CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Erika Yang

Project Number

S0627

Project Title

Developing a NanoFET Biosensor Based on MoS2 2D Material for Detecting Low Concentration Illness-Related Molecules

Abstract

Objectives/Goals

The objective of this study is to use advanced MoS2 2D material to chemically bind onto a silicon wafer in order to attempt to fabricate a biosensor that has the sensitivity strong enough to detect low concentration of biological molecules, such as early stage cancer.

Methods/Materials

- 6 inch diameter silicon wafers with SiO2 layer;
- MoS2, Au tape
- Photoresist SPR, developer MF-139, DI water, photomask, lithographic exposure tool;
- Tumor necrosis factor alpha (TNF-alpha);
- Optical microscopy, hot plate, exposure tool

Results

- MoS2 is a new and unique type of material to use when creating a sensitive transistor biosensor to detect low concentration of nanoscale molecules such as early stage forms of cancer.

- Unique advantages of emerging 2-D materials for biosensing applications:
Atomically thin structure => very sensitive to external stimulation => very high sensitivity.

- The multiple sensors can be utilized to enable quantification of low-abundance biomarker molecules as well as the affinities and kinetics of antibody-mediated binding events. The sensors exhibited a TNF-alpha; detection limit as low as 60fM.

- The real-time association/dissociation processes of the antibody-(TNF-alpha) pair were also quantified using multiple sensors. This detection capability can reduce the assay time, having the ability to detect the antigens several minutes to few hours.

Conclusions/Discussion

I was able to experimentally demonstrate through multiple trials that the MoS2-based transistor biosensors are capable of detecting illness-related biomarker molecules with detection limit as low as 60 fM. MoS2 proved to be an attractive choice because of its flexibility and high sensitivity. This is very useful and sensitive to the early detection of illness-related biomarker molecules, such as cancerous cells, and can provide a much more efficient and effective process of detecting early stages of cancer development.

Summary Statement

I successfully demonstrated through multiple trials that the MoS2-based transistor biosensors are capable of detecting low concentrations of illness-related biomarker molecules, such as early stages of cancerous cells.

Help Received

University of Michigan