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Discretely distributed 1D V_2O_5 nanowires over 2D MoS_2 nanoflakes for enhanced broadband flexible photodetector covering Ultraviolet to Near Infrared region

*Parikshit Sahatiya[1], K.Chandra Sekhar Reddy[1] and Sushmee Badhulika[1]**

[1]Department of Electrical Engineering, Indian Institute of Technology Hyderabad, Hyderabad, 502285, India.

**Corresponding author: E-mail: sbadh@iith.ac.in; Telephone: 040-23018443 Fax 04023016032*

Experimental Section:

Synthesis of MoS_2 on Al foil: Aluminum foil as the substrate was utilized for the hydrothermal growth of MoS_2. The seed solution was prepared by mixture of 10mM of sodium molybdate ($Na_2MoO_4.2H_2O$) and 20mM of thiourea (CH_4N_2S) in deionized (DI) water. The Al foil substrate was dipped in as-prepared seed solution for 1 h followed by drying at 80 °C. A nutrient solution comprising of 50mM sodium molybdate and 100 mM thiourea was stirred in DI water for 30 min. Thereafter, the seed-coated Al foil paper and the nutrient solution were transferred to the hydrothermal reactor and was maintained at 200 °C for 20 h. The reactor was allowed to cool down naturally and the resultant black colored aluminum foil was dried at 80 °C.

Electrospinning of V_2O_5 nano fibers: 0.4g of polyacrylonitrile (PAN) polymer was dispersed in 5ml of N,N–dimethylformamide (DMF) solution (8 wt. %), followed by the addition of 0.5g of Ammonium metavandate to form a uniform viscous solution ready for electrospinning. The solution was loaded into syringe and electrospinning was performed with direct current voltage of 12KVbetween the needle tip and the Al foil collector separated by a distance of 10cm. The flow rate of the polymer solution was fixed at 8µL/min. The collected V_2O_5 nanowires over the Al foil were calcined at 400ºC for 2hrs.

Fabrication of Photodetector: The as grown MoS_2 on Al flexible substrate was cut into 7 mm x 7mm dimension. MoS_2-Al foil was then masked with polyimide tape at the end which would serve

as the contact area on MoS_2. V_2O_5 nanowires dispersed in DMF solution was then spin coated on MoS_2-Al foil. It should be noted here that the spin coating parameters are tuned to obtain discrete distribution of 1D V_2O_5 nanowires on 2D MoS_2. The mask was then removed followed by defining the contacts with silver (Ag) paste.

Materials and Characterization: Sodium molybdate, Thiourea, Polyacrylonitrile and Ammonium metavandate were purchased from Sigma-Aldrich and were used as received for the growth of MoS_2-V_2O_5 hybrids. The structural characteristics of the prepared hybrids were investigated using X'pert PRO XRD with Cu Kα radiation. Raman spectra were obtained from Raman spectrometer (SenterrainVia opus, Bruker) having an excitation wavelength of532 nm. FESEM analysis was performed by ZEISS Ultra-55 SEM to study morphology. UV–visible–NIR spectra were obtained using LAMBDA UV/Vis/NIR spectrophotometers (PerkinElmer). The electrical measurements were carried out with Keithley 4200 SCS instrument. The as-fabricated devices were tested for broadband photodetector application on illuminating UV, visible, and IR radiations. The lamp sources utilized for UV, vis, and IR illumination had a wavelength (λ) of 365, 554, and 780 nm, respectively.

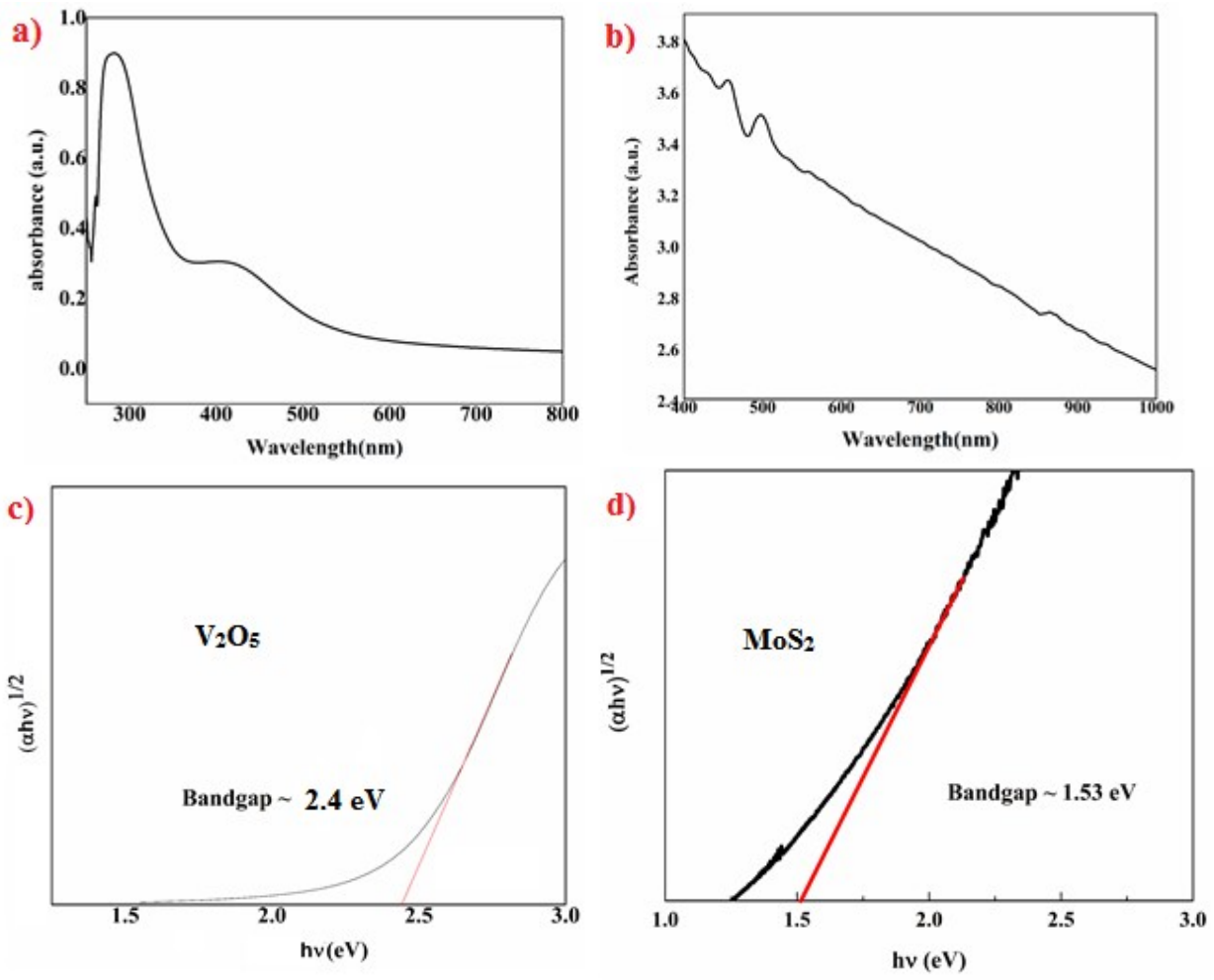

Figure S1: UV-VIS spectra of a) V_2O_5 nanowire showing absorbance in UV to visible region b) MoS_2 showing absorbance in visible to NIR region c) Tauc plot of V2O5 demonstrating a bandgap of 2.4 eV and d) Tauc plot of MoS2 demonstrating a bandgap of 1.53 eV

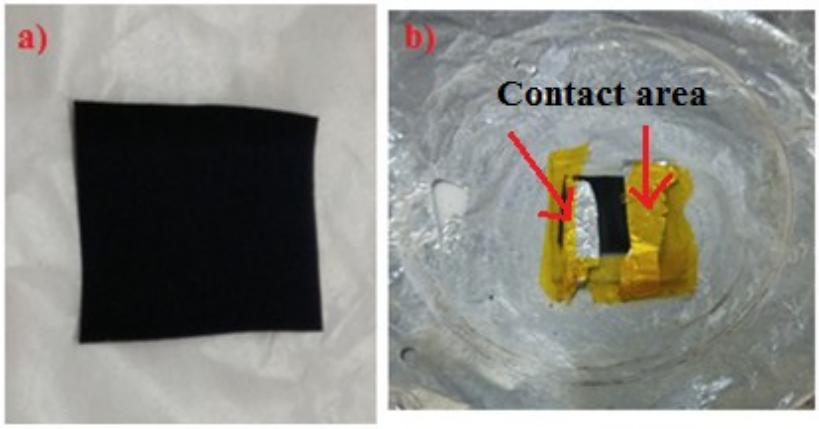

Figure S2: Photographic images of a) MoS2 grown on Al foil b) Masking the side areas of the device for defining metal contact area

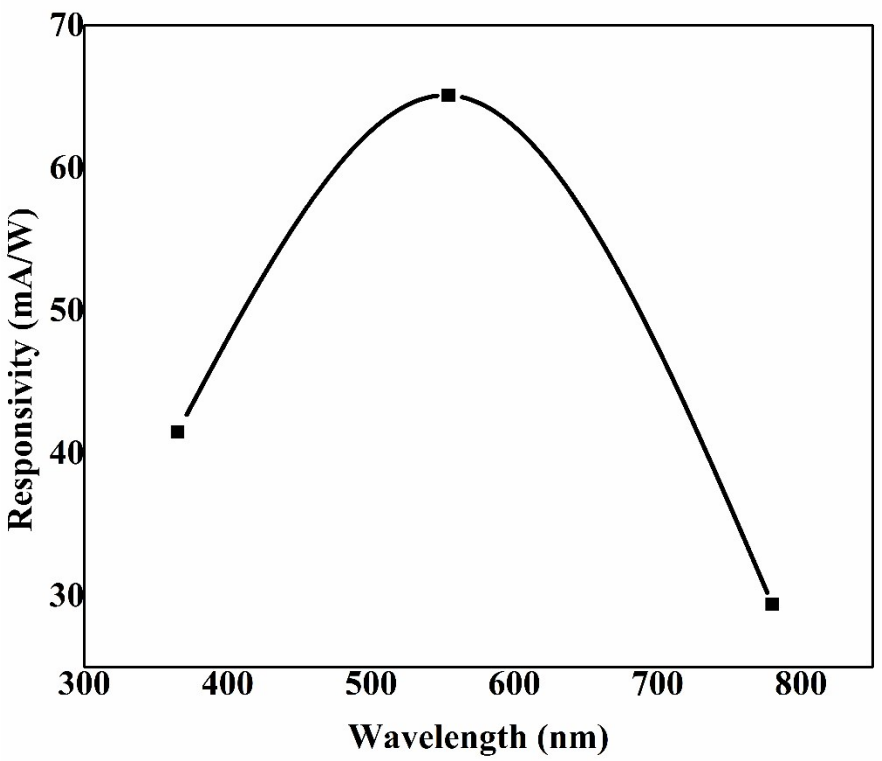

Figure S3: Graph showing the spectral response of the MoS_2/V_2O_5 photodetector from 365 nm to 780 nm

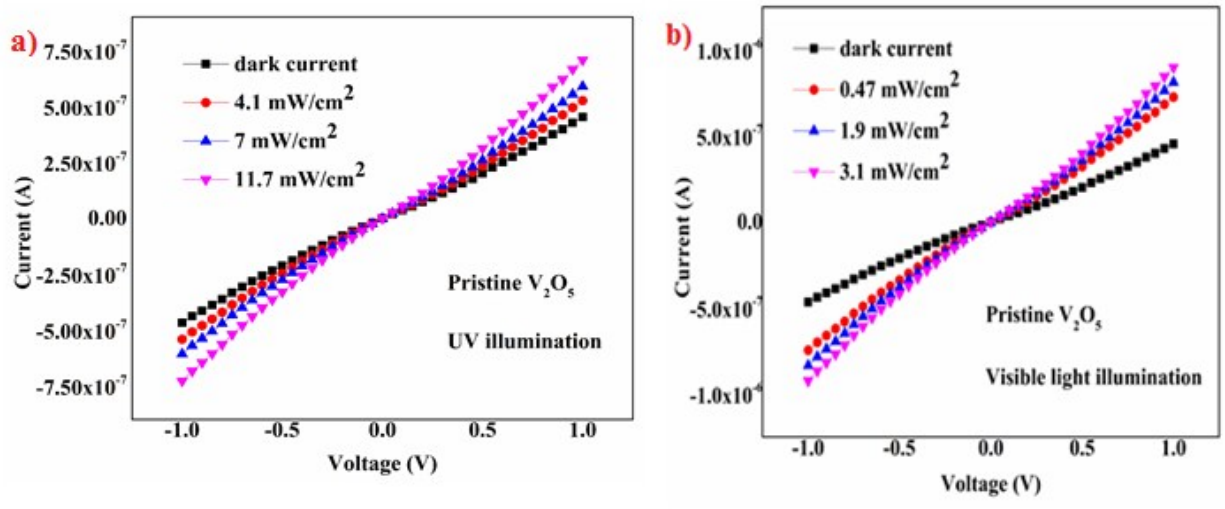

Figure S4: I-V characteristic of pristine V_2O_5 for different a) UV light intensities b) visible light intensities

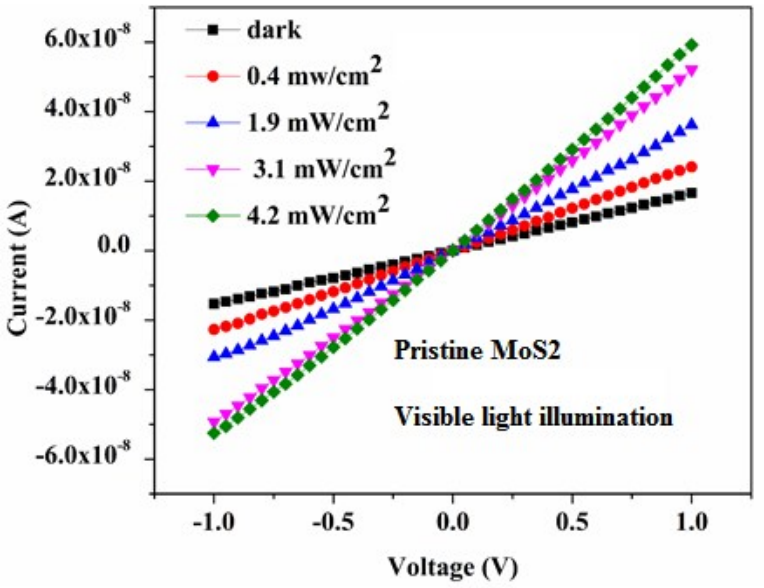

Figure S5: I-V characteristic of pristine MoS_2 for different visible light intensities