SES13-2013-000263

Abstract for an Invited Paper
for the SES13 Meeting of
the American Physical Society

Tuning Electrical and Optical Properties of 2D Atomic Crystals[1]

A.K.M. NEWAZ, Vanderbilt University

Two-dimensional (2D) atomic crystals are recently discovered materials that are only atoms thick, and yet can span laterally over millimeters. The diverse family of such materials includes graphene, a semimetal with massless relativistic charge carriers, and monolayer molybdenum disulfide (MoS_2), a direct band gap semiconductor with strong spin-orbit interaction. Since every atom in these materials belongs to the surface, their physical properties are greatly affected by the immediate microenvironment. In my talk, I will demonstrate the wide tunability of the electrical and optical properties of both graphene and MoS2 and discuss some novel device applications. In the first part of the talk, I will demonstrate the use of graphene field effect transistors (FETs) in sensing different physical parameters of *nanometer-thick* interfacial liquid volumes. I will show that charge carrier scattering in graphene can be efficiently suppressed, i.e., the electronic quality can be improved, by placing graphene into a higher dielectric liquid environment. In the second part of my talk, I will focus on mononalyer MoS_2 and demonstrate that its optical properties, fluorescence quantum yield and transparency, can be tuned via electrical gating. In particular, we have observed a hundredfold modulation of excitonic photoluminescence from MoS_2 at room temperature by varying the electric fields within ± 1.7 MV/cm. Our findings demonstrate that MoS_2 is the thinnest possible electroactive material.

[1]NSF CAREER DMR-1056859, DTRA grant HDTRA1-10-0047, NSF EPS 1004083 and NSF ARI-R2 DMR-0963361