Liquid phase exfoliated few layered WS_2 thin sheets-based Photodetector

Abid, Poonam Sehrawat, S. S. Islam*

Centre for Nanoscience and Nanotechnology, Jamia Millia Islamia (A Central University), India.
E-mail: sislam@jmi.ac.in

Abstract: Photodetectors are attracting scientific community from long time due to their wide-range of chemical, biochemical, medical and healthcare, and imaging applications. WS_2 has attracted much attention owing to its unique optical and electronic properties which depend heavily on the number of layers present. WS_2 shows the indirect to direct band transition while going from bulk to monolayer [1,2]. A large-scale production is necessary for its possible application in electronic devices. Among the various possible synthesis routes, liquid-phase exfoliation (LPE) has emerged as an inexpensive and scalable technique to produce layered 2D materials. The HRTEM, XRD, Raman and UV-Vis spectroscopy was performed to monitor the exfoliation process. We report optical sensing properties of LPE processed WS_2 film deposited over interdigitated SiO_2/Si substrate via drop-casting. The developed sensor exhibits highest sensitivity at 635nm vis-à-vis near IR, and it ensures its capability to operate efficiently in the broad spectral window. The sensitivity is found to be 138% at 300K, while response- and recovery time ~78.2ms and ~16ms respectively. Power density dependent studies establish linear relationship between power-density and photoresponsivity upto 2.5 mA/W, beyond which nonlinearity arises. Sensor's stability and cycling repeatability remain unaffected even after prolonged exposure for four months under ambient atmospheric condition and this suggests not any requirement of encapsulation since sensor performance is still qualitatively very high.

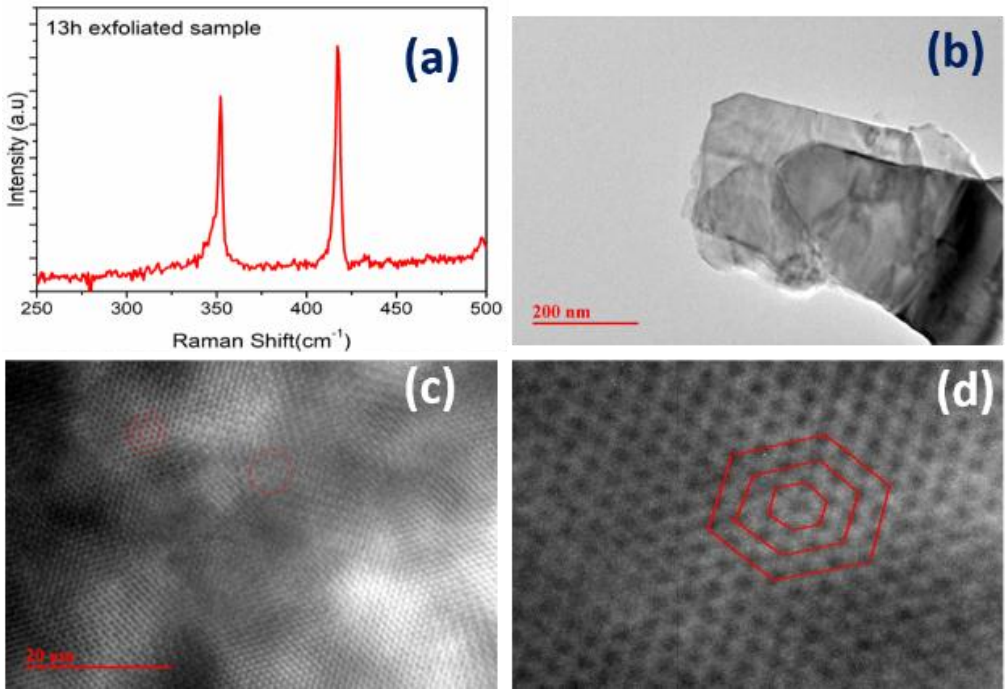

Figure 1: (a) Raman spectra (b, c & d) TEM, HRTEM images of 13h exfoliated WS_2 sample.

5th International Conference on Nanotechnology for Better Living (NBL-2019), Jointly organized by National Institute of Technology (NIT) Srinagar and Indian Institute of Technology (IIT) Kharagpur; April 7 – 11, 2019 at SKUAST, Shalimar Srinagar, Jammu and Kashmir, India; Editor: Dr. M. A. Shah and Prof. P. Banerji, ISBN:978-81-939516-0-6; Published by Applied Science Innovations Pvt. Ltd., Pune, Maharashtra, India.

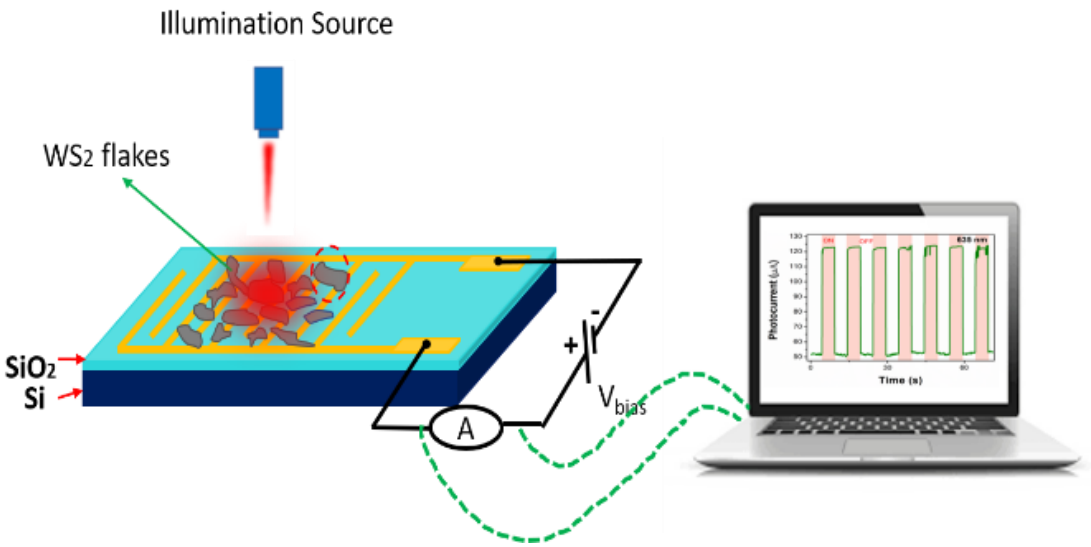

Figure 2: Schematic diagram of experimental set-up.

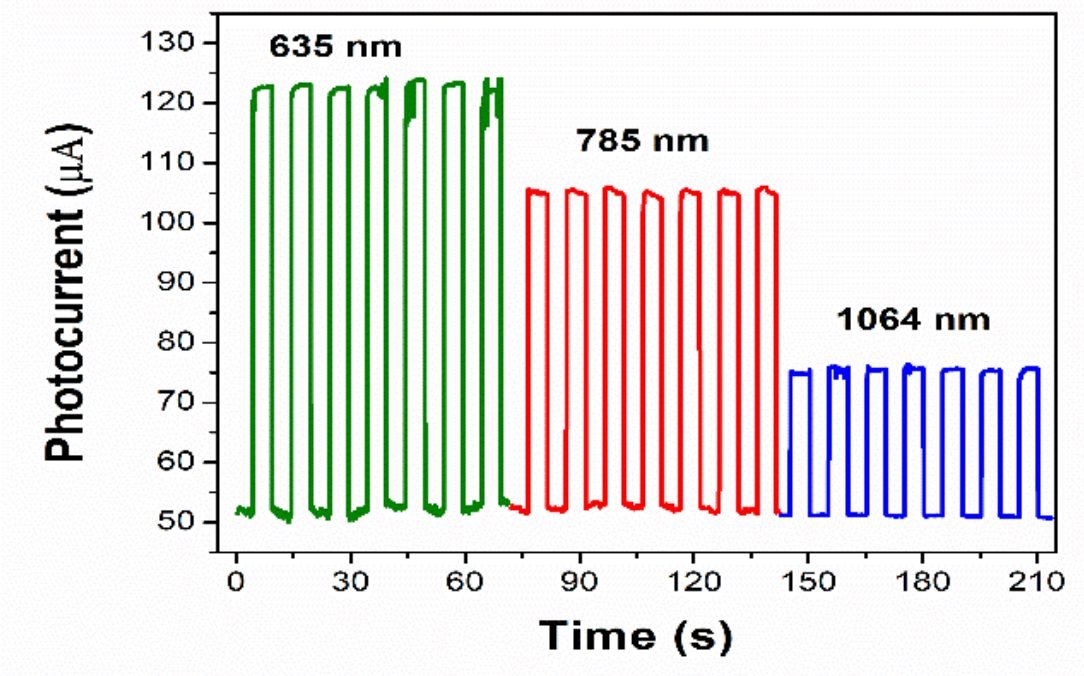

Figure 2: Photoconductive response of prepared sensor at various wavelengths (635 nm, 785 nm, and 1064 nm).

References:

1. Wang, Q. H., Kalantar-Zadeh, K., Kis, A., Coleman, J. N. and Strano, M. S., 2012. Electronics and optoelectronics of two-dimensional transition metal dichalcogenides, Nature nanotechnology, 7 (11), p.699.
2. Zhao, W., Ghorannevis, Z., Chu, L., Toh, M., Kloc, C., Tan, P. H. and Eda, G., 2012. Evolution of electronic structure in atomically thin sheets of WS_2 and WSe_2. ACS Nano, 7(1), pp.791-797.

5th International Conference on Nanotechnology for Better Living (NBL-2019), Jointly organized by National Institute of Technology (NIT) Srinagar and Indian Institute of Technology (IIT) Kharagpur; April 7 – 11, 2019 at SKUAST, Shalimar Srinagar, Jammu and Kashmir, India; Editor: Dr. M. A. Shah and Prof. P. Banerji, ISBN:978-81-939516-0-6; Published by Applied Science Innovations Pvt. Ltd., Pune, Maharashtra, India.