7th Asia-Pacific Conference on Plasma Physics, 12-17 November, 2023,
Port Messe Nagoya, Japan

Simulation Analysis for Detection of various Biomolecules in a Double Gate Plasma-Assisted Carbon Nanotube Field Effect Transistor (DG-CNFET)

Bhargavi Sharma[1], Nagendra Singh[1], Jyoti Upadhyaya[1] and Mansha Kansal[2]

[1]Department *of Biotechnology, Gautam Buddha University, Greater Noida, UP, India*
[2]Department of Applied Physics, Delhi Technological University, Bawana Road, Delhi-110085, India

e-mail: bhargavisharma030@gmail.com (Bhargavi Sharma) and *kansal.mansha@gmail.com (Mansha Kansal)*

Abstract

These days, practically every field uses a biosensor in some capacity. Biosensors are cutting-edge analytical tools that combine transducers and biological recognition components to identify and measure certain molecules or analytes in complex samples. These advanced devices interact with the target analyte of interest using the inherent sensitivity and specificity of biological elements, such as enzymes, proteins, antibodies, nucleic acids, or entire cells. The biological recognition element and the analyte interact to produce a quantifiable signal, which is subsequently transformed into useable data by the biosensor's transducer component. Medical diagnostics, environmental monitoring, food safety, biotechnology, and pharmaceutical research are just a few of the industries where biosensors are used. Biosensors are employed in the medical industry to diagnose illnesses, keep track of biomarkers, and monitor vital signs in real time. They have made a substantial contribution to personalised medicine by providing quick and precise results that help with early detection and treatment choices. This study suggests a Double Gate Plasma-Assisted (DG-CNFET) based biosensor for the detection of various biomolecules. The impact of different biomolecule species (e.g., Uricase, Protein, APTES, ChOX, Streptavidin and Biotin) on the device's performance metrics has been studied. With the addition of biomolecules to the nanocavity, it has been noted that the drain current increases significantly. Similarly, biomolecules can also be used to obtain the change in transconductance. We analyse the various electrical properties of proposed device e.g., transconductance, output conductance and cutoff frequency at different plasma assisted channel radius. In addition to the excellent power performance of DG Plasma-Assisted CNFET, this device has demonstrated good sensing and can be effectively used for biosensing applications.

References

1. R. Narang, M. Saxena, and M. Gupta, Investigation of dielectric modulated (DM) double gate (DG) junctionless MOSFETs for application as a biosensors, *Superlatt. Microstruct.* **85**, 557 (2015).
2. C. Vu, Field-effect transistor biosensors for biomedical applications: recent advances and future prospects. *Sensors* **19**, 4214 (2019).
3. Y. Chen et al., Field-effect transistor biosensor for rapid detection of Ebola antigen. Sci. Rep. **7(1)**, 1–8 (2017).
4. I.M. Hyungsoon, X.-J. Huang, B. Gu, Y.-K. Choi, A dielectric modulated field-effect transistor for biosensing. Nat. Nanotechnol. **2,** 430–434 (2007).
5. M. Kansal, S.C. Sharma, Plasma-based nanoarchitectonics for vertically aligned dual-metal carbon nanotube field-effect transistor (VA-DMCNFET) device: effect of plasma parameters on transistor properties. *Appl. Phys. A* **128**, 28 (2022). https://doi.org/10.1007/s00339-021-05096-2
6. M. Kansal, S.C. Sharma, Performance Evaluation & Linearity Distortion Analysis for Plasma- Assisted Dual-Material Carbon Nanotube Field Effect Transistor with a SiO_2-HfO_2 Stacked Gate-Oxide Structure (DM-SGCNFET). *Silicon* **14**, 12381–12391 (2022). https://doi.org/10.1007/s12633-022-01930-1