In-plane Magnetoresistance of Graphene in Ni/Graphene/Ni Spin-valve-like Structure: A New Prospective of Spin-logic Device

◦(M2) Yusuf Wicaksono[1], Halimah Harfah[1,2], Koichi Kusakabe[1]

Osaka Univ. [1], Univ. of Indonesia [2]

E-mail: yusufwicaksono@artemis.mp.es.osaka-u.ac.jp

We present magnetic properties and electronic structure studies of a graphene-based nano-spin-valve-like structure theoretically. Magnetic nickel layers on both sides of graphene are considered. A spin-polarized generalized-gradient-approximation determines electronic states. In the most energetically stable stacking arrangement of graphene and two nickel layers, the anti-parallel spin configuration of the underlayer and overlayer magnetic moments has the lowest energy[1]. The spin density mapping and obtained band-structure results show that when upper and lower Ni(111) slabs have anti-parallel (parallel) magnetic-moment configuration, the carbon atoms of sublattice A and B will have antiferromagnetic (ferromagnetic) spin configuration. A band gap at the Dirac cone is open when the alignment is anti-parallel configuration, and it is closed when the alignment is parallel configuration[1]. Therefore, the in-plane conductance of the graphene layer depends on the magnetic alignment of two nickel slabs when the Fermi level is adjusted at the Dirac point. Our results also indicate a spin filtering effect of electron current in the graphene electrode which leads the material act as a magnetic-field-induced switch for the electron current. These findings along with room-temperature spin transport property of graphene and long propagation diffusion lengths (several micrometers)[2] open the opportunity to develop a graphene-based spin-logic device.

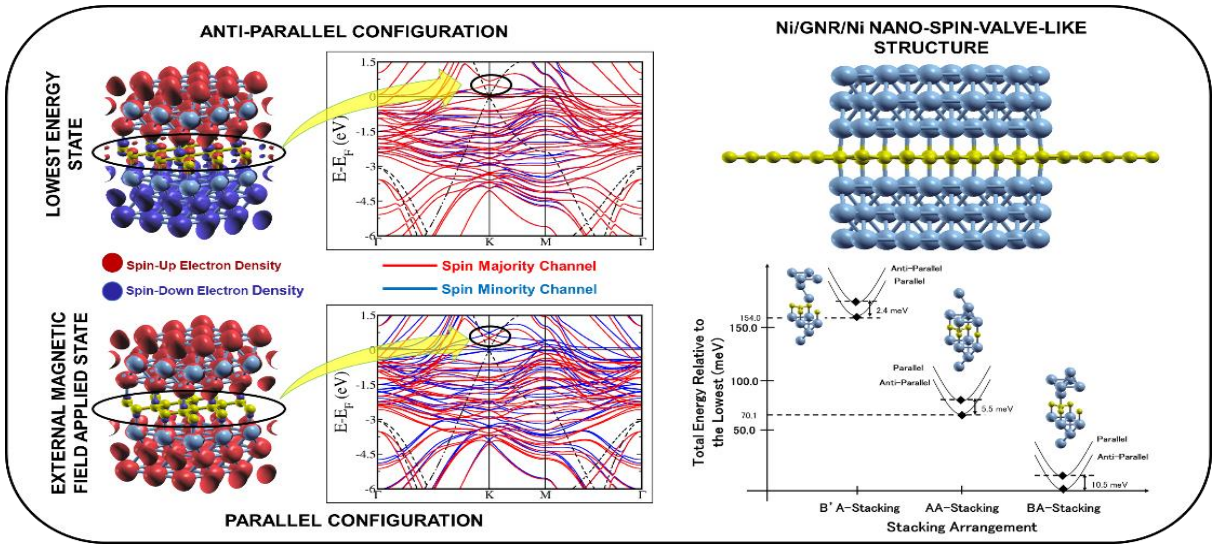

Figure 1: Spin-dependent charge density mapping (left) and bandstructure of Ni/Graphene/Ni nanostructure (middle). When the magnetic moment between upper and lower nickel slabs is antiparallel (parallel), the Dirac cone of graphene is open (close). The proposed structure of spin-logic device (right).

References

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