11:00~11:30

Exploring the High Mobility Performance via Gate-Dielectric Engineering of MoS_2 Channel

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Abstract

Two-dimensional (2D) material such as graphene, MoS2, and h-BN etc, attracting lots of attention in recent years. In previous researches, the 2D material not only applies in switching devices as field-effect transistors (FETs) but also shows the high potential for logical, optical and bio-sensor applications. However, it is a challenge to substitute the 2D material as a silicon, which employing the 2D material as a channel suffers the trapped charge from the oxide layer easily. The h-BN as dielectric layer which can block the charge impurity from SiO2 and forming a MoS2 /h-BN heterostructure to fabricate the 2D-FET device. The dielectric constant of h-BN is 4 which is similar with SiO2 as a good insulating layer. Compare with SiO2, h-BN has atomic flat surface and free dangling interface which show the good performance in dielectric engineering of FETs device.

In this work, the h-BN as dielectric material showing low characteristic temperature (T0), which not only reducing the scattering form SiO2 substrate but also screening the doping effect from substrate. Also, the contact problem of MoS2 /h-BN shows the low contact resistivity and lower Schottky barrier height. Furthermore, we also utilize the h-BN as top gate dielectric layer todemonstrate double gate FET device. Compare with single gate device, the double gate can improve the subthreshold swing (SS.), current density (Jon) and mobility.