異種強磁性体ヘテロ接合の一方向性スピンプレーナーホール磁気抵抗

Unidirectional spin planar Hall magnetoresistance in heterostructures of two ferromagnets

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The electrical generation of spin current is one of the most important topics in spintronics. Recently, ferromagnet has drawn much attention as a spin current source because magnetization offers controllability of spin polarization direction [1-3]. Here, we detect the spin current owing to the planar Hall effect (PHE), which has hardly been investigated ever, by means of the unidirectional magnetoresistance (UMR) [4].

Fig. (a) shows the illustration of the UMR in a heterostructure composed of two ferromagnetic materials. When the charge current is applied, PHE induces spin current flowing along the magnetization direction. Then, the spin current generated in the one ferromagnet is injected into the other. Since the spin orientation depends on the polarity of charge current, this spin current results in UMR in analogy to the giant magnetoresistance.

To quantitatively investigate the UMR, we measured the second harmonic resistance $R_{2\omega}^{xx}$ while rotating the external magnetic field of 9 T in *zx*-plane. Fig. (b) shows the angle dependence of $R_{2\omega}^{xx}$ in Py(6 nm)/Co(3 nm) and Co(3 nm)/Py(6 nm) systems, where the thermoelectric signal is removed. The observed sin2θ symmetry is consistent with the spin current generation by PHE [1,3]. In addition, the UMR reverses its sign depending on the stacking order of the two ferromagnetic layers, which further evidences the above-mentioned scenario. Our study provides a clue to understand the charge-spin conversion in ferromagnets.

This work was supported by JSPS KAKENHI and Spintronics Research Network of Japan.

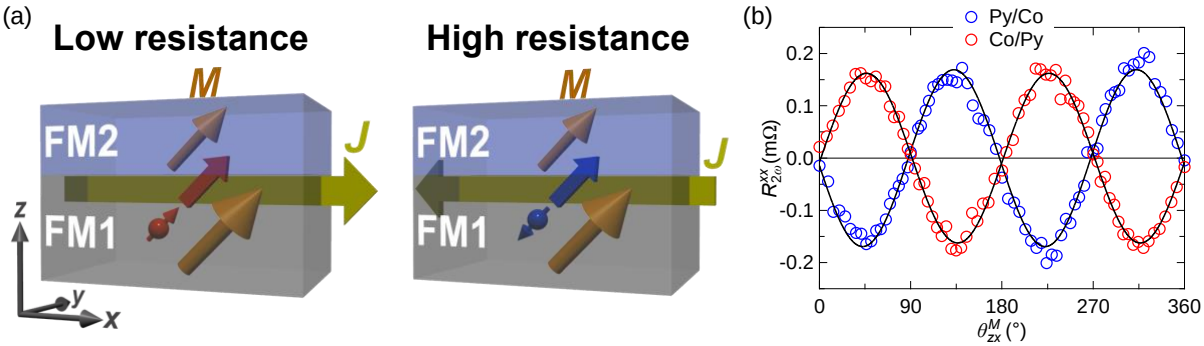

Figure. (a) Schematic illustration of the UMR effect originating from planar Hall current. (b) Magnetization angle dependence of the second harmonic resistance in Py/Co and Co/Py systems. θ_{zx}^{M} represents the polar angle of magnetization direction.

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