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Charge-spin conversion at interfaces with spin splitting

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The two-dimensional electronic systems with band-splitting like the surface state of a topological insulator (TI) and Rashba interface provide unique opportunities for spintronics applications. The spin-momentum locking in the surface state offers a possibility of a highly efficient charge-spin current (C-S) interconversion compared with ordinary spin Hall effect in paramagnetic metals. The interfacial C-S conversion mechanism has been proposed by Edelstein in 1990 [V. M. Edelstein, Solid State Commun. 73, 233–235 (1990).]. For Ag/Bi Rashba interface, it was recently observed [J.C. Rojas Snchez et al, Nat. Commun. 4, 2944 (2013).]. For the further development of interfacial spin current devices, it is important to quantitatively evaluate the conversion efficiency between charge and spin current. Firstly, we investigated the C-S conversion in surface state of topological insulators, which are appropriate materials for efficient interfacial C-S conversion. We prepared the TI ((Bi1-xSbx)2Te3: BST)/non-magnetic metal (Cu)/ferromagnetic-metal (NiFe) tri-layer films. By applying spectral analysis based on spin-torque ferromagnetic resonance (ST-FMR) to BST/Cu/NiFe tri-layer films, we succeeded in determining the C-S conversion efficiency of a surface state of TIs, whose Fermi level was varied by tuning the Sb composition. We found that in bulk insulating conditions the interface C-S conversion effect via Dirac surface state is evaluated as nearly constant large values [K. Kondou et al., Nat. phys, (2016) doi:10.1038/nphys3833]. Secondary, we measured S-C conversion effect in non-magnetic metal/oxide interface. We found the S-C conversion phenomenon in non-magnetic metal (Cu)/oxide (Bi2O3) interface, which may be caused by Rashba effect like Ag/Bi interface [K. Karube et al., Appl. Phys. Exp. 9, 033001 (2016).]. Interestingly, the amplitude of S-C conversion efficiency strongly depends on Cu layer thickness. These findings have important implications for development of future spintronic devise using the interface spin conversion effect.