Dielectric Modulated Triple Metal- Plasma Assisted - Carbon Nanotube Field Effect Transistor (TM-PA-CNTFET) Biosensor for Detection of Various Biomolecules

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Abstract

There has been growing interest in field-effect transistor (FET)-based biosensors due to their advantages in terms of miniaturization and sensitivity. However, as silicon nanotubes face scaling challenges, researchers have turned to high-mobility channel alternatives, particularly carbon nanotubes (CNTs). CNTs, defined as graphitic cylindrical or spherical filaments often with conical tips, measure in nanometers in radius and several microns in length. In this work, a novel design for a biosensor named Dielectric Modulated Triple Metal- Plasma Assisted - Carbon Nanotube Field Effect Transistor (TM-PA-CNTFET) Biosensor for Detection of Various Biomolecules has been proposed. This work is based on a Plasma-Assisted Carbon Nanotube Field Effect Transistor in which CNT is grown using PECVD technique and used as a channel of FET. A detailed analysis was conducted on the TM-PA-CNTFET, focusing on biomolecules such as MCF-10A as a1, Hs578T as a2, and MDA-MB-231 as a3. This was achieved by modifying the permittivity of the TM-PA-CNTFET, which alters the movement of charges in the carbon nanotube based plasma region, thereby altering drain current, Transconductance, output conductance, sub-threshold slope and other related parameters. These results emphasize the importance of precise plasma control in maximizing device efficiency. The proposed TM-PA-CNTFET design aligns strongly with experimental observations, confirming its feasibility for real-world biosensing applications. This study provides critical insights into the role of plasma-assisted fabrication in advancing TM-PA-CNTFET technology for next-generation biosensors.

References

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