Two Dimensional Vertical Heterojunction with MoS_2, $MoSe_2$, and WSe_2

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Abstract

Two dimensional material graphene has been a hot material for the researchers worldwide because of its fascinating mechanical, chemical, physical, thermal, and electrical properties [1]. However, because of its lack of band gap, its application to digital device has a limitation. Recently new two dimensional materials, such as molybdenum diselenide ($MoSe_2$), molybdenum disulfide (MoS_2), tungsten diselenide ($MoSe_2$), and tungsten disulfide (WS_2), are getting a spotlight because of their band gap [2–4]. With the graphene, these materials become the candidates which can replace silicon for future transparent and flexible electronics.

In this study, we made vertical heterojunction using two dimensional materials using $MoSe_2$, MoS_2, and WSe_2. The junctions consist of these materials show rectifying behavior like p-n junction. Single $MoSe_2$ device shows unipolar rectifying behavior because of its double Schottky barriers (Figure 1). The $MoSe_2$ transistor shows about 10^5 on/off ratio and huge hysteresis which can be applicable to switch and/or memory devices. $MoSe_2$-MoS_2 junction devices also show rectifying behavior depends on their flake thickness (Figure 2 and 3). Junction consist of thick flakes shows severe reverse current (Figure 2) otherwise thin junction shows almost no reverse current (Figure 3).

References

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Figures

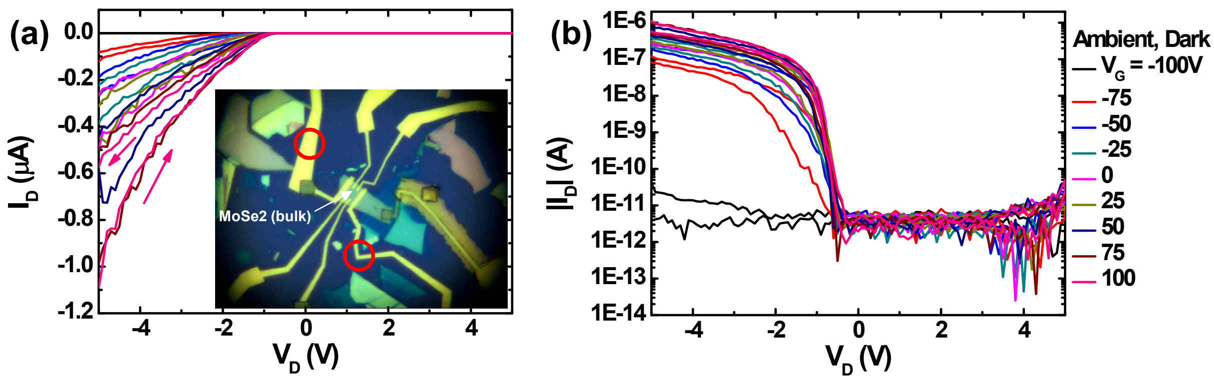

Figure 1. Linear (a) and log (b) scale output curve of $MoSe_2$ transistor. Inset in (a) shows the optical image of fabricated device. Red circles are probed electrodes in measurement.

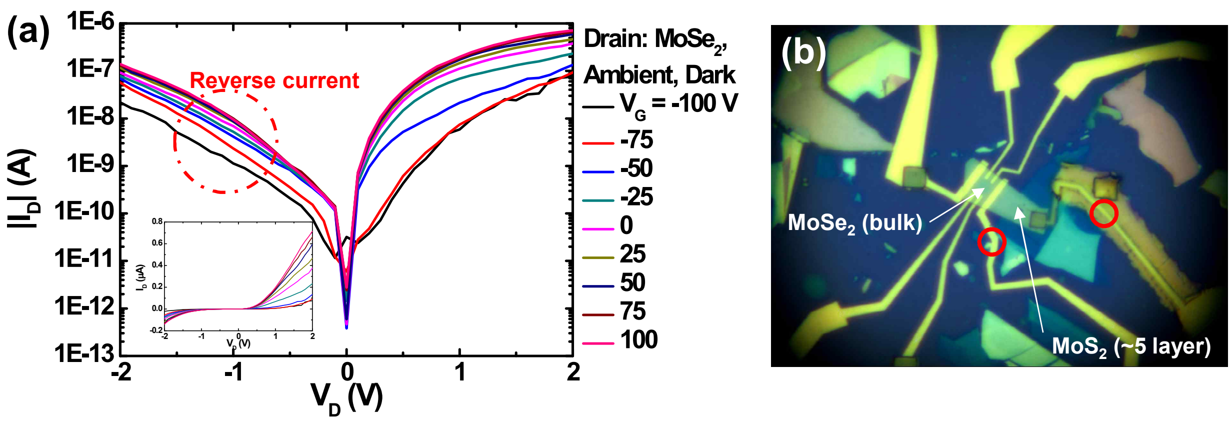

Figure 2. (a) log scale output curve of $MoSe_2$-MoS_2 junction device. Inset is linear scale of it. (b) Device structure of $MoSe_2$-MoS_2 junction device. Red circles are probed electrodes in measurement.

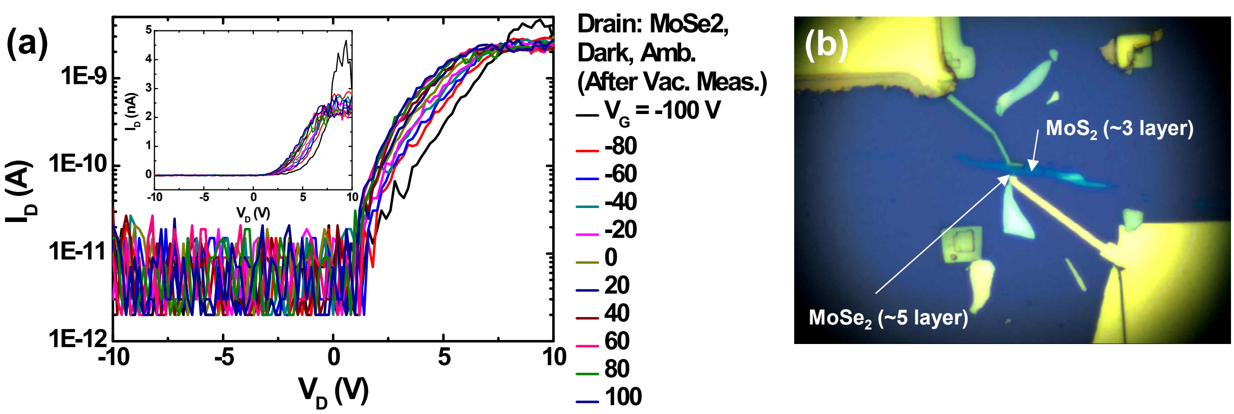

Figure 3. (a) log scale output curve of $MoSe_2$-MoS_2 junction device. Inset is linear scale of it. (b) Device structure of $MoSe_2$-MoS_2 junction device.