Gate-tunable ambipolar transistor and photodetector in graphene/$MoSe_2$ barristor device

Gwangtaek Oh[1]
Ji Hoon Jeon[1], Young Chul Kim[2], Yeong Hwan Ahn[2] and Bae Ho Park[1]

1 Division of Quantum Phases & Devices, Department of Physics, Konkuk University, Seoul, Republic of Korea

2 Department of Physics and Department of Energy Systems Research, Ajou University, Suwon, Republic of Korea

gwangtaek@naver.com

High-quality channel layer is required for next-generation flexible electronic devices. Graphene is a good candidate due to its high carrier mobility and unique ambipolar transport characteristics but typically shows a low on/off ratio caused by gapless band structure. Here we propose a graphene/$MoSe_2$ channel layer with high-k ion-gel gate dielectric. The graphene/$MoSe_2$ device shows both high on/off ratio and carrier mobility. Most importantly, it reveals ambipolar behaviors which are controlled by external bias, although such ambipolarity has never been previously reported in graphene/semiconductor barristor structures. Therefore, our graphene/$MoSe_2$ barristor with ion-gel gate dielectric can offer various with high performances. Here we make a contact of graphene and $MoSe_2$. The graphene/ $MoSe_2$ barristor exhibits high on/off ratio of 10^5 and high mobility. The modulation of graphene's Fermi level (E_F) by applying gate voltage (V_g) is confirmed by the change in Schottky barrier height at the graphene/$MoSe_2$ junction. Such field effects including ambipolar behaviors are locally investigated by using scanning photocurrent microscopy (SPCM). We have shown that graphene/$MoSe_2$ barristor can be created to obtain highly efficient photocurrent generation and photodetection. Therefore, our graphene/MoSe2 barristor with ion-gel gate dielectric can be a suitable candidate for a ambipolar transistor (with high mobility and on/off ratio) and gate tunable broad-area photodetector (with high EQE and responsivity).

References

[1] Heejun Yang, Jinseong Heo, Seongjun Park, Hyun Jae Song, David H. Seo, Kyung-Eun Byun, Philip Kim, InKyeong Yoo, Hyun-Jong Chung, Kinam Kim, Graphene Barristor, a Triode Device with a Gate-Controlled Schottky Barrier. Science 336 (2012) 1140-1143.

[2] K. S. Novoselov, V. I. Fal'ko, L. Colombo, P. R. Gellert, M. G. Schwab & K. Kim, A roadmap for graphene, NATURE, 490 (2012) 192

Figures

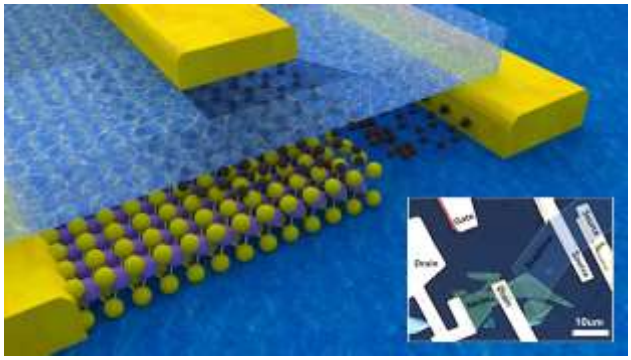

Figure 1: Graphene/MoSe2 barristor characterization. Schematic diagram and optical microscope image of graphene/$MoSe_2$ barristor device(inset).