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Tailoring the properties of two dimensional molybdenum disulfide
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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 expo-
sure 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 expo-
sure 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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