From: Yashowanta N Mohapatra
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Subject: FW: [MSP] PhD Open Seminar : Shikha Srivastava: Electronic Properties of multilayer MoS2

Indian Institute of Technology Kanpu
Materials Science Programme

Ph.D. Open Seminar

Title: " Electronic properties of multilayer MoS2 flakes: a Schottky diode based study"
Speaker: Shikha Srivastava
Date: 21 July 2021 (Wednesday)
Time: 3:30PM
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Abstract :
Layered molybdenum disulfide (MoS2) is a promising n-type semiconductor having an inherent bandgap in its bulk as well as in monolayer form. Multilayer molybdenum disulfide (m-MoS2) has attracted much attention due to the indirect bandgap (1.2 eV) and wide spectral response. A lot of applications utilize multilayer MoS2 flakes based heterostructures over the years. Among them, MoS2|ZnO based heterostructure is found to be suitable for charge separation and charge transport processes. However, the electrical properties of this heterointerface are yet to be studied in detail.

In this thesis, we seek to study the transport properties across MoS2|ZnO heterointerface. We utilize MoS2 flakes, exfoliated from natural and synthetic MoS2 single crystals in view of their possible applications in electronic devices. For this purpose, Au|m-MoS2|ZnO device is fabricated and characterized through temperature dependent current-voltage (J-V), capacitance-voltage (C-V), and Impedance analysis. The fabricated isotype heterostructure device exhibits a rectification ratio of the order of ~103 over the measured temperature range of 19 K to 300 K. Temperature dependent J-V characteristics reveal that while tunneling is dominant at low temperature, diffusion mechanism controls the charge transport in the high temperature regime. The barrier height due to band-alignment at the interface is found to have Gaussian distribution with a mean energy of 0.95 eV. We also report charge carrier freezeout due to de-ionization of the dominant donor in MoS2 at a characteristic temperature of approximately 37 K, which correlates with features of both J-V and C-V characteristics.

Further, a detailed temperature dependent analysis of the complex part of the impedance spectra Im (Z) in the space charge limited current (SCLC) regime is used to determine the inter-layer charge carrier mobility(μ⊥) in m-MoS2 flakes obtained from two different sources. The calculated inter-layer mobility exhibits μ⊥ ~ Tδ temperature dependence with δ~0.9-1.6 and thereby revealing that impurity scattering is the dominant mechanism. A further confirmation that the mobility is limited by charged

states. In Synthetic MoS2 flakes, an additional defect state at around 0.7eV was detected. It is for the first time that the defect distribution in MoS2 flakes have been obtained using this direct differential capacitance method, which was enabled by the Schottky barrier device structure used in this study.

These investigations will pave the way for defect engineering in multilayer MoS2 flake devices for electronic and optoelectronic applications.

Y. N. Mohapatra
(Thesis Supervisor)