Lithographically Patterned Metallic Conduction in Single-Layer MoS_2 via Plasma Processing

Michael G. Stanford[1], Yu-Chuan Lin[2], Maria Gabriela Sales[3], Anna N. Hoffman[1], Chris Nelson, Kai Xiao[2], Stephen McDonnell[3], Philip D. Rack[1,2]*

1. Department of Materials Science and Engineering, University of Tennessee, Knoxville, TN 37996
2. Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, Oak Ridge, TN 37831
3. Department of Materials Science and Engineering, University of Virginia, Charlottesville, VA 22904

*Corresponding author: Philip Rack, prack@utk.edu

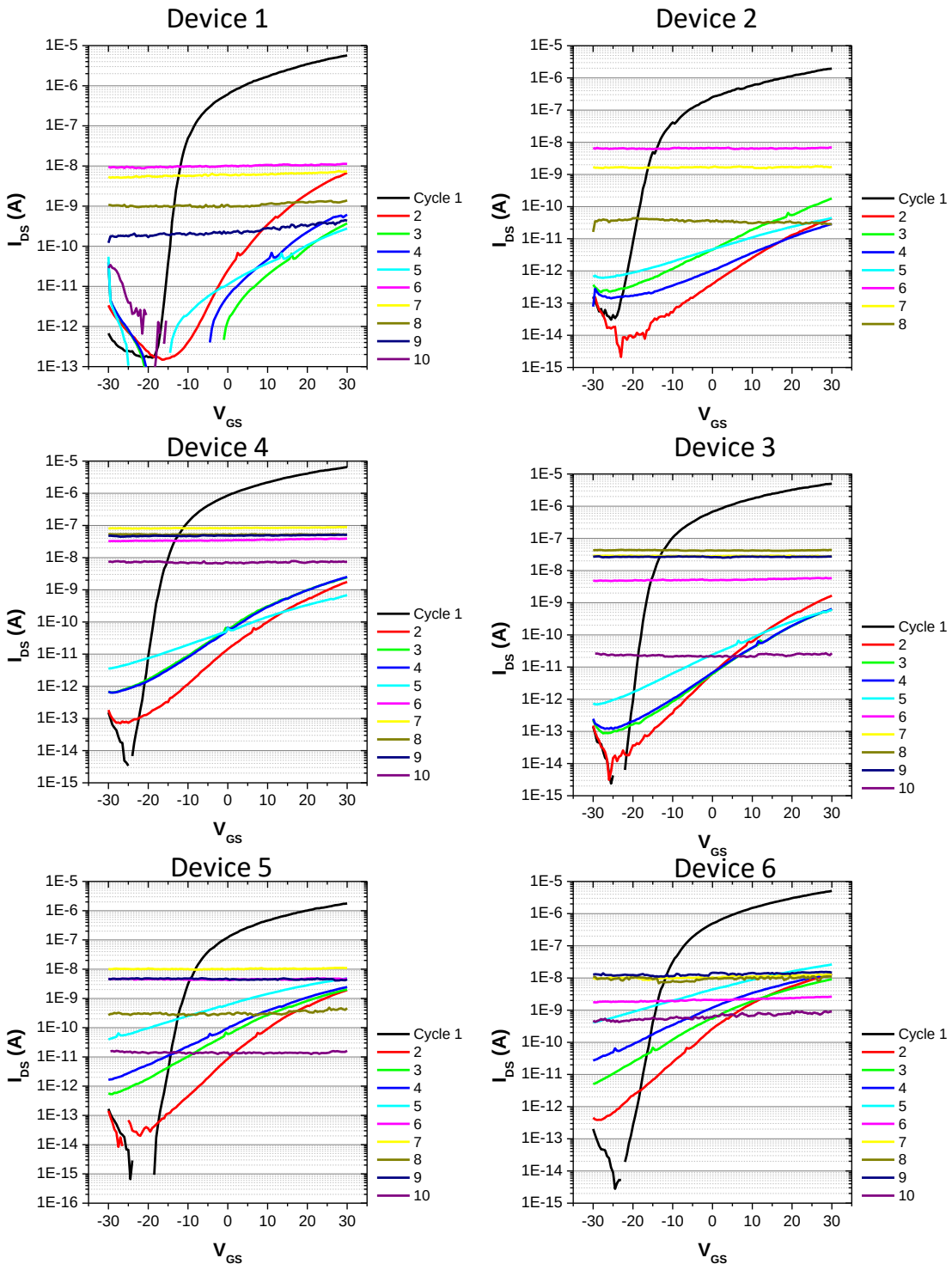

Figure S1. Transfer curves for 6 MoS_2 field-effect transistors exposed to cycles of hydrogen plasma and atmospheric oxygen.

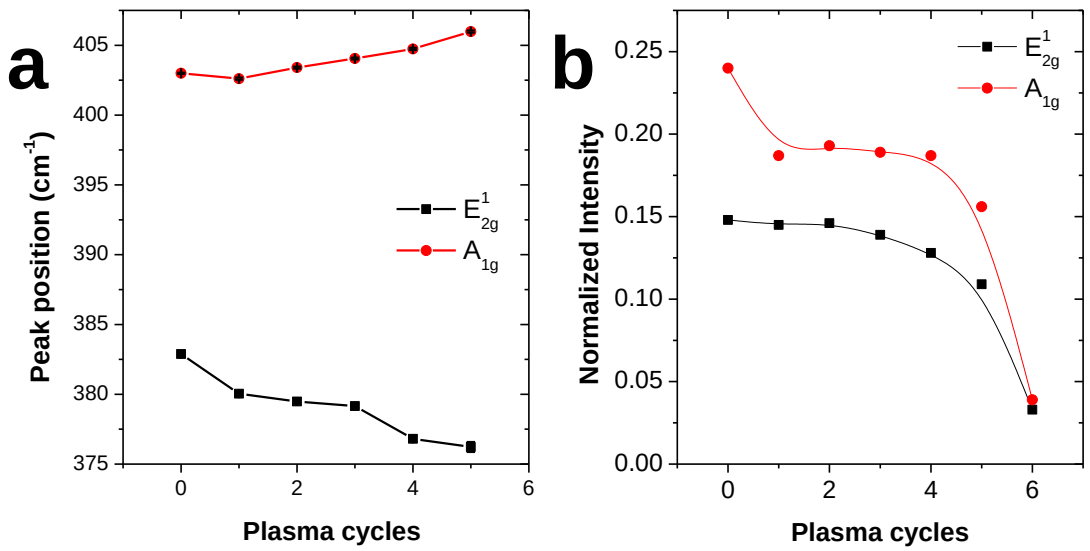

Figure S2. (a) Position of MoS_2 E^1_{2g} and A_{1g} Raman peaks as a function of plasma cycles.

(b) Intensity of the respective Raman peaks as a function of plasma cycles.

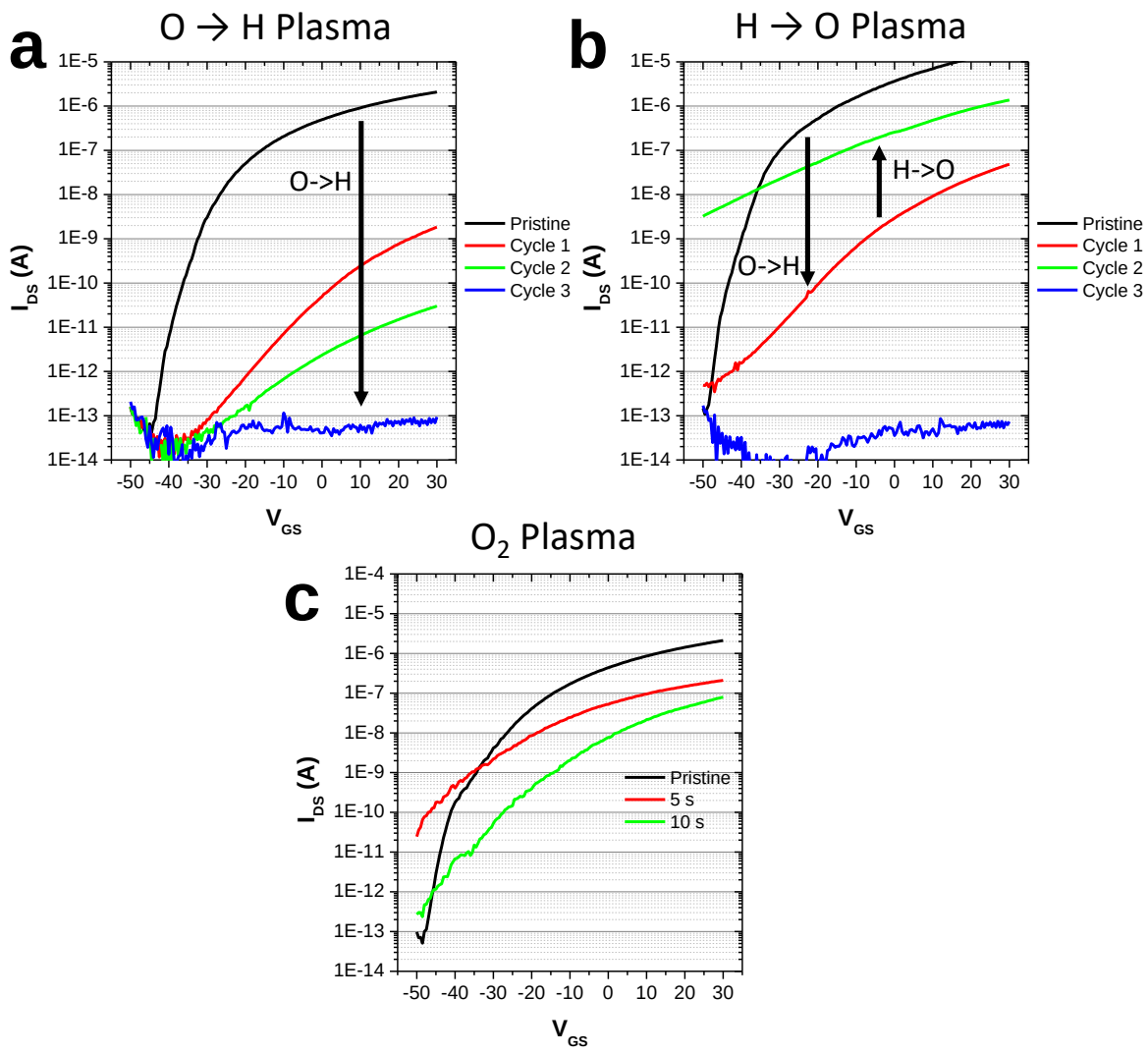

Figure S3. Transfer curves for MoS_2 FETs after exposed to various strategies of plasma exposure. (a) Transfer curves when exposed to cycles of O plasma followed by H plasma (O → H plasma). This results in insulating behavior for the material. (b) Transfer curve for a device in which the first plasma cycle was O → H plasma. This, once again, resulted in a suppression in conductivity over all gate voltages. A subsequent H → O plasma was employed which increased the conductivity of the MoS_2. (c) Transfer curves for a device which was solely exposed to O plasma.

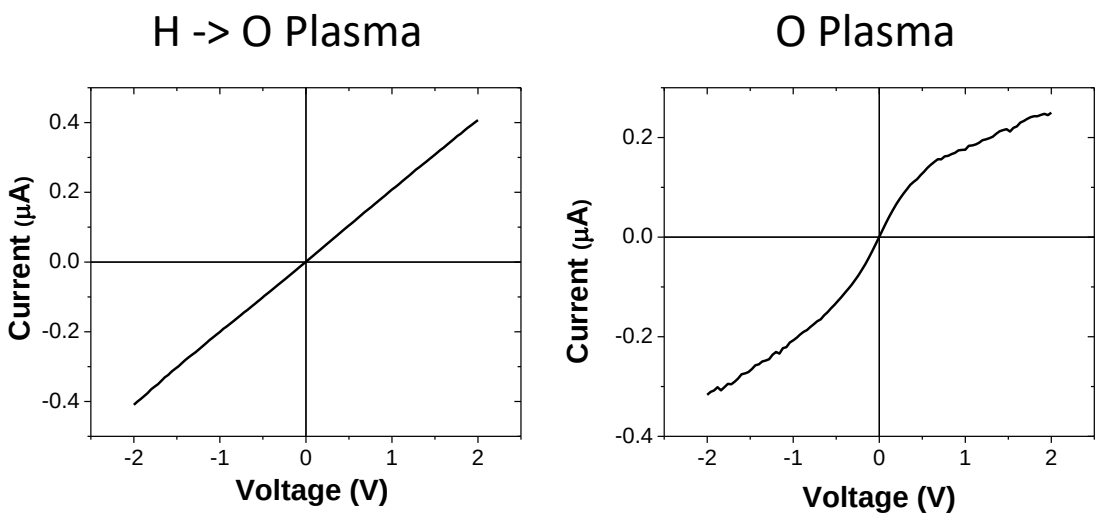

Figure S4. Current-voltage (I-V) characteristics for MoS_2 FETs exposed to H → O plasma cycles (left) and solely oxygen plasma (right). Linear I-V characteristics for the H → O plasma cycles suggest that the material exhibits metallic conduction.

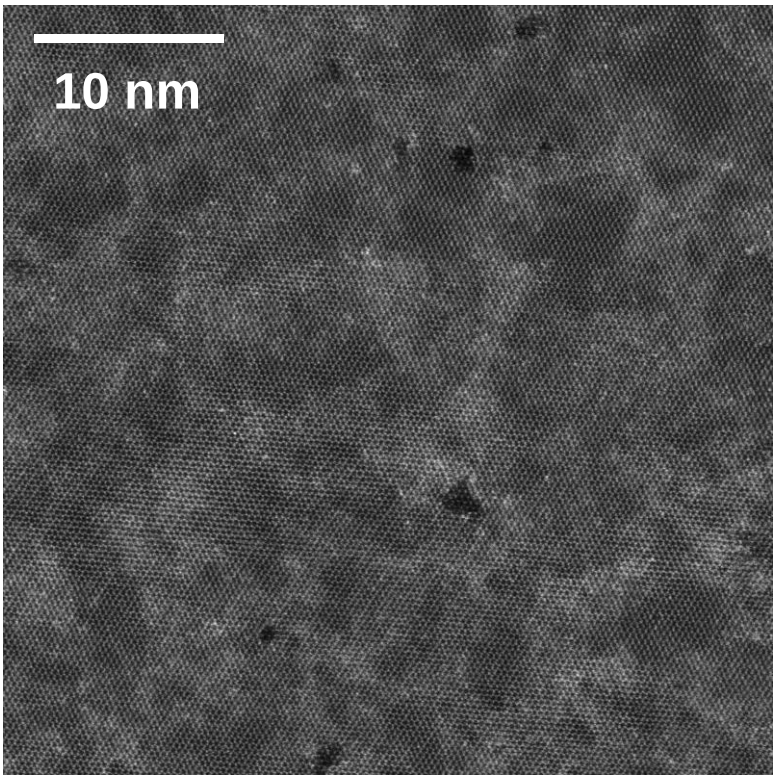

Figure S5. STEM image showing MoS_2 exposed to H_2 + 2s O_2 plasma exposure.

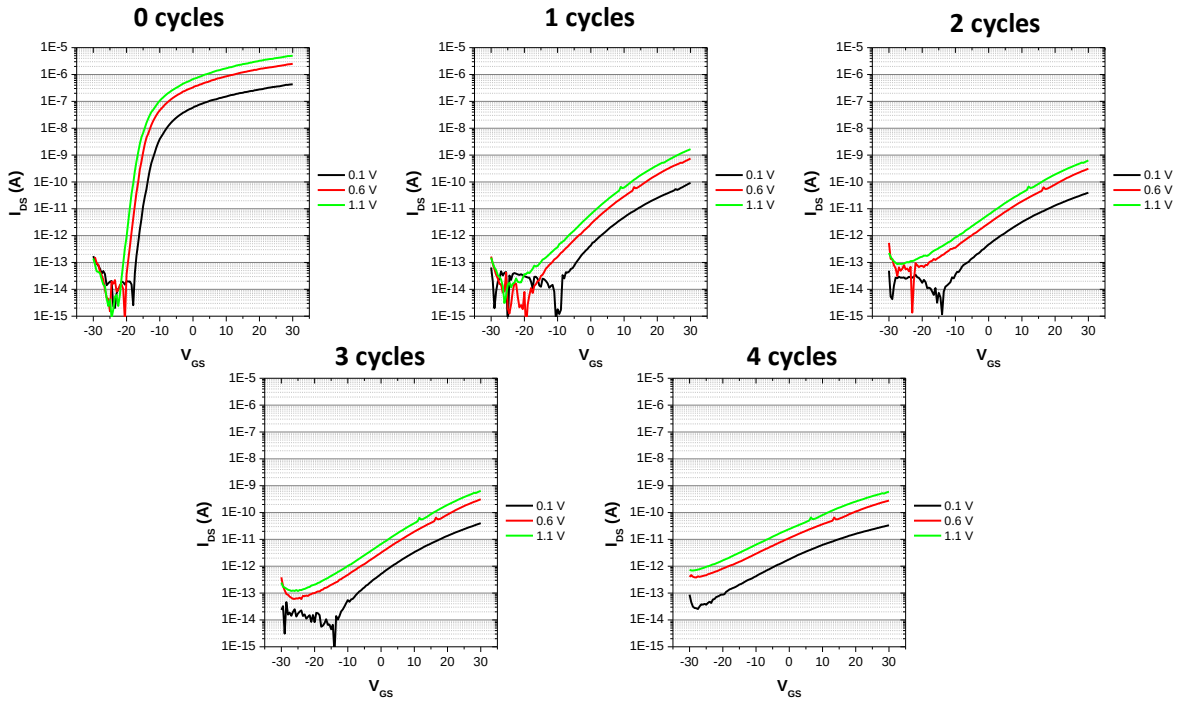

Figure S6. Transfer curves for MoS_2 after H_2 plasma + atmosphere cycles. Notably, DIBL increases with increasing plasma cycles. Devices are no long able to turn "off" at 1.1 V source-drain voltage after 2 cycles of plasma.