Tunability of optical absorption of MoS_2 by electrical gating and its application in a hybrid modulator

Tongcheng Yu
Vasyl G. Kravets, Fan Wu, Gregory H. Auton, Shinji Imaizumi, Alexander N. Grigorenko

School of Physics and Astronomy, the University of Manchester, M13 9PL, Manchester, UK

tongcheng.yu@postgrad.manchester.ac.uk

Abstract

It was recently established that optical constants of 2D monolayers, in contrast to many bulk semiconducting materials such as Si, Ge, GaAs, could vary significantly with electrical field[1-2]. Here we investigated the electric field effect on optical properties of a monolayer of molybdenum disulphide (MoS_2). This field effect is utilised to achieve ~10% visible light modulation for a hybrid electro-optical resonant modulator based on MoS_2. A suggested hybrid nanostructure consists of a CMOS compatible Si_3N_4 dielectric layer sandwiched between a thin gold film and a MoS_2 monolayer which enables a selective enhancement of polarised electro-absorption in a narrow window of angles of incidence and a narrow wavelength range near MoS_2 exciton transition energies. The possibility to modulate visible light with 2D materials and the robust nature of light modulation by MoS_2 could be useful for creation of reliable ultra-compact electro-optical hybrid visible-light modulators.

References

[1] Reed, G. T.; Mashanovich, G.; Gardes, F.Y.; Thomson, D.J, *Nat. Photon*, 4(2017), 518-526.
[2] Mak, K.; Shan, J., *Nat. Photon*, 10 (2016) 216-226.

Figures

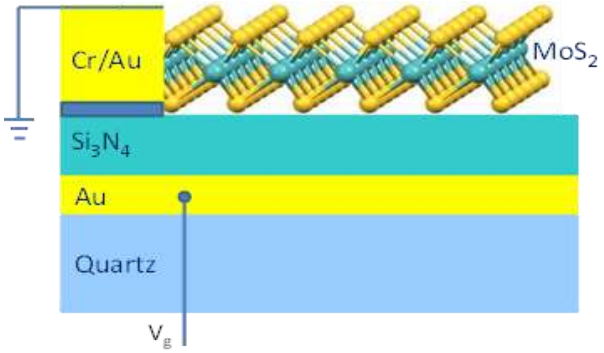

Figure 1: Schematic illustration of the $Au/Si_3N_4/MoS_2$ modulator structure.

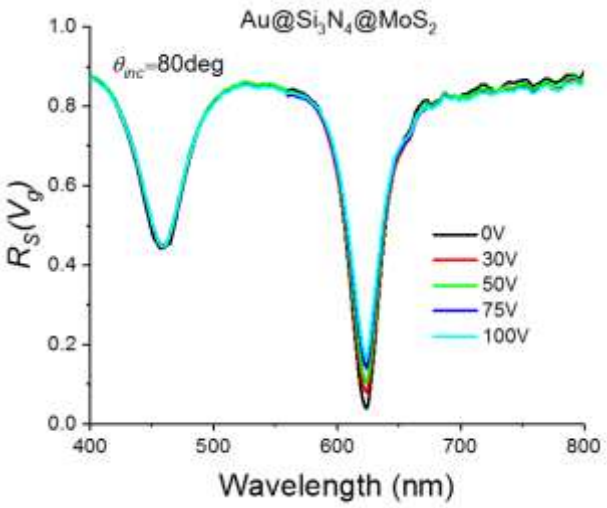

Figure 2: Change in s-polarised reflectance in the $Au/Si_3N_4/MoS_2$ hybrid modulator for different gating voltages with an incident angle of 80 degree.