Influence of MoS_2/Silicon Interface States on Bias Dependent Photoresponse

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Introduction: Two-dimensional (2D) transition metal dichalcogenides (TMDCs) with intriguing optoelectrical properties has attracted significant interest for various device application. Considering the bandgap of 2D TMDCs layered materials in the range of 1.7-2.2 eV is also significant interest to integrate with bulk semiconductor to develop van-der-wall heterostructures. MoS_2/Silicon based device has to be studied in order to achieve better device performance and high speed photodetectors.[1,2] In this work we explore the influence of MoS_2/Silicon interface states on bias dependent photoresponse.

Experimental: Molybdenum Oxide (MoO_3) (approximately 0.1g) was deposited on the surface of p-type Silicon using thermal evaporator. Subsequently, sulfurization was carried out at a temperature of 750 ºC in argon and hydrogen gas mixture. Ag and Al electrodes were deposited on Silicon and MoS_2, respectively. Current-density voltage measurements were carried out using two probe system and Keithley 2401 Source Meter. In addition to the above, further material analysis was done to understand the device characteristics.

Results and discussion: Figure (a) and (b) shows spectral response of fabricated device under a bias voltage of 0V and -5 V, respectively. Under applied bias voltages we observed that the maximum spectral response lies approximately between 750 to 950 nm. Interestingly, there was no significant enhancement of photoresponse below 450 nm at the bias voltage of -5V. This is attributed to carrier recombination at the heterostructure interface of MoS_2/Silicon for the photocarriers generated for shorter wavelength.

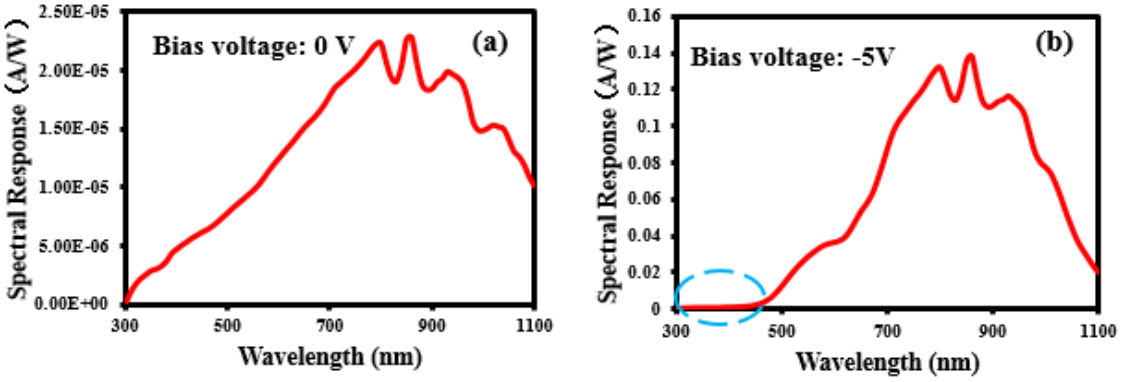

Figure 1 Spectral response of the fabricated Al/MoS_2/Silicon/Ag heterojunction device at (a) 0V and (b) -5V

Reference 1. Wang, Q. H., Kalantar-Zadeh, K., Kis, A., Coleman, J. N. & Strano, Nat. Nanotechnol. 7, 699–712 (2012). 2. Zhang, K. et al., Nanoscale 10, 336–341 (2018).