Electrical detection of surface conduction in magnetic Weyl semimetal $Co_3Sn_2S_2$ thin films

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A shandite-type compound $Co_3Sn_2S_2$ has been identified as a magnetic Weyl semimetal through recent transport and spectroscopic studies. On the surface of $Co_3Sn_2S_2$, the Fermi arc that connects a pair of Weyl points is projected, resulting in topological surface states [1,2]. The surface states are expected to produce surface conduction robust against disorder, which can potentially be utilized for spintronic devices. However, it is difficult to detect the surface conduction with $Co_3Sn_2S_2$ bulk samples because the bulk conductance proportional to the sample thickness t overwhelms the surface conductance independent of t (Fig. 1). In this study, we used $Co_3Sn_2S_2$ thin films to suppress the contribution of bulk conductance and analyzed the t-dependence of sheet conductance G_s across the ferromagnetic transition temperature T_C [3].

The $Co_3Sn_2S_2$ thin films were grown on Al_2O_3(0001) substrates by rf magnetron sputtering. We measured the t-dependence of G_s for the films t = 23–61 nm that exhibited the giant anomalous Hall effect below the T_C ~ 180 K [4]. While the G_s data in the paramagnetic state were explained by the single bulk component $G_s \sim G_s^{bulk} \propto t$, the G_s data in the ferromagnetic phase showed a finite intercept at the limit of t = 0 nm. This indicates the occurrence of an additional t-independent conductance under the ferromagnetic condition. As shown in Fig. 2, the temperature dependence of the analyzed G_s at the limit of t = 0 nm is metallic, which is consistent with the Fermi arc-induced surface conduction in the magnetic Weyl semimetal phase. In this presentation, we will show the detailed analysis and discuss the dimensionality of the surface conducting channel.

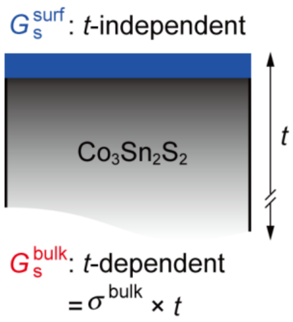

Fig. 1. Surface conduction in magnetic Weyl semimetal $Co_3Sn_2S_2$.

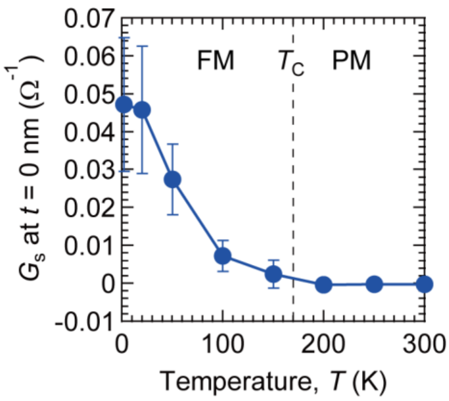

Fig. 2. Temperature dependence of the G_s at the limit of t = 0 nm (FM: ferromagnetic state, PM: paramagnetic state).

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[3] J. Ikeda *et al.*, *Commun. Phys.* **4**, 117 (2021).
[4] J. Ikeda *et al.*, *Commun. Mater.* **2**, 18 (2021).