הטכניון - מכון טכנולוגי לישראל

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הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

Monday, January 12th, 2026 at 13:30

Room 6

Combining Quartz Crystal Microbalance with Dissipation (QCMD) measurements and Frequency-Domain Lattice-Boltzmann Method (FreqD-LBM) simulations to shed light on biomolecules at solid-liquid interfaces.

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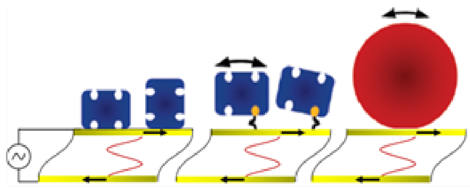
Molecular-level characterization of solid-liquid interfaces is of fundamental interest, while practical applications rely on molecular-level control of interfacial properties. QCMD is a surface analytical technique capable of characterizing solid-liquid interfaces with molecular-level detail.[1] It is based on monitoring resonance parameters, frequency and bandwidth (dissipation), of shear acoustic piezoelectric resonators. In the presence of particulate adsorbates (see figure), these parameters contain information on adsorbate size and mobility: the rocking and pivoting of the adsorbates around the contact regions (see figure).[2] Several *ad hoc* recipes for extracting adsorbate sizes and contact properties from QCMD data have been developed: an extrapolation method,[3] used to study liposome deformation;[4] a calibration-based method for measuring molecular weights of surface-anchored glycosaminoglycans;[5] and one based on the adsorbate intrinsic viscosity.[6] Yet, a consistent method for interpreting QCMD data from particulate adsorbates remains elusive. Its development hinges on the



This work is concerned with particulate adsorbates, such as streptavidin molecules (left), virus particles or liposomes (right) that are adsorbed to the surface of a piezoelectric resonator (yellow) or anchored to it (center), studied in liquid. The resonator executes oscillatory shear motion (straight black arrows) that causes the adsorbates to rock (double-headed arrows) and pivot (not shown) around the contact region. Adapted from ref. 2.

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1 Quartz Crystal Microbalance with Dissipation Monitoring for Studying Soft Matter at Interfaces. 2024; https://doi.org/10.1038/s43586-024-00340-4.

2 Dissipation in Films of Adsorbed Nanospheres Studied by Quartz Crystal Microbalance (QCM). 2009; https://doi.org/10.1021/ac901381z.

3 Model-Independent Analysis of QCM Data on Colloidal Particle Adsorption. 2009; https://doi.org/10.1021/la803912p.

4 Adsorbed Liposome Deformation Studied with Quartz Crystal Microbalance. 2012; https://doi.org/10.1063/1.3687351.

5 A Quartz Crystal Microbalance Method to Quantify the Size of Hyaluronan and Other Glycosaminoglycans on Surfaces. 2022; https://doi.org/10.1038/s41598-022-14948-7.

6 Extracting the Shape and Size of Biomolecules Attached to a Surface as Suspended Discrete Nanoparticles. 2017; https://doi.org/10.1021/acs.analchem.7b00206.

ability to solve the Stokes equation for various adsorbate geometries and mechanical properties in three dimensions to obtain velocity fields needed for calculating interfacial stresses, and from them—the resonance parameters, on personal computers in reasonable time frames. FreqD-LBM[7] has recently emerged as a promising candidate for this purpose. It is well-suited to QCMD because it is based on the complex amplitudes of oscillatory motion and naturally incorporates complex viscosities with which QCMD operates. In this work, we study the adsorption and anchoring of neutravidin—a protein commonly used in biosensing and molecular biophysics—with QCMD under various conditions where it adsorbs either as individual molecules or as aggregates, and attaches to the surface in different ways. We then use FreqD-LBM simulations to model these conditions and arrive at a semi-quantitative interpretation of the QCMD data. It is hoped that this work will pave the way for a QCMD data interpretation framework from particulate adsorbates.

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Refreshments will be served at 13:15.

[7] The Frequency-Domain Lattice Boltzmann Method (FreqD-LBM): A Versatile Tool to Predict the QCM Response Induced by Structured Samples. 2025; https://doi.org/10.1002/adts.202401373.