Development of Microfluidic Devices For In Situ investigation of Cells Using Surface-Enhanced Raman Spectroscopy

Yu-Han Ho

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Committee:

Qiuming Yu

Shaoyi Jiang

Francois Baneyx

Chemical Engingeering

University of Washington

Abstract

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Yu-Han Ho

Chair of the Supervisory Committee:

Qiuming Yu

Chemical Engineering

Surface-enhanced Raman spectroscopy (SERS) has immerged as a power analytical and sensing technique for many applications in biomedical diagnosis, life sciences, food safety, and environment monitoring because of its molecular specificity and high sensitivity. The inactive Raman scattering of water molecule makes SERS a suitable tool for studying biological

systems. Microfluidic devices have also attracted a tremendous interest for the aforementioned applications. By integrating SERS-active substrates with microfluidic devices, it offers a new capability for in situ investigation of biological systems, their dynamic behaviors, and response to drugs or microenvironment changes. In this work, we designed and fabricated a microfluidic device with SERS-active substrates surrounding by cell traps in microfluidic channels for in situ study of live cells using SERS. The SERS-active substrates are quasi-3D plasmonic nanostructure array (Q3D-PNA) made in h-PDMS/PMDS with physically separated gold film with nanoholes op top and gold nanodisks at the bottom of nanowells. The Q3D-PNAs with the strongest local electric fields (hot spots) at the top and bottom water/Au interfaces, designed by 3D finite-difference time-domain (3D-FDTD) electromagnetic simulations, were placed at the up and down stream of the microfluidic channel for sensitive analysis of cells and small components, respectively. The microfluidic device was fabricated via soft lithography. We demonstrated that normal (COS-7) and cancer (HpeG2) cells were captured on the Q3D-PNAs and investigated in situ using SERS.