the role and influence of various process, experimental variations and hybridization profiles of the biomolecules on the sensitivity of the DM-TFET biosensor has been discussed to analyze the pros & cons of DM-TFET based biosensors by having a fair performance comparison with DM-FET biosensor.

References

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