Fabrication and simulation of silicon nanogaps pH sensor as preliminary study for Retinol Binding Protein 4 (RBP4) detection

Abstract - In this research, a silicon nanogap biosensor has the potential to play a significant role in the field of biosensors for detecting Retinol Binding Protein 4 (RBP4) molecules due to its unique nanostructure morphology, biocompatibility features, and electrical capabilities. Additionally, as preliminary research for RBP4, a silicon nanogap biosensor with unique molecular gate control for pH measurement was developed. Firstly, using conventional lithography followed by the Reactive-ion etching (RIE) technique, a nanofabrication approach was utilized to produce silicon nanogaps from silicon-on-insulator (SOI) wafers. The critical aspects contributing to the process and size reduction procedures were highlighted to achieve nanometer-scale size. The resulting silicon nanogaps, ranging from 100 nm to 200 nm, were fabricated precisely on the device. Secondly, pH level detection was performed using several types of standard aqueous pH buffer solutions (pH 6, pH 7, pH 12) to test the electrical response of the device. The sensitivity of the silicon nanogap pH sensor was 7.66 pS/pH (R^2 = 0.97), indicating that the device has a wide range of pH detecting capacity. This also includes the silicon nanogap biosensor validated by simulation, with the sensitivity obtained being 3.24 µA/e.cm² (R^2 = 0.98). The simulation of the sensitivity is based on the interface charge (Qf) that represents the concentration of RBP4. The results reveal that the silicon nanogap biosensor has excellent characteristics for detecting pH levels and RBP4 with outstanding sensitivity performance. In conclusion, this silicon nanogap biosensor can be used as a new electrical RBP4 biosensor for biomedical diagnostic applications in the future.

Corresponding Author: Assoc. Prof. Dr. Mohammad Nuzaihan Md Nor
Corresponding Author's Email: m.nuzaihan@unimap.edu.my

Link to Publication: https://doi.org/10.58915/ijneam.v18i1.1684