High Magnetoresistance Ratio on the In-plane Conductance of Graphene in Ni/Graphene/Ni Nanostructure

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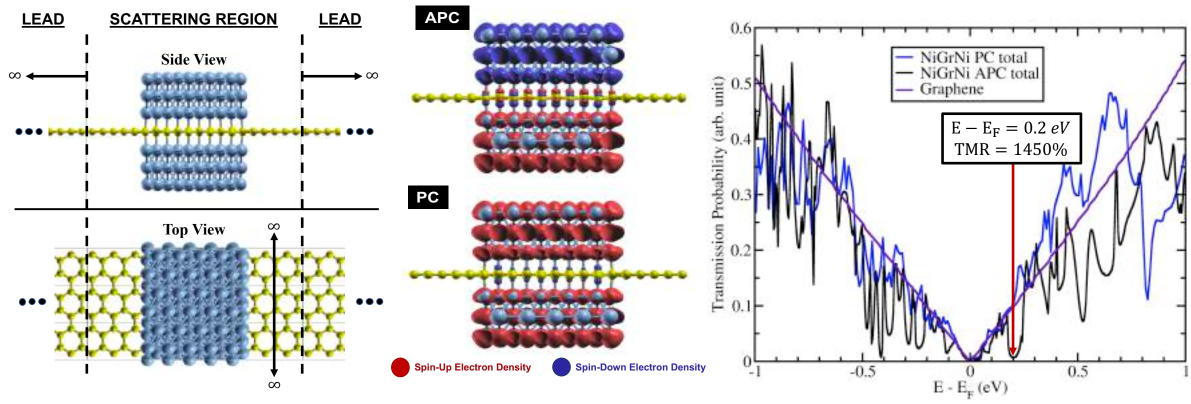
We present a theoretical study on graphene's in-plane conductance, which some parts of it sandwiched with Ni(111) slabs, as shown in figure 1(a). Our previous study showed that when Ni/graphene/Ni heterostructure is considered, the gapped Dirac cone of graphene can be controlled depending on Ni slabs' magnetic alignment [1]. When upper and lower Ni(111) slabs have antiparallel (parallel) magnetic-moment configuration, the carbon atoms of sublattices A and B will have antiferromagnetic (ferromagnetic) spin configuration. A bandgap at the Dirac cone is open when the alignment is antiparallel configuration, and it is closed when the alignment is parallel configuration. This characteristic is also shown for our considered system, as shown in figure 1(b). Thus, controlling the open and close bandgap in Ni/graphene/Ni part is expected. The transmission probability of in-plane conductance of the system in figure 1(a) is shown in figure 1(b). When Ni slabs have antiparallel alignment, we found that the opened bandgap of Dirac cone at $E - E_F = 0.2\ \mathrm{meV}$ in Ni/graphene/Ni part resulting in almost zero conductance. Meanwhile, when Ni slabs have parallel alignment, the Dirac cone's closed bandgap resulted in the transmission probability having a similar profile as pristine graphene. These transmission probability results lead to a high magnetoresistance by 1450%.



(a) (b) (c)

Figure 1. (a) The considered system of graphene with the middle part of it sandwiched with Ni(111). (b) The spin-charge density mapping of the considered system. (c) Transmission probability of the system with Ni slabs in antiparallel and parallel alignment.

References

[1] Y. Wicaksono, S. Teranishi, K. Nishiguchi, and K. Kusakabe, Carbon 143 (2019) 828-836.