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Tuning the Electrical and Optical Properties of MoS_2 under High Pressure AVINASH P. NAYAK, Department of Electrical & Computer Engineering, University of Texas at Austin, JIE ZHU, JUNG-FU LIN, Jackson School of Geosciences, University of Texas at Austin, DEJI AKINWANDE, Department of Electrical & Computer Engineering, University of Texas at Austin — Transition metal dichalcogenides (TMDCs), such as molybdenum disulfide (MoS_2), has been of recent interest to many theoretical and experimental studies. MoS_2 has served as a potential material for optoelectronic and field-effect-transistors (FETs) with high on/off ratios (up to 10^8). MoS_2 is composed of quasi-two-dimensional sheets that are stacked on top of one another where each monolayer is tri-layered with a transition metal, molybdenum, in the middle that is covalently bonded to a chalcogen atom, sulfur, located on the top and bottom of the layers. These layers are separated by weak van der Waals (vdW) forces along the c-axis which makes the properties of MoS_2 anisotropic. Having control over the electronic properties, and therefore, the band-gap of MoS_2, allows for a wide range of applications from electrochemical devices to tunable photo-detectors to be adopted. We demonstrate the electronic phase transition of MoS_2 from semiconducting to a metallic state at $\sim$15GPa. The electronic transport properties in the semiconducting region (lower pressures) exhibits a shockley-like behavior while in the metallic region (higher pressures), we observe ohmic transport. We also examine the light-induced electronic properties by creating optical switches under pressure in greater detail. This photo-current behavior of MoS_2 allows for optical switches with three order decrease in turn-on time. We examine the change in the activation energy, optical Raman, XRD, and resistance, by inducing pressure to MoS_2 up to 35 GPa.

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