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Electronic and magnetic structures of RB_4 (*R*=Gd, Tb, Dy, Yb)

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Rare-earth tetraboride RB_4 consists of the rare-earth ion (*R*) planes stacked along the c-axis and two kinds of boron atoms between R ion planes. The first type of the boron atoms forms of B6 octahedra oriented along the c-axis ,which are connected by the second type of boron atoms. A strong structural anisotropy in these compounds gives rise to electrical and magnetic anisotropic properties. RB_4 has a complex magnetic ground state except for YbB4. It is recently proposed that the magnetic state has a strong correlation with the orbital degree of freedom.

In this study, we have investigated the electronic and magnetic properties of RB4 by using both the linearized muffin-tin orbital (LMTO) and the full potential linearized augmented plane wave method (FLAPW). The local spin-density approximation was adopted for the exchange-correlation potential and the spin-orbit coupling term was also considered. We assumed the collinear spin configuration in these calculations. We have found stable magnetic ground states for RB_4 (R=Gd, Tb, Dy), but a non-magnetic ground state for YbB_4. A few bandscrossing the Fermi level in YbB4 indicate a possible mixed valence state.

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Micromagnetic simulations on current-driven domain-wall depinning

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Recent explosive researches have been focused on current induced domain wall motion which is applicable to a high recording density storage memory (~ Tbit/in^2). Precise control and manipulation of magnetic domain structure have become one of the key issues in current induced domain wall motion. Notch on magnetic nano wire was used to control the magnetic domain wall [1]. Approximately, uniform current distribution was used for the current induced domain wall motion near the notch in nanowire. However, the non-uniform current distribution is made near the notch in nanowire. In this work, we calculated exact current distribution for the nanowire with notch from Laplace equation and investigated the effect of exact current distribution and compared with uniform current distribution on critical current for domain wall depinning.

Domain wall structure and magnetization dynamics are micromagnetically modeled by including spin transfer torqueterm in LLG equation [2].

The rectangular nanowire is 400 nm long and 32 nm width and 5 nm thick. The simulated material was Permalloy with a saturation magnetization of 800 emu/cc, an exchange constant of 1.3e-6 erg/cm, no crystalline anisotropy, damping parameter of 0.02, spin polarization factor of 0.7 [3]. The nanowire was discretized into cubic cells of 4 nm × 4 nm × 5 nm. Fig. 1shows the critical current and the critical field for (a) exact current distribution considering notch and (b) uniform current distribution. At a low magnetic field region, the critical current of (a) is smaller by ~ 0.2 mA than that of (b). However, at a higher magnetic field region, there is no difference between two cases (a) and (b). The cross section area for current flow is reduced near notch region. Therefore, critical currents for DW motion in the case of exact current density are smaller than those in the case of uniform current density.

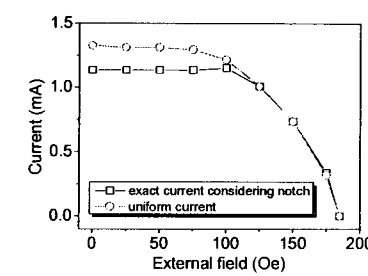

Fig. 1. Domain wall depinning critical current for (a) exact current considering notch and (b) uniform current

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