UNIVERSITY OF CENTRAL FLORIDA

NANOSCIENCE TECHNOLOGY CENTER
ADVANCED MATERIALS PROCESSING & ANALYSIS CENTER

GRADUATE RESEARCH SEMINAR SERIES

Friday
May 6, 2015

12:15 PM

Research Pavilion
NSTC
Conference Room 475

Pizza and drinks will be provided

Novel Two-Dimensional (2D) Transition Metal Dichalcogenide (TMD) Heterostructures for Emerging Electronics

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As the miniaturization of modern electronic devices continues, scientists have turned to what are now known as two-dimensional (2D) semiconductors which are made up of a few atom thick semiconducting layers – the ultimate size limit of device units. Some 2D semiconductors present electrical properties compatible to those of what are already used in the modern electronics industry, but requiring a much lower cost for their preparation. More advantages come from that when these materials are stitched together to create "heterojunctions" which exhibit electrical properties promising for developing new technologies that function at near atomic length scales. Particularly, recent discovery of 2D transition metal dichalcogendies (TMDs; e.g., MoS_2, WS_2, etc) has created considerable interest due to their potential for atomically thin, multifunctional 2D heterojunctions benefiting from their unusual electrcial, optical, and mechanical properties. A major hurdle for the technological realization of these promising materials has lied in developing reliable methodologies to rationally integrate 2D TMDs in a controllable and scalable manner, thus realizing 2D heterojunctions with desired dimension, orientation, and functionalities. In this talk, I will present new ways to fabricate 2D TMD heterostructures by using chemical and phyiscal means. In the first part of the talk, I will introduce a new chemical synthesis method to stack up multiple 2D TMDs based on MoS_2 and WS_2 in a highly controlled manner. These new 2D MoS_2/WS_2 heterostructures whose thickness was only 7-8 nm were produced on a scale of over a few Centimeters Square, which is sufficient to cover conventional wafers used in modern semiconductor technologies. Atomic scale structural characterizations involving electron microscopy directly revealed that two distinct 2D layers perfectly maintained atomically sharp heterojunctions. Electrical transport measurements reveal diode-like behavior with clear current rectification, further confirming the formation of high-quality heterojunctions. In the second part of the talk, I will introduce the fabrication of lateral 2D heterojunctions on few layer 2D MoS_2 flakes by using an oxygen plasma treatment. A specific exposure of oxygen plasma converts pristine MoS_2 to oxygen-rich MoO_x-MoS_2 compound, which leads to the formation of heterojunctions at the interface of MoS_2/MoO_x-MoS_2. A clear current rectification is observed across the heterojunction due to the band offset between the pristine and the oxygen-exposed MoS_2. The intrinsic controllability of the presented methods to realize heterojunctions in 2D semiconductors would open new avenues in designing unconventional 2D electronic devices with multifunctionalities.