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Self-Biased Diode Based on MoS_2

Diode is an important type of device for modern nano-electronics applications, and almost all logic functions and many analog circuits can be realized using diodes. In conventional design, the diodes are usually fabricated by formation of a p-n junction using controlled doping of semi-conductor, however, conventional doping techniques have limitations at ultra-small channels [1]. In this work, we have demonstrated the operation of self-biased diodes based on MoS_2 using self-biasing effect of ion gel. The asymmetric biasing of ion gel from source and drain electrodes in single layer MoS_2 field effect transistor (FET) configuration is the main reason for diode operation. This asymmetric biasing is achieved by passivizing one electrode of FET with polymethylmethacrylate (PMMA) while the other electrode is uncovered and the entire FET is immersed in ion-gel as shown in Fig. 1(a). During forward bias, the device current is increased because of carriers accumulated by the positive electric field of ion gel. Whereas during reverse bias, the carriers are depleted in MoS_2 channel by the negative electric field from the ion gel and very small current flows through the MoS_2 channel. A high on/off of around 10^3 in device current is achieved using this technique as shown in Fig. 1(b). Moreover, Schottky barrier width at metal-MoS_2 interface also changes with carrier concentration in the channel and plays an important role in modulating the device current [2].

References

[1] Asen Asenov, Andrew R Brown, John H Davies, Savas Kaya, and Gabriela Slavcheva, IEEE Transactions on Electron Devices, 9 (2003), 1837
[2] Muhammad Atif Khan, Servin Rathi, Inyeal Lee, Lijun Li, Dongsuk Lim, Moonshik Kang, and Gil-Ho Kim, Applied Physics Letter, 9 (2016), 93104

Figures

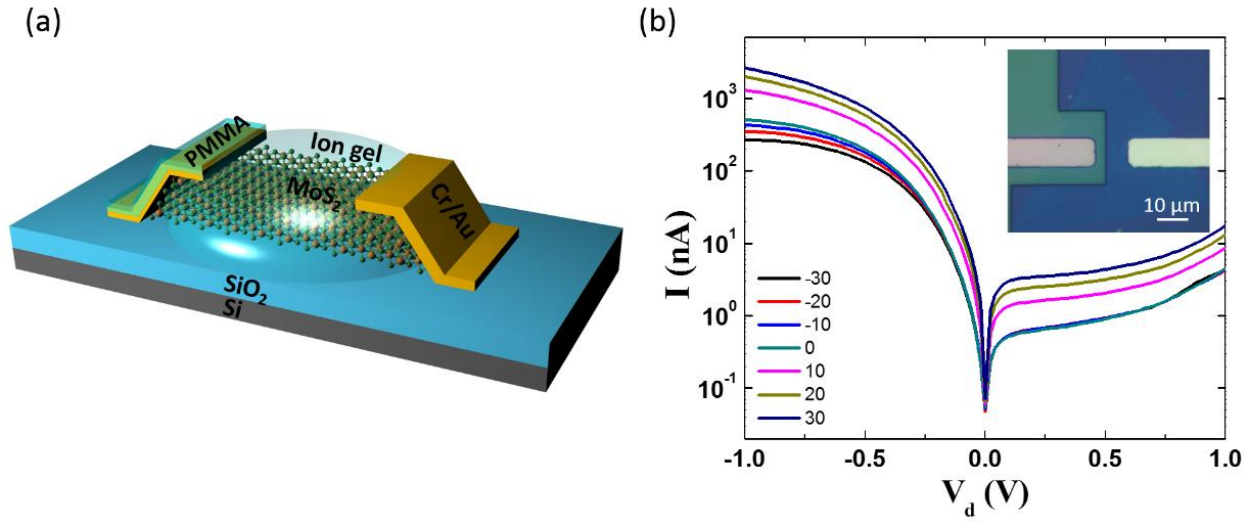

Figure 1: (a) Schematic of self-biased diode (b) I-V_d curve for MoS_2 self-biased diodes based on ion gel at different back gate voltages (inset shows optical microscope image of device)