Department of Biomedical Engineering
The Chinese University of Hong Kong

Graduate Seminar – PhD Oral Defence

Student	**:**	Ms. LI Yitong
Supervisor	**:**	Prof. GAO Zhaoli
Date	**:**	17 July 2026
Time	**:**	2:00 pm
Venue	**:**	Room 404, William M W Mong Engineering Building, CUHK

Title: Engineering Hierarchical Carbon Nanotube Architectures for High-performance Wearable Electrochemical Sensors

Real-time, non-invasive physiological monitoring constitutes a key requirement for personalized healthcare and athletic performance assessment. However, this capability is critically dependent on wearable sensors that combine high sensitivity, mechanical robustness, and electrochemical stability. While carbon nanotubes (CNTs) offer exceptional mechanical, electrical, and thermal properties for such applications, the translation of these advantages into practical wearable devices has been constrained by fabrication bottlenecks, limited mechanical durability, and insufficient signal stability. To address these challenges, this thesis presents research that establishes a pathway from the precision synthesis of CNT nanomaterials to the engineering of high-performance wearable electrochemical sensors.

First, to overcome fabrication bottlenecks, the reliable synthesis of vertically aligned carbon nanotube (VACNT) arrays was developed. Although VACNTs offer high electrical conductivity and structural robustness, their growth is hindered by catalyst agglomeration and low yield. By developing an electron-beam glancing-angle deposition (EB-GLAD) approach, fine morphological control over ultrathin catalyst layers was achieved, yielding high-quality VACNT arrays with a height of up to 2.53 mm. Second, to enhance mechanical durability, these high-quality arrays were employed to engineer a textile-based electrochemical platform. By continuously drawing a conductive CNT sheath from the arrays and wrapping it around a stretchable Spandex core, a flexible hybrid fiber was fabricated. This architecture withstands 500 stretch cycles under high mechanical stress while retaining sensitive detection of sodium ions in human sweat. Finally, to address signal instability, specifically baseline drift arising from water penetration under fluidic conditions, a solvent-densified, monolithic VACNT transducer architecture was designed. By structurally densifying the transducer matrix to restrict liquid permeation, this highly stable platform attains a sodium-sensing resolution of 0.01 mM (1%) against a 1 mM background. Overall, these combined advances provide a robust, high-resolution, and practical foundation for next-generation continuous physiological monitoring.

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

For enquiries, please contact Ms. Joyce Chan, Department of Biomedical Engineering at 3943 8278