Pt/IrMn/CoFeB 系における外部磁場下での電流誘起交換バイアス反転 Current-induced switching of exchange bias under external magnetic field in Pt/IrMn/CoFeB system 東大工¹, 阪大産研², 阪大 CSRN³ ⁰長谷川 顕登¹, 小山 知弘^{2,3}, 千葉 大地^{2,3} The Univ. of Tokyo¹, ISIR, Osaka Univ.², CSRN, Osaka Univ.³, ^oKento Hasegawa¹, Tomohiro Koyama^{2,3}, and Daichi Chiba^{2,3}

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The exchange bias (EB) effect in ferromagnet/antiferromagnet heterostructures is important for many spintronic applications, such as magnetic random access memories. In general, the EB is induced by field cooling process, where a system is heated above the blocking temperature followed by cooling in external magnetic field to align magnetization of ferromagnetic layer. However, recent reports achieved a current induced reversal of EB by spin-orbit torque under zero magnetic field [1,2]. In this study, we have investigated the switching behavior of EB by injecting current pulse under external magnetic field.

We prepared an in-plane magnetized Ta(1.0 nm)/Pt(4.0 nm)/IrMn(8.0 nm)/CoFeB(3.0 nm)/MgO(3.0 nm)/Ta(0.5 nm) layers on thermally oxidized Si substrate by rf sputtering. In order to determine the EB, the magnetoresistance (MR) was measured using four-probe method (Fig. (a)). Although the EB was not observed in the pristine device, the EB field along the y-axis appeared after injecting a current pulse with +45 mA amplitude under zero magnetic field. The EB can be switched by injecting negative current pulse of -45 mA (Fig. (b)), which is consistent with the previous report [2], and the direction of EB is determined by spin-orbit torque and Oersted field. In addition, we found that injecting a current pulse of +45 mA under in-plane magnetic field $\mu_0 H_y = \pm 50$ mT induced the EB in $\pm y$ direction (Fig. (c)). These results indicate that the direction of exchange bias can also be determined by the external magnetic field just like the field cooling process.

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Figure. (a) Schematic illustration of the experimental setup and coordinate system. (b) The MR (ΔR_{xx}) curve after injecting a current pulse of ±45 mA under zero magnetic field. (c) The MR curve after injecting a current pulse of +45 mA under $\mu_0 H_y = \pm 50$ mT.

[1] P. -H. Lin et al., Nat. Mater. 18, 335 (2019). [2] H. -J. Kim et al., Appl. Phys. Lett. 115, 022401 (2019).