The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

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Date	***:***	1 June 2022 (Wednesday)
Time	***:***	1:00 pm
Zoom Link	***:***	https://cuhk.zoom.us/j/93126758806?pwd=QXdzclBsOWt5MXlSaldNUHAvYnFnUT09
Meeting ID	***:***	931 2675 8806
Password	***:***	444370

Title: Photo-responsive Fluorosurfactant based on Plasmonic Nanoparticles for Droplet Microfluidics

Droplet microfluidics has become a powerful technique for large-scale studies of single cells and molecules, where uniform droplet reactors with well-controlled sizes and microenvironments are generated, manipulated, and analyzed. Currently, fluorocarbon oil is the most commonly used continuous phase given its good gas permeability, chemical inertness, low toxicity to bioentities, and low solubility to polar molecules. Kinetic stabilization of the water-in-fluorocarbon oil droplets requires the surfactants to be partially fluorophilic and hydrophilic, termed fluorosurfactants. While the stability of droplets is the prerequisite in droplet microfluidics, currently available fluorosurfactants serve merely as a stabilizer without offering any additional functions for droplet manipulation. This thesis, therefore, proposes a novel photo-responsive fluorosurfactant based on fluorinated plasmonic nanoparticles (f-PNPs), not only stabilizing the water-in-oil droplets but functioning as an intermediary for light-driven light droplet manipulation. Fluorinated gold-silica core-shell nanoparticles (f-Au@SiO_2) were synthesized as a demonstration of f-PNPs to stabilize monodispersed droplets generated in a flow-focusing channel. These droplets showed photo-responsive behavior under laser illumination as observed by the explosive generation of vapor bubbles, effectively guiding droplet movement toward a designated direction. The stability of the droplet interface was also transiently modulated by localized photothermal heating, enabling droplet merging induced by the laser in a highly controllable manner. Subsequently, the light-induced bubble generation was applied for selective release of trapped droplets, demonstrating advantages including fast response and simple system configuration. Fluorescence-activated droplet release was demonstrated in a 5×5 floating trap array, which can be potentially scaled up for large-scale screening. Further, the possibility of performing droplet polymerase chain reactions (dPCR) in these f-Au@SiO_2 stabilized droplets was investigated. The droplets were thermally stable and compatible with dPCR with optimized conditions of polymerase and buffer. A fast photothermal ddPCR platform is expected to be developed with the optimization of the f-Au@SiO_2 configuration. Overall, the fluorosurfactant based on f-PNPs is expected to advance the development of droplet microfluidics platforms for large-scale bioanalytic applications.

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

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