Effect of Dresselhaus spin orbit interaction on current-induced skyrmion dynamics

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1. Introduction

In magnetic systems with an inversion asymmetry and large spin-orbit coupling, the anti-symmetric exchange interaction called the Dzyaloshinskii-Moriya interaction (DMI) becomses non-negligible[1,2]. Recently magnetic skyrmions stabilized by DMI are expected to have potential as information unit for storage and logic devices [4,5]. There are two main spin orbit interaction in skyrmion studies. One is formed by interfacial DM interaction induced by Rashba spin orbit interaction. The other is bulk DM interaction induced by Weyl spin orbit interaction. But studies about skyrmion stabilized by Dresselhaus spin orbit interaction has lacked.

2. Simulation Scheme

We investigate skyrmion velocity using Landau-Lifshitz-Gilbert equation with an spin hall spin transfer torque with two types spin orbit interaction (Rashba and Dresselhaus). We use following parameters; nanowire width is 40 nm, thickness is 1 nm, cell size is $1\times1\times1$ nm^3, saturation magnetization is 800 emu/cm^3, damping constant is 0.1, exchange stiffness constant is 1.2×10^{-6} erg/cm, DM constant is 2 erg/cm^2, spin hall angle is 0.1, perpendicular magnetocrystalline anisotropy K_u is 0.8×10^7 erg/cm^3.

3. Result and Discussion

Figure 1 shows that both skyrmion velocity have linear dependence with current density, which is consistent with the prediction based on collective coordinate approach. In contrast to interfacial DM interaction, the DM

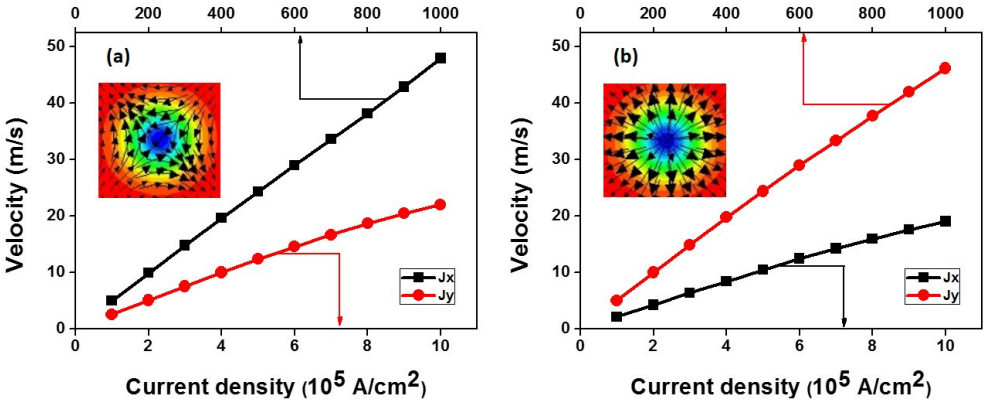

Fig. 1. Skyrmion velocity as a function of current density J for different current flow direction. (a) DM induced by Dresselhaus spin orbit interaction, (b) DM induced by Rashba spin orbit interaction

interaction induced by Dresselhaus spin orbit interaction case has different aspect for current flow direction, it is because spin hall torque symmetry has 90° difference with spin orbit torque symmetry driven by Dresselhaus spin orbit interaction.

5. Reference

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