Spin-Orbit Torque in Graphene/Co Hetero-system

Kenan Song, Aurelien Manchon and Udo Schwingenschlögl

Physical Science and Engineering Division, King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia

kenan.song@kaust.edu.sa

The spin-orbit torque (SOT) technique has opened new horizons for the development of innovative magnetic devices beyond memories and data storage [1]. We investigate interfacial spin texture and SOT at the interface between Co (001) and a graphene monolayer, a system that has recently been predicted to display large *Rashba* effect [2, 3], see Fig. 1*a*. When graphene is attached to the surface of Co (001), the inversion symmetry is broken, which results in the onset of a built-in perpendicular electric field. As a result, in the presence of the large spin-orbit coupling of Co, *Rashba* effect emerges at the interface. Therefore, a spin density driven by a net current can be achieved at the interface, bringing SOT into such a heterostructure [4]. Using density functional theory, we show that Co atoms at the interface exhibit spin-momentum locking, which is in line with the phenomenological picture presented above. Close to the Fermi level, the graphene Dirac cones couple with the Co 3*d* states around the *K* and *K*' points (Fig. 1b), resulting in a spin texture odd in momentum *k* (Fig. 1*c*). This special spin texture promotes current-driven SOT. We then project the band structure obtained by first principles onto Wannier orbitals to get the tight-binding Hamiltonian. Non-equilibrium properties then are calculated using the Kubo formula. Our results show that the SOT can be used to electrically control the magnetization of the Co layer and to realize fast non-volatile data reading and writing.

References

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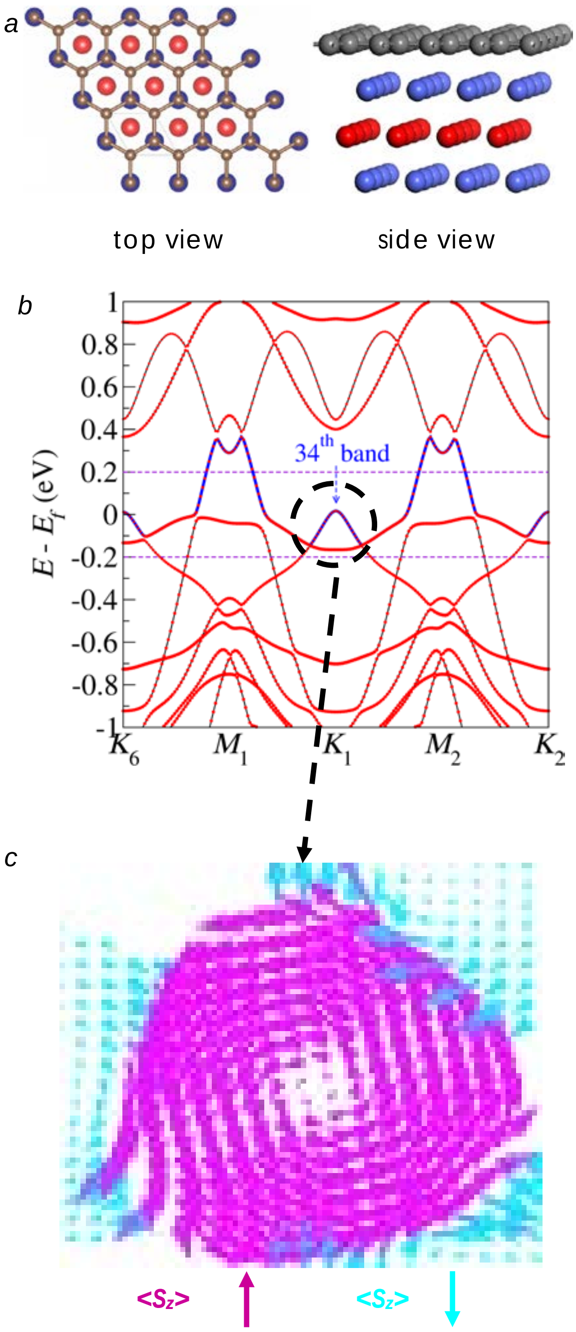

Figure 1: SOT in the graphene/Co heterostructure. *a* – theoretical model; *b* – band structure (red colour: contribution of Co); *c* – top view of the spin texture on of the 34th band