Interaction of Nanoparticles with Model Cell Membranes: Implications for Nanoparticle Toxicity

PENG YI and Kai Loon Chen (PI)

Department of Geography and Environmental Engineering

Johns Hopkins University

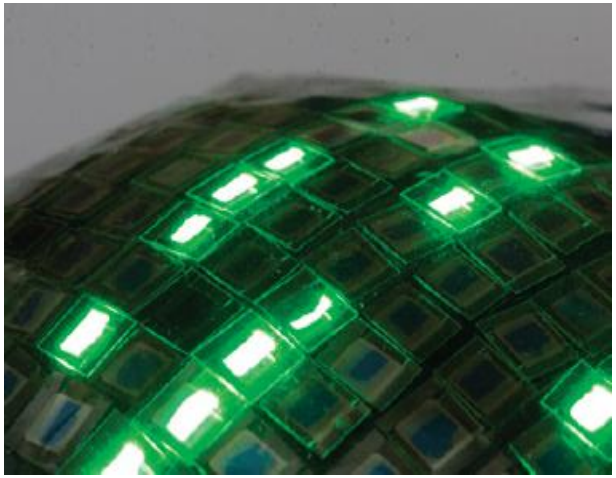
SRC Engineering Research Center for Environmentally Benign Semiconductor Manufacturing

Nanoparticle Applications in Semiconductor Industry

- CeO_2, Al_2O_3, and SiO_2 nanoparticles are employed in chemical mechanical planarization

http://www.levitronix.com/cmp-slurry.html

- Carbon nanotubes (CNTs) are employed in organic LED



Sekitani et al., *Nature Materials*, **2009**, 494-499

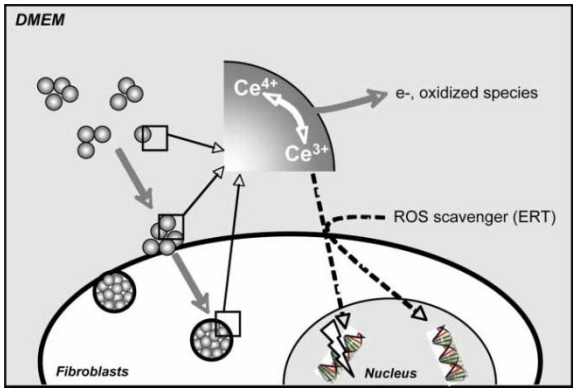
Toxicity of Nanoparticles

- CeO_2 and SiO_2 nanoparticles damage the membranes and DNA of human cells

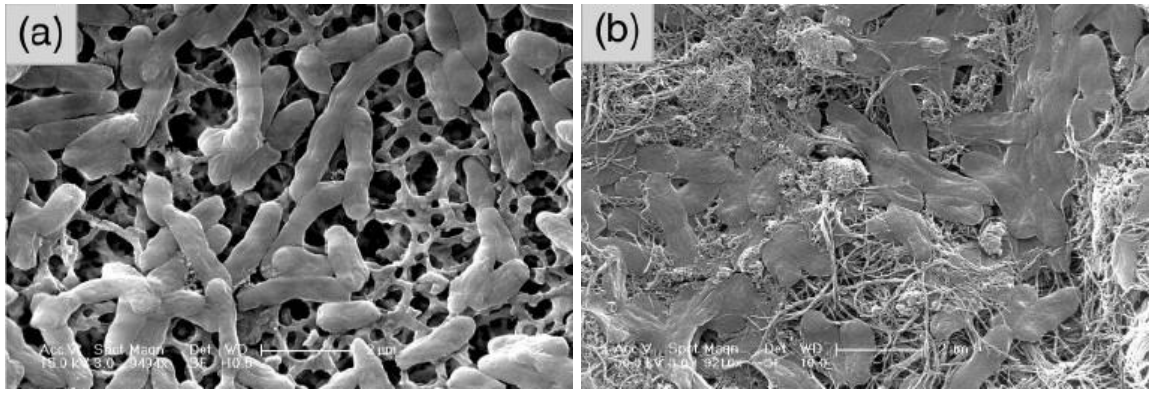
Lin et al., *International Journal of Toxicology*, **2006**, 451-457

Lin et al., *Toxicology and Applied Pharmacology*, **2006**, 252-259

Auffan et al., *Nanotoxicology*, **2009**, 161-171



- CNTs damage bacterial membranes and inhibit bacterial growth



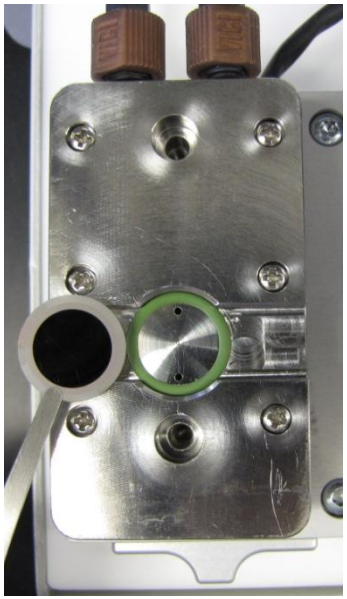
Kang et al., *Langmuir* **2007**, 8670-8673

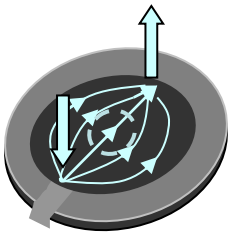
Objective

To investigate the adsorption and desorption behavior of nanoparticles on model cell membranes

Quartz Crystal Microbalance with Dissipation Monitoring (QCM-D)

www.qsense.com

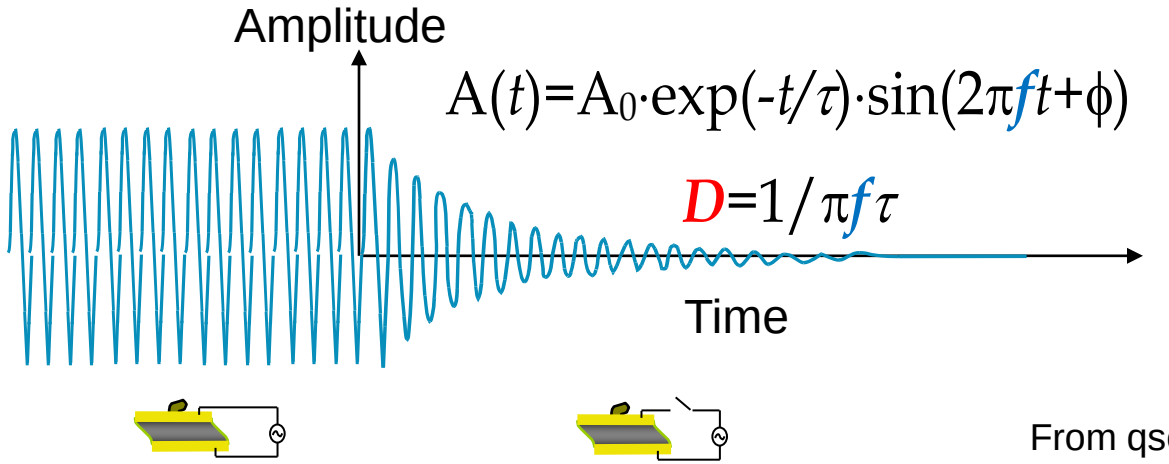




- Widely used in cell and molecular biology (e.g., interaction of biomacromolecules with model cell membranes)
- An emerging technique for studying the interaction of nanoparticles with environmental surfaces

Principle of QCM-D

Frequency and Dissipation

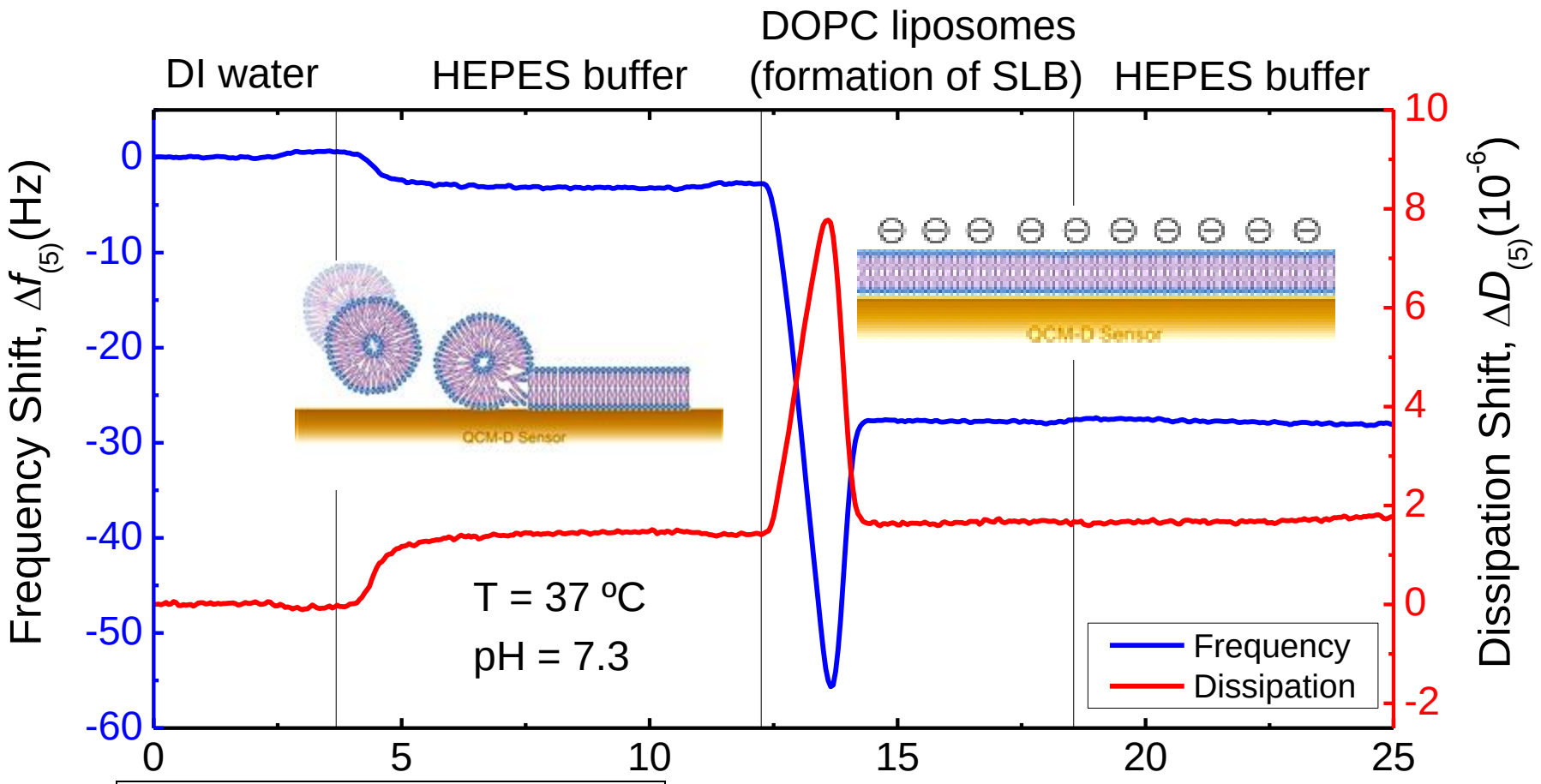


From qsense

- Generally, the frequency decreases as the deposited mass on the crystal increases; the dissipation increases as the softness of the deposited layer increases

- The mass of the deposited layer can be derived from Voigt-based modeling

Formation of Model Cell Membranes on QCM-D Crystals



DOPC:1,2–dioleoyl–*sn*–glycero –3–phosphocholine

SLB: supported lipid bilayer

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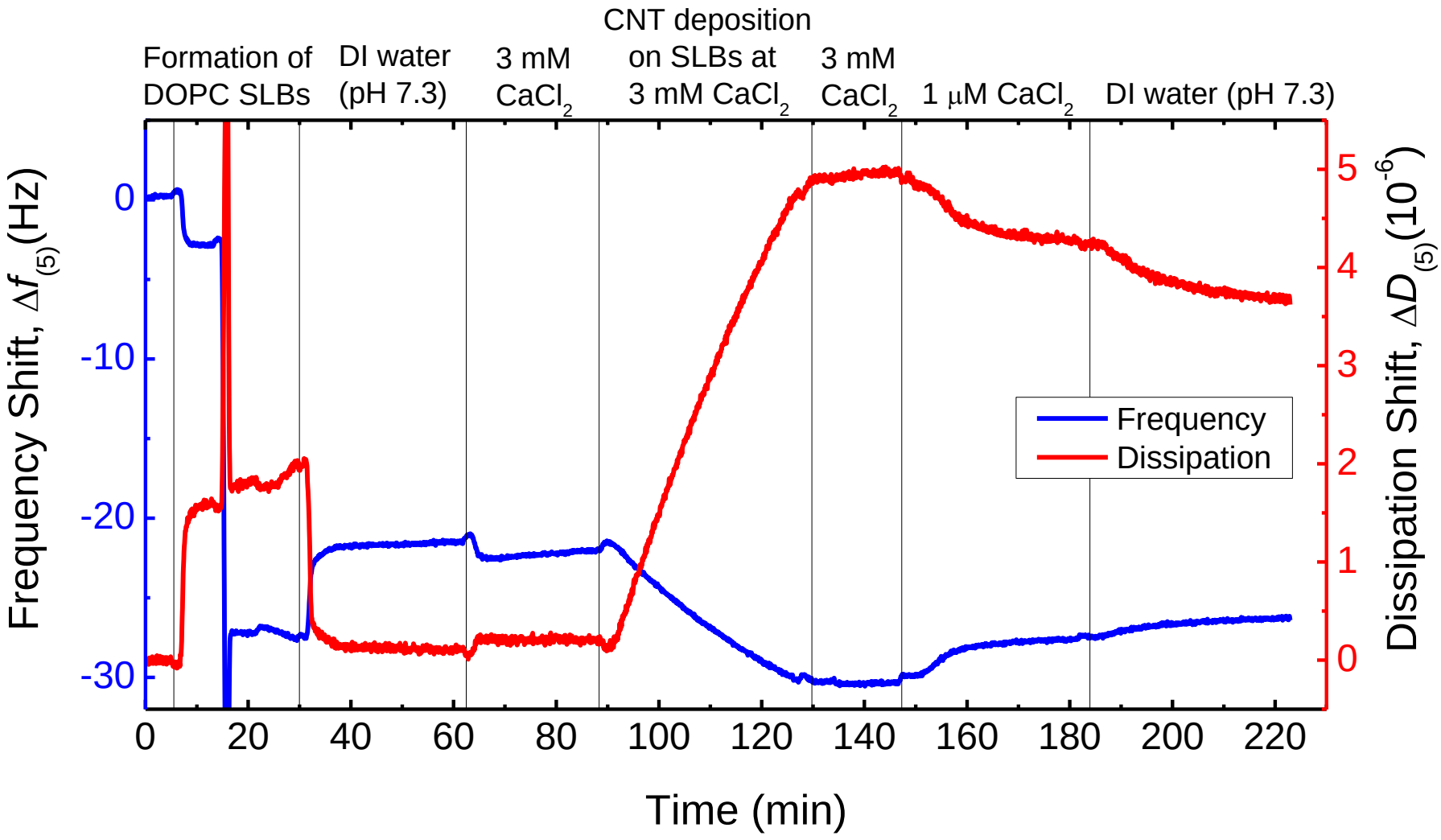
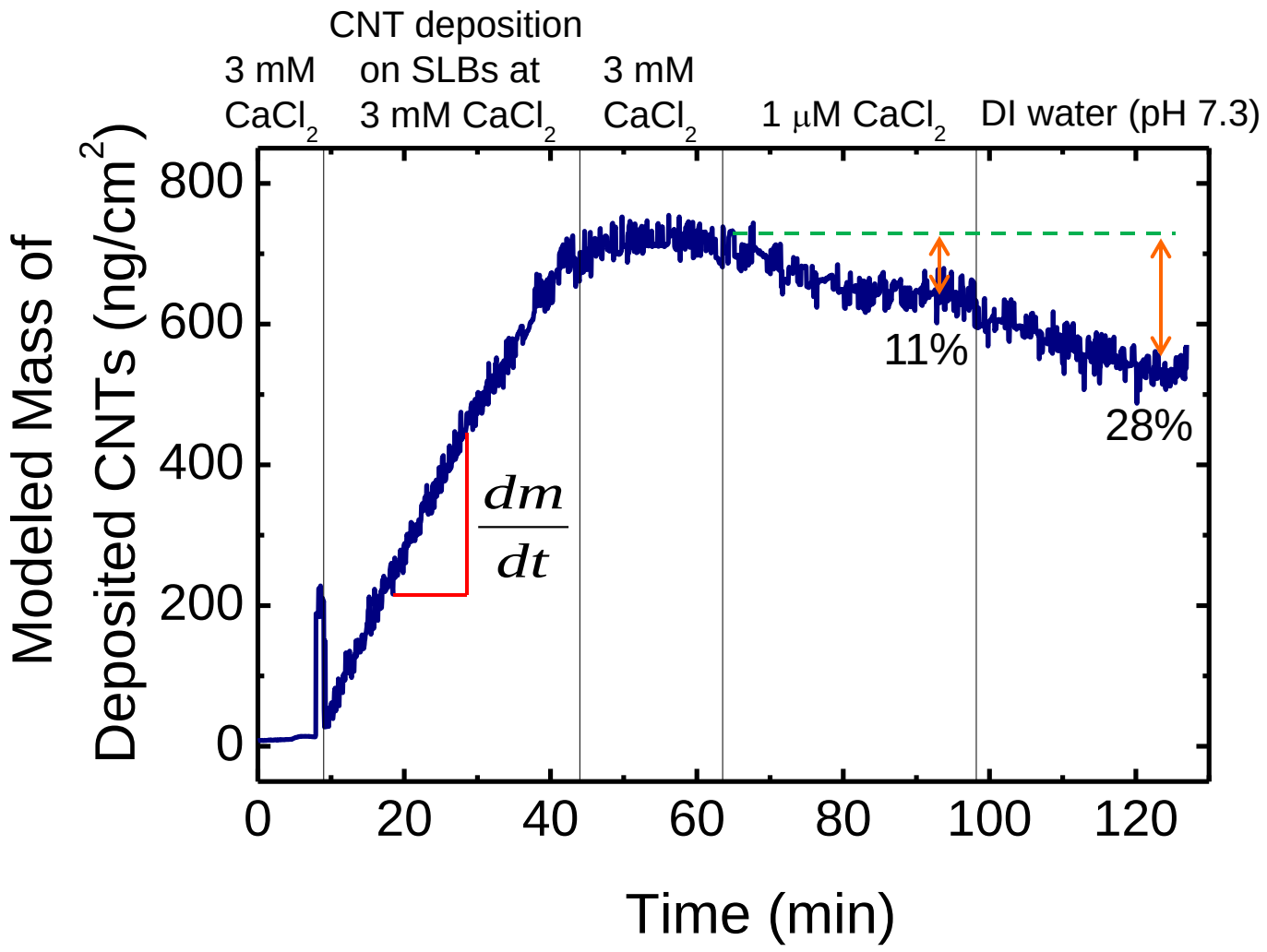
From qsense

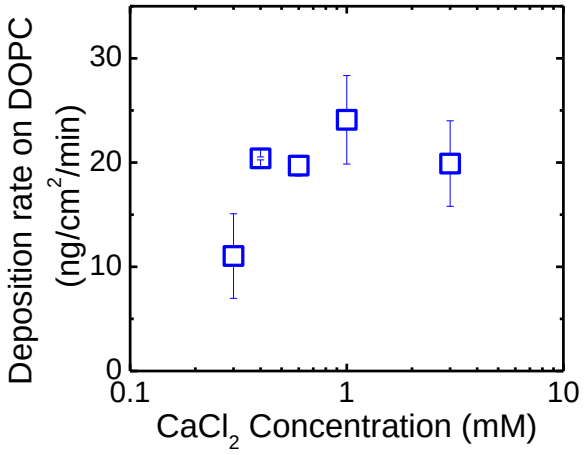
Adsorption and Desorption of CNTs on Model Cell Membranes

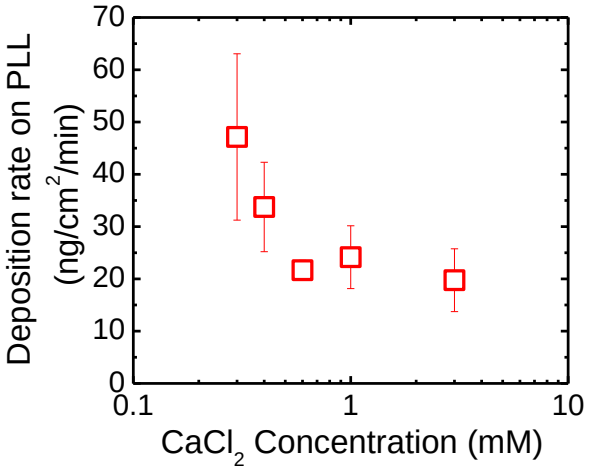


Adsorption and Desorption of CNTs on Model Cell Membranes

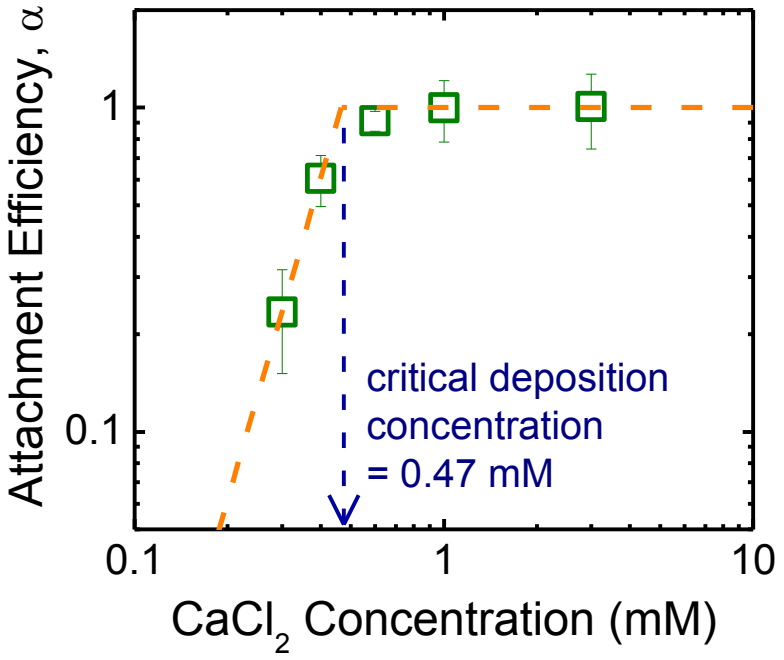


Influence of Solution Chemistry on the Adsorption of CNTs on DOPC SLBs





(PLL: poly-L-lysine)



$$\alpha = \frac{dm/dt}{(dm/dt)_{fav}}$$