Contact Resistance of Molybdenum Disulfide Field Effect Transistor with Doped-Graphene Electrodes

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Abstract

Recently, the interest in layered tow-dimensional (2D) semiconducting transition metal dichalcogenides (TMDs) field effect transistor (FET) has been increased for the next generation electronic device. Especially, molybdenum disulfide (MoS_2) has attracted worldwide attention using channel material of the FET, showing high on/off ratio and high mobility.[1] However, most reports on the high performance of the MoS_2 FET have dealt with single crystalline bulk MoS_2 using scotch tape method. There are few reports on contact properties of the chemically synthesized MoS_2 compared with mechanical exfoliated MoS_2. Thus, there are need for systematic investigation of contact characteristic with synthesized MoS_2.

The nature of MoS_2 FET is Schottky barrier transistor, which is switched by the tuning of the Schottky barriers at the metal-semiconductor interface. Many study commonly reported that this Schottky barrier can be attributed to the presence of sulfur vacancies, which is related to Fermi level pinning at contact and resulted in contact resistance increase. In order to reduce contact resistance, widely research efforts have been made recent years such as chemically doped contacts, low work function metal contacts. Another approach of reducing contact resistance has reported using high conductivity of the graphene, which is inserted between the metal and semiconductor [2].

The purpose of our work is to investigate the effect of the doped-graphene electrode on the contact characteristic of the chemically synthesized MoS_2 FET. We synthesized mono layer graphene and 1~3 layer MoS_2 by using chemical vapor deposition. Doped-graphene is transferred on the MoS_2/SiO_2 substrate and then back-gate MoS_2 FET is fabricated by using photo-lithography and etching process. Applying doped-graphene electrode, the threshold voltage was slightly shifted in the negative direction and the drain current in the above threshold region was significantly increased.

There are two kinds of mechanism which can be summarized as the occupation of sulfur vacancies by dopants at the graphene-MoS_2 interface and the enhancement of carrier injection at metal-graphene interface. Both mechanism are pretty similar assuming that the doping effect is accomplish by the extra carrier. More detailed discussions will be presented.

References

[1] B. Radisavljevic, A. Radenovic, J. Brivio, V. Giacometti, A. Kis, Nat. Nanotechnol., **6** (2011) 147

[2] Y. Du, L. Yang, J. Zhang, H. Liu, K. Majumdar, P. D. Kirsch, P. D. Ye, IEEE Electron Device Lett. **35**, (2014) 599

Figures

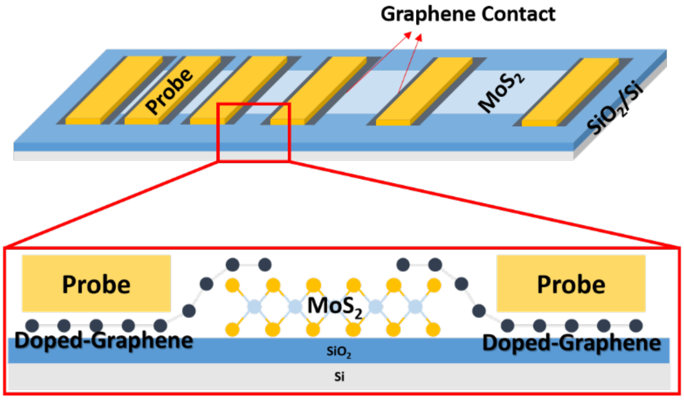

Figure 1 Schematic of the atomic layer MoS_2 back-gate FET with doped-graphene electrode