Defect Engineering in 2-Dimensional Materials: Graphene, Doped-Graphene and Beyond

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This talk will first provide an overview of different defects in 2-Dimensional materials including graphene and Chalcogenides. In particular, we will focus on: *1)* defining the dimensionalities and atomic structures of defects; *2)* pathways to generating structural defects during and after synthesis and, *3)* the effects of having defects on the physico-chemical properties and applications. We will then discuss the synthesis of large-area, high-quality monolayers of nitrogen-, boron- and silicon-doped graphene sheets on Cu foils using ambient-pressure chemical vapor deposition (AP-CVD). Scanning tunneling microscopy (STM) and spectroscopy (STS) demonstrate that defects in doped graphenes arrange in different geometrical configurations exhibiting different electronic and chemical properties. Interestingly, these doped layers can be used as efficient molecular sensors and electronic devices. In this context, Graphene enhanced Raman spectroscopy will be introduced and it will explained that by doping graphene with Nitrogen, the Fermi level (E_F) of graphene shifts, and if this shift aligns with the lower unoccupied molecular orbital (LUMO) of a molecule, charge transfer would be enhanced, thus significantly amplifying the molecule's vibrational Raman modes. Concentrations as low as 10^{-11} mol/L of different dye molecules can be detected using GERS. Finally, we will discuss the controlled synthesis and assembly of chalcogenide monolayers on different substrates. The electronic performance of monolayers of MoS2, WS2 and hetero-systems operating under flexural strain will also be presented. Our findings demonstrates that it is now possible to use chalcogenide layers for the fabrication of flexible electronic devices, however, defect control is required to tailor their performance.

Keywords: graphene, dopant, defects

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