Transverse transport properties of 2D Fe3GaTe2

Jisang Hong
Brahim Marfoua
Department of Physics, Pukyong National University, Busan, Korea
hongj@pknu.ac.kr

Anomalous transverse conductivities such as anomalous Hall conductivity (AHC), anomalous Nernst conductivity (ANC), and anomalous thermal Hall conductivity (ATHC) play a crucial role in the emerging field of spintronics. Motivated by the recent fabrication of two dimensional (2D) ferromagnetic thin film Fe_3GaTe_2, we investigate the thickness dependent anomalous transverse conductivities of the 2D Fe_3GaTe_2 system (from one to four layers). We find that the atomically ultra-thin 2D Fe_3GaTe_2 system shows above room temperature ferromagnetism with large perpendicular magnetic anisotropy energy. Furthermore, we obtain large AHC of -490 in four-layer thickness, and this is further enhanced to -590 S/cm with small electron doping. This AHC is seven times larger compared to the measured AHC in thicker 2D Fe_3GaTe_2 (178 nm). The ANC also reaches 1.05 A/K.m in the four-layer structure. Along with these, the four-layer system exhibits a giant ATHC (-0.11~ -0.14 W/K). This ATHC is comparable to the giant ATHC found in Weyl semimetal $Co_3Sn_2S_2$. Our results suggest that the atomically ultra-thin 2D Fe_3GaTe_2 system shows outstanding anomalous transverse conductivities and can be utilized as a potential platform for future spintronics and spin caloritronics device applications.

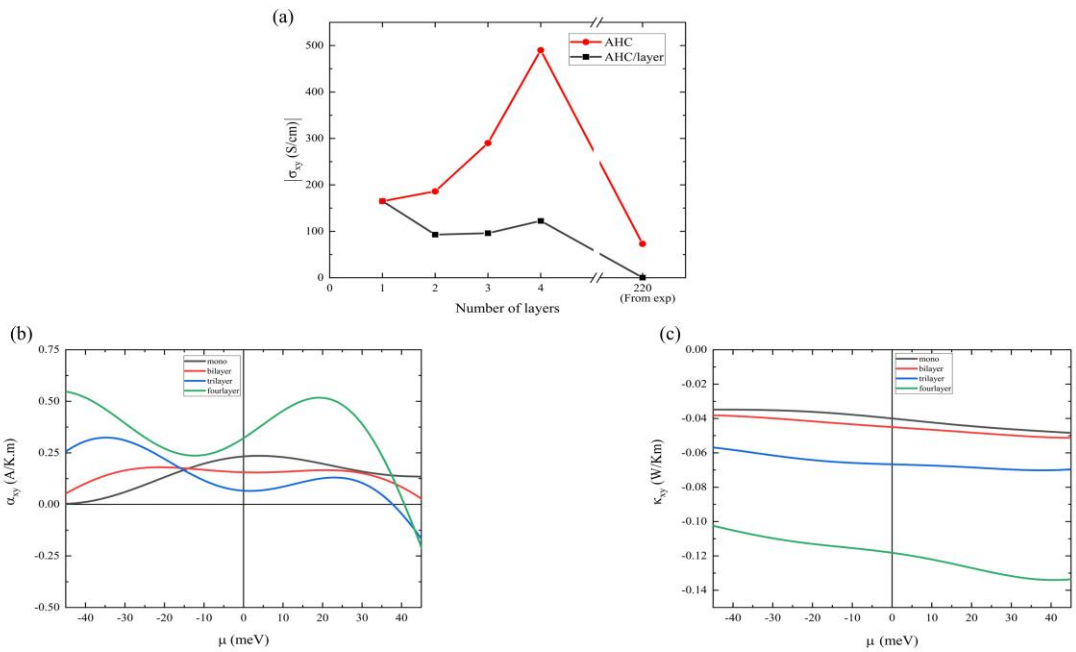

Figure 1:
Thickness dependent anomalous transverse transport coefficients. Thickness dependent (a) anomalous Hall conductivity (σ_{xy}) as a function of the chemical potential of 2D Fe_3GaTe_2 systems. (b) anomalous Hall conductivity (σ_{xy}) at Fermi energy of 2D Fe_3GaTe_2 systems (from monolayer to four-layer and including experimental data). (c) anomalous Nernst conductivity (α_{xy}) and (d) anomalous thermal Hall conductivity (κ_{xy}) as a function of the chemical potential of 2D Fe_3GaTe_2 systems. Here, the black, red, blue, and green lines represent the monolayer, bilayer, trilayer, and four-layer Fe_3GaTe_2 systems.