Faculty of Engineering and Applied Science
Chemical Engineering Seminar Series

Manipulating 2D Materials with Interfacial Engineering Approaches for Improved Electrochemical Devices

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Thursday, February 14, 2019, 2:30pm
Dupuis Hall, Room 215

ABSTRACT

Graphene and related 2D nanomaterials are expected to revolutionize many applications due to their unique optical, electronic and mechanical properties. These atomically thin sheets are typically micron to submicron-sized in lateral extent when exfoliated from bulk precursors and must be controllably assembled into large area films or coatings to form functional nanocomposites. Graphene-based materials hold significant promise for applications such as rechargeable batteries and supercapacitors which require electrodes with high surface area and controlled porosity while, on the other hand, they can also be processed into non-porous or selectively permeable membranes for applications such as water desalination. Engineering materials which traverse these seemingly conflicting abilities depend largely on how we manipulate their colloidal assembly and aggregation behavior during processing.

In this talk, I will discuss some of the innate processing challenges associated with the fabrication of porous and non-porous films from 2D materials obtained by the exfoliation of bulk precursors. I will then describe several new methods being developed in my laboratory to address or by-pass these challenges in the context of enabling both higher performance energy storage devices as well as improved thin film membranes which can be used in applications ranging from lithium anode protection to desalination. Towards the development of improved supercapacitors and lithium-sulfur batteries, I will highlight recent work that uses colloidal co-assembly strategies to intimately combine active materials into dense, high surface area graphene networks. On the other hand, to create dense blocking layers, membranes and heterostructures, I will discuss a new monolayer film deposition method which utilizes the air-water interface and liquid-liquid spreading to enable continuous film growth and transfer. Finally, I will discuss recent work that investigates the use of laser-conversion of commercial and custom-designed polymers to make patterned, high surface area electrodes for miniaturized and flexible electrochemical devices w simple imbibition and heterogeneous nucleation and growth processes.