Yale Institute for Nanoscience and Quantum Engineering

Friday- April 22, 2016

12:00 to 1:00 p.m.

BECTON SEMINAR ROOM

Light lunch will be served at 11:45 a.m.

Elsa Yan

Department of Chemistry, Yale University

"Chiral Sum Frequency Generation Spectroscopy for Characterization of Protein Structures at Interfaces"

Characterization of protein secondary structures at interfaces in situ and in real time is important to understand biological processes associated with cell membranes and solve problems in various fields of biomedical sciences and engineering. However, such characterization is challenging because it requires methods that are selective to both interfaces and protein secondary structures. We demonstrated that chiral sum frequency generation spectroscopy (SFG) can provide amide I and N-H stretch vibrational signals that are free of water background and characteristic to various protein secondary structures such as parallel beta-sheet, anti-parallel beta-sheet, alpha-helix, 3-10 helix and disordered structures, thus enabling characterizations of proteins at interfaces, similar to circular dichroism spectroscopy for secondary structural characterizations in solution. Using chiral SFG, we studied an amyloid protein, human islet amyloid polypeptide (hIAPP) that is associated with type II diabetes. We observed in real time conformational changes of hIAPP from disordered structures to alpha-helices and then beta-sheets upon interactions with a lipid surface. We analyzed the amide I spectra of the misfolded hIAPP in beta-sheet structures and extracted information about its orientation at the lipid surface, providing insight into pathogenic mechanism of the amyloid disease. We also used chiral N-H/N-D stretching modes as a probe for monitoring real-time proton exchange in protein backbones, introducing a method for studying dynamics and solvent exposures of proteins at interfaces. These results demonstrate chiral SFG as a new tool for characterizing protein structures at interfaces that can potentially be used to address a wide range of fundamental and engineering problems.

Desiree Plata

Department of Chemical & Environmental Engineering, Yale University

What does Environmental Chemistry have to do with Nanotechnology and Vice Versa? Controlling Matter at the Nanoscale to Reduce Global Scale Impacts

Carbon-based nanomaterials are poised to help overcome many global challenges, including providing renewable energy storage and access to clean water. However, these nanomaterials have synthetic routes that are plagued by inefficient atom conversion and high energetic requirements, often resulting in more environmental damage than they offset through technological advances. Furthermore, the promise of these materials has yet to be realized in the commercial sector due to limitations in manufacturing; in particular, molecular-scale control of shape, alignment, defect density, and chirality is not yet demonstrated at scale. Here, we describe insights gained into carbon nanotube (CNT) formation mechanisms derived from an understanding of gas phase transformations that occur during catalytic chemical vapor deposition (CVD). Additionally, the influence of reactive atmosphere on catalyst-on-substrate stability (i.e., sintering and Ostwald ripening) is described. Taken together, a detailed chemical understanding of the reactive atmosphere, the supported catalyst, and their influence on the CNT formation process can be used to simultaneously minimize environmental impacts while maximizing the molecular-scale control during material fabrication.

Host: Professor Eric Altman