PURDUE UNIVERSITY SCHOOL OF MATERIALS ENGINEERING

MSE SEMINAR

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Understanding the chemistry of graphene and two-dimensional nanomaterials

Abstract

Two-dimensional (2D) materials have unique quantum-confined properties in a form that is highly processable. Graphene, the archetypal 2D nanomaterial, is a single atomic layer of carbon with extraordinary properties including exceptionally high electronic carrier mobilities, thermal conductivity, and mechanical strength. Graphene-based applications have been demonstrated in high-speed electronics, chemical and biological sensing, optoelectronics, and energy storage and conversion. In addition, there is a wide-ranging library of 2D nanomaterials including transition metal oxides and dichalcogenides with diverse physical properties that are attracting great interest from researchers. In applications of 2D nanomaterials, the interaction of these atomically thin sheets with other materials plays a crucial role, particularly in influencing the electronic and chemical properties. There is a need to understand and control these interactions at nanometer scales. The chemical functionalization of graphene via organic chemistry is actively being pursued for modifying the electronic structure and doping level of graphene, and for altering its affinity toward various organic, inorganic, and biological materials.

I have pursued the chemical functionalization of graphene via both covalent and non-covalent methods. First, I have explored the self-assembly of organic semiconducting molecules into ordered monolayers on graphene, and their characterization using atomic resolution scanning tunneling microscopy (STM). These organic layers can serve as high quality seeding layers for the deposition (ALD) of oxides that act as gate dielectrics in graphene electronics. Second, I have studied the direct covalent attachment of chemical groups onto the graphene lattice from aryl diazonium salts. The chemical reactivity of graphene toward this reaction was found to depend strongly on the nature of the underlying substrate, which influences the Fermi level in graphene, as shown by Raman spectroscopic mapping. Finally, I have developed new methods in the spatial patterning of graphene chemistry via scanning probe lithography and reactivity imprint lithography, which will enable new applications in electronic devices and chemical sensors. In my future research, I will apply the insights into the interactions of graphene with organic molecules toward newly emerging transition metal dichalcogenide nanomaterials.

Short Bio

Dr. Qing Hua Wang is currently a postdoctoral researcher at the Massachusetts Institute of Technology in the Department of Chemical Engineering. She obtained her Ph.D. in Materials Science and Engineering at Northwestern University in 2010 and her B.A.Sc. in Engineering Science at the University of Toronto in 2005. Her research is focused on the synthesis, characterization, and application of 2D nanomaterials, in particular studying the interactions of these materials with molecules and materials for applications in electronics. Her research interests also include scanning probe microscopy, optical spectroscopy, self-assembly, and nanofabrication.

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