**Simulation of a Silicon Nanowire FET Biosensor with Varying Surface Charges for Diabetes Mellitus (DM) Monitoring Applications**

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**ABSTRACT**

Diabetes Mellitus is a growing global health concern due to its rapidly increasing prevalence and high morbidity and mortality rates. This study focuses on examining the impact of silicon nanowire channel width and the number of channels on the performance of silicon nanowires in the early detection of Diabetes Mellitus.To achieve this, silicon nanowire structures with varying widths were modelled. Using Silvaco ATLAS simulation software, three types of p-type silicon nanowire sensors were designed with identical height and length, but with widths of 0.01, 0.05, and 0.10 µm. The devices were simulated to observe and compare their electrical characteristics.Results show that reducing the channel width leads to a decrease in the drain current (Id) due to increased resistance, which is attributed to a higher surface-to-volume ratio. The narrowest channel width exhibited the greatest resistance to Id.To further evaluate performance, device configurations with three and five channel pairs were tested. Various values of negative interface charge (Qf = -0.1, -0.5, -1.0, -1.1, and -1.5 e·cm⁻²) were applied to the interaction layer or surface channel. A higher negative surface charge increased Id, as it attracted hole carriers toward the surface of the p-type nanowire, leading to charge carrier accumulation and easier current flow across channels.Additionally, increasing the number of channels enhanced the Id response. The configuration with five channels demonstrated the highest sensitivity, measured at 7.635 μA/e·cm², indicating its strong capability to detect negative interface charges. This suggests that devices with a greater number of nanowire channels offer improved interaction with target biomolecules, making them promising candidates for early disease detection applications.

**Keywords:** *Silicon nanowire, Diabetes mellitus, Biosensor, Device simulation, Surface charge*