The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – MPhil Oral Defence

Student : Mr. Md Masruck Alam
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Date : 16 June, 2023
Time : 10:00 am
Zoom Link : https://cuhk.zoom.us/j/99360959655?pwd=WGxtc29NaDhydHNZdXh5TTI5Y3E2UT09
Meeting ID : 993 6095 9655
Password : 658013

Title: Single-Walled Carbon Nanotube Field Effect Transistor Arrays for Chemical Vapor Sensing

Early detection of diseases is crucial to reduce the loss of life and prevent long-term disabilities associated with the progression of the illness. With the advent of nanotechnology-based biosensors, the rate of mortality has decreased due to the improved capabilities of point-of-care disease diagnosis. However, many of the current diagnostic technologies face challenges related to invasive or complicated sampling procedures for the detection of different diseases. Researchers have reported a non-invasive pathway to diagnose diseases by analyzing chemical vapors, such as different volatile organic compounds (VOCs) emitted from body fluids, particularly exhaled breath. Major challenges of this technique include the fact that some volatile chemical biomarkers in exhaled breath are present in significantly low concentrations (sub ppm levels). Additionally, the presence of various chemical compounds in the mixture makes it difficult to selectively identify disease biomarkers. Consequently, there is a pressing need for a novel chemical sensor capable of detecting low concentrations of chemical vapor compounds. This thesis work aimed to address the aforementioned challenges by developing highly sensitive chemical vapor sensor arrays capable of selectively detecting volatile chemical biomarkers of interest. We selected semiconducting single-walled carbon nanotubes (SWCNTs) as the sensing material due to their resistance being highly sensitive to the environment. In this project, one of the major challenges is the synthesis of highly semiconducting-enriched SWCNTs suitable for scalable sensor fabrication. To address this issue, we have developed a chemical vapor deposition (CVD) synthesis process to produce semiconducting SWCNTs on SiO_2 and on quartz substrates for scalable sensor fabrication. Improved sensitivity and selectivity of the sensors have been demonstrated by functionalizing SWCNTs with single-stranded DNA (ssDNA) oligomers. The DNA-CNT responses towards different VOCs were then demonstrated by observing changes in source-drain current. This technology can be used to selectively detect the simulated VOC biomarkers present in exhaled breath. We fabricated CNT-FET sensor with a different base sequence of ssDNA and analyzed the common VOCs biomarkers found in the exhaled breath of Tuberculosis (TB) patients. So far, we have demonstrated sensor responses down to <20 ppb levels, and we plan to further analyze the sensitivity to ppt levels of VOCs in complex mixtures.

***** ALL ARE WELCOME *****

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