Spin-orbit torque in sputtered W-Te/Ru/CoFeB thin film

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Spin-orbit torque (SOT), a current-induced torque observed in nonmagnet (NM)/ferromagnet (FM) bilayers, has been extensively studied not only from a fundamental perspective but also for its potential in efficiently controlling magnetization [1-3] for nonvolatile memory and neuromorphic computing applications. Large SOT is known to arise when the NM layer consists of heavy metals such as β-W due to their strong spin-orbit coupling [4]. Recently, type-II Weyl semimetals have been shown to generate unconventional SOT in terms of the torque direction [5]. WTe_2 is a representative example, exhibiting both the unconventional characteristics and high SOT generation efficiency [6]. However, most previous studies have used samples prepared by exfoliation or molecular beam epitaxy. The properties of sputtered WTe_2/CoFeB films on silicon substrates—more relevant for practical applications—remain insufficiently explored.

In this work, we deposit W-Te/Ru/CoFeB thin films on thermally oxidized silicon substrates using DC/RF magnetron sputtering and evaluate their effective spin Hall conductivity, a parameter representing the efficiency to generate SOT per unit current density, via the harmonic Hall technique (Fig. 1) [7,8]. We investigate the effects of the W-Te composition and underlayer materials on both the thermal durability and the magnitude of the effective spin Hall conductivity. We find that the choice of underlayer significantly influences the properties of the W-Te layer and resultant effective spin Hall conductivity σ_{SH} (Fig. 2). We also fabricate W/Ru/CoFeB as a reference of conventional materials and compare the results with W-Te/Ru/CoFeB. Detailed findings will be discussed in the talk. The results offer new insights into the potential application of Weyl metals in practical spintronic devices.

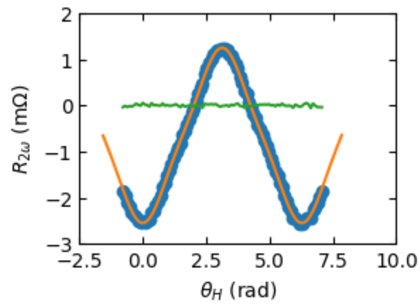

Fig.1 Angle dependent harmonic Hall resistance

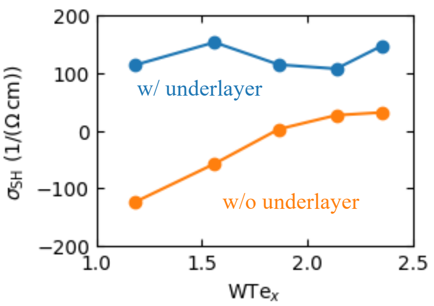

Fig. 2 Effective spin Hall conductivity as a function of W-Te composition

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