Current-induced motion of synthetic antiferromagnetic skyrmion bubble

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Magnetic skyrmion [1] which is a quasi-particle whose spins cover a unit sphere has attracted much attention because of various emergent exotic spin-dependent phenomena due to non-trivial topology in real space [2]. Room-temperature magnetic skyrmion has been demonstrated in heavy metal/ ferromagnet systems due to an interfacial Dzyaloshinskii-Moriya interaction (DMI) induced by strong spin-orbit coupling [3]. The spin-orbit coupling also gives rise to spin-orbit torques (SOTs) under in-plane current, allowing efficient control of the skyrmion [3]. However, there still remain some fundamental issues for applications. For instance, skyrmion Hall effect (SkHE), a diagonal motion of skyrmion with respect to the current direction owing to the Magnus force [4], limits the velocity of skyrmion motion on a track [5]. In addition, large stray-field in ferromagnetic multilayer system imposes a limit on scaling of skyrmion-based device concepts [6]. Theoretical studies predicted that antiferromagnetic skyrmions are free from these limitations [7,8]. Experimentally, skyrmion Hall effect-free motion has been achieved in ferrimagnetic alloy, although the emergence of favorable features is limited at an angular-momentum compensation temperature [9].

Here we show a SkHE-free motion of skyrmion bubbles at room temperature in a synthetic antiferromagnetic (SyAF) system. We show that the SyAF skyrmion can be driven with an order of magnitude smaller current density than conventional ferromagnetic skyrmion bubbles at comparable velocities. The achieved favorable properties are attributed to the employed stack structure which is engineered so that the Ruderman-Kittel-Kasuya-Yosida (RKKY) interaction, DMI, and SOT act in a concerted way [10].

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