Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Tailoring the properties of two dimensional molybdenum disulfide SAIFUL I. KHONDAKER, MUHAMMAD R. ISLAM, NARAE KANG, UDAI BHANU, HARI P. PAUDEL, MIKHAIL EREMENTCHOUK, LAURENE TETARD, MICHAEL N. LEUENBERGER, NanoScience Technology Center and Department of Physics, University of Central Florida — The ability to tailor the properties of a material is essential to optimize device functionality. In this talk, I will present evidence that the electrical and optical properties two-dimensional (2D) molybdenum disulfide (MoS_2) can be tuned by controlled exposure to oxygen plasma. We find that the mobility, on-current and resistance of 2D MoS_2 FETs vary exponentially by up to four orders of magnitude with respect to the plasma exposure time. Photoluminescence (PL) study show a decrease of PL intensity leading a complete quenching. Raman studies show a significant decrease of intensity of MoS_2 peaks with the creation of new oxidation induced peak, while X-ray photoelectron spectroscopy (XPS) study show peaks associated with MoO_3 after plasma exposure. We suggest that during exposure to oxygen plasma, the energetic oxygen molecules interact with MoS_2 and create MoO_3 rich defected-regions, which are insulating. MoO_3 defected-regions act as a tunnel barrier for the injected conduction electrons, giving rise to the exponential increase in resistivity as a function of plasma exposure time. Bandstructure calculation shows that the PL quenching upon plasma exposure is due to the creation of MoO_3 defected-regions which causes a direct to indirect bandgap transition in monolayer MoS_2.

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Date submitted: 13 Nov 2014 Electronic form version 1.4