Spin-orbit torque induced switching of antiferromagnet/non-magnet metallic structure

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Utilization of antiferromagnets (AFMs) as active components of spintronic devices offers several unique advantages complementing current ferromagnet (FM) based spintronic architectures [1-8]. The capability of electrical writing and reading is crucial for the development of AFM-based spintronic devices [4-7]. One of the possible candidates satisfying the requirement is Mn-based metallic alloys (Mn-X where X = 4d/5d metal). In our previous work, we have demonstrated magneto-resistive effects in an AFM/heavy-metal (HM) PtMn/Pt structure [8], which offers electrical reading scheme of stored information without auxiliary FMs. Here, we demonstrate electrical writing of PtMn/Pt by spin-orbit torques.

The multilayer films with stack structures sub./buffer/PtMn(10)/Pt(5)/Ru(1) (PtMn/Pt, hereafter) (in nm) are grown by sputtering and patterned into star-shaped devices. Electrical writing is achieved by applying pulsed currents ($I_{\mathrm{Write}}{}^{1}$ and $I_{\mathrm{Write}}{}^{0}$) along orthogonal directions, while read-out is achieved by measuring transverse Hall resistance R_{Hall} (Fig. 1(a),(b)). Figure 1(c) shows the results of electrical writing for different current amplitudes. A combination of electrical measurements with X-ray magnetic imaging on similar structures shows a reorientation of antiferromagnetic Néel vector upon application of $I_{\mathrm{Write}}{}^{1}$ and/or $I_{\mathrm{Write}}{}^{0}$.

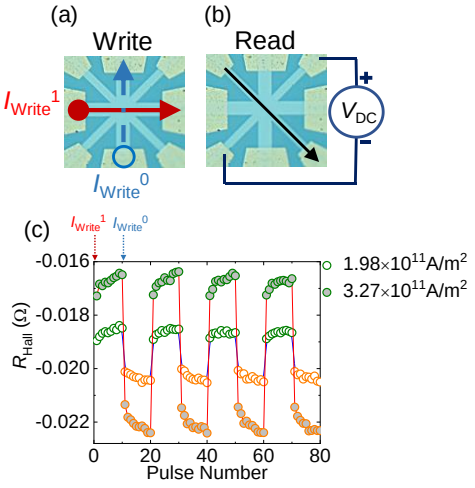

Figure 1: Schematic diagram of measurement. (a) Writing scheme under $I_{\mathrm{Write}}{}^{1}$ and/or $I_{\mathrm{Write}}{}^{0}$. (b) Read-out by measuring transverse voltage (V_{DC}) under application of read current. (c) Electrical writing in PtMn/Pt for different current density in Pt layer.

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