Department of Biomedical Engineering
The Chinese University of Hong Kong

Graduate Seminar – PhD Oral Defence

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Date	***:***	6 August 2026 (Thursday)
Time	***:***	2:00 pm
Venue	***:***	Room 408, William M W Mong Engineering Building, CUHK

Title: Phase Singularity Enhanced Beam Shift for Ultrasensitive Plasmonic Biosensing

Plasmonic biosensors offer highly surface-specific biomolecule detection but remain limited in clinical applications due to the simultaneous demands for ultrahigh sensitivity, wide dynamic range, high throughput, and robust assay protocols. This thesis presents a novel phase-amplified beam-shift interrogation paradigm that leverages the enhanced Goos–Hänchen (GH) effect to address these issues.

This approach achieves a sensitivity magnification of one to two orders of magnitude over conventional intensity-based plasmonic sensors. Multiple material platforms—including Silver-GST, Silver-Gold, Silver-Alumina, and Aluminum-Alumina—were systematically evaluated. Fabricated sensors demonstrated refractive index resolutions of **10^{-7} to 10^{-8} RIU**. The Aluminum-Alumina platform, designed for UV plasmon excitation, additionally provides enhanced sensitivity toward UV-absorbing biomolecules such as DNA. To overcome the inherent trade-off between sensitivity and dynamic range, a tunable Silver-Alumina-Graphene sensor was developed, in which electrostatic modulation of graphene's Fermi level enables real-time tracking of the optimal sensing point. For improved throughput, a scalable parallel sensing scheme was implemented using a Digital Micromirror Device (DMD) to generate multiple interrogation beams, combined with camera-based optical amplification of beam shifts, enabling multi-analyte detection and enhanced spatial resolution. Furthermore, a novel surface-based Toehold-Mediated Strand Displacement (TMSD) assay protocol was established for label-free DNA detection. By monitoring the release of a pre-loaded contrast agent, the method achieves **1aM** sensitivity, significantly outperforming conventional absorption-based approaches.

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

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