Searching for high temperature quantum anomalous Hall materials

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The quantum anomalous Hall (QAH) effect is a quantum Hall effect induced by spontaneous magnetization instead of an external magnetic field. The effect occurs in two-dimensional (2D) insulators with topologically nontrivial electronic band structure characterized by a non-zero Chern number. The experimental observation of the QAH effect in thin films of magnetically doped $(Bi,Sb)_2Te_3$ topological insulators (TIs) paves the way for applications of dissipationless quantum Hall edge states, but an ultralow temperature of 30 mK is required to reach a perfect quantization. Further studies in this direction require magnetic TI materials that can show the QAH effect at higher temperature, to which heterostructure is one of the approaches [2]. We performed systematic studies on the QAH effect in magnetically doped TI films of different thicknesses, magnetic dopants and compositions [3, 4]. The results clarify the relationship between the QAH effect and the energy band structure, electronic localization and ferromagnetism of magnetic TI films and provide insights into how to obtain high temperature QAH materials. By co-doping Cr and V in $(Bi,Sb)_2Te_3$ TI films, we increase the temperature for the QAH effect to such a level that full quantization is achieved at 300 mK (Fig. 1), and zero-field Hall resistance of 0.97 h/e^2 is observed at 1.5 K.

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