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Revealing antiferromagnetic transition of van der Waals $MnPS_3$ via vertical electrical resistance measurement

Abstract

Understanding the correlation between the electronic and magnetic properties of materials is a crucial step to functionalize or modulate their properties [1, 2]. However, it is not straightforward to electrically characterize magnetic insulators, especially large-bandgap materials, due to their high resistivity [3]. Here, we successfully performed electrical measurements of a two-dimensional (2D) antiferromagnetic insulator, van der Waals-layered $MnPS_3$, by accounting for the vertical graphene/$MnPS_3$/graphene heterostructure. Antiferromagnetic transition is observed by the variance in electrical resistance from the paramagnetic to antiferromagnetic transition near ~78 K in the vertically stacked heterostructure devices, which is consistent with the magnetic moment measurement. Our density functional calculations demonstrate a significant change of the bandgap from 0.2 eV (no spin state) to 1.5 eV (antiferromagnetic state), which consequently explains the distinct transition change in the resistance measurement via vertically stacked devices. This opens an opportunity for modulating the magnetic transition of 2D van der Waals materials via an electrical gate or surface functionalization.

References

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