Defect Engineering in 2-Dimensional Materials: From Theory to Applications

M. Terrones

1Department of Physics, Department of Chemistry, Department of Materials Science and Engineering and Center for 2-Dimensional & Layered Materials. The Pennsylvania State University, University Park, Pennsylvania 16802, USA & Institute of Carbon Science and Technology, Shinshu University, JAPAN

This talk will first provide an overview of different defects in 2-Dimensional materials such as 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 could be used as efficient molecular sensors and electronic devices. Finally, we will discuss the controlled synthesis and assembly of chalcogenide monolayers on different substrates. The electronic performance of monolayers of MoS$_2$, W$_2$S$_2$ 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.