Two-dimensional Ferrovalley Semi-Half-Metal and Tunable Valley-Unbalanced Quantum Anomalous Hall Effect

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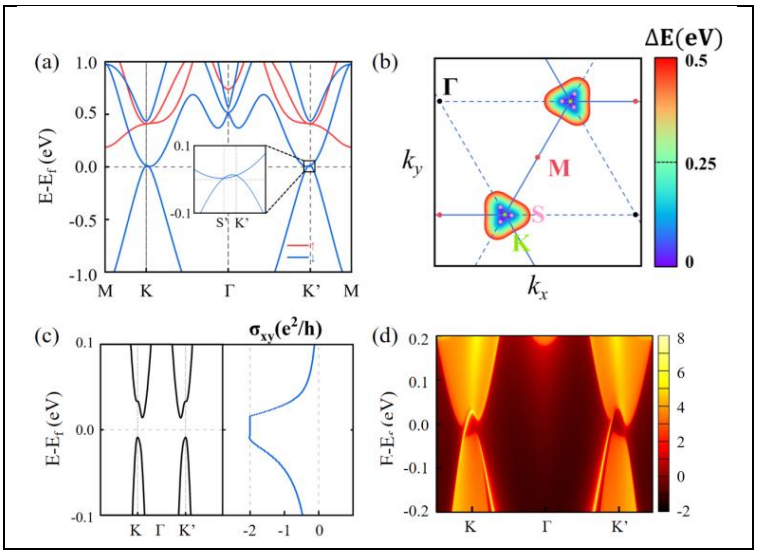
As a promising competitor for novel quantum devices, magnetic topological materials attract much attention in recent year for its interesting physical properties in magnetism and electron transport. In this work, we find a ferromagnetic topological material with a high Chern number of 2. Based on first principle calculations, we find 1T-CrS_2F_2 monolayer, which is halogenide of 1T-CrS_2 that has been successfully synthesized is stable at regular situation and possess intrinsic ferromagnetism as well as energy valleys. When spin-orbit coupling(SOC) is considered, the anomalous hall conductance appears as a quantum platform of -2 e^2/h and two metallic edge states are discovered between valence band and conduction band. However, the presence of space inversion symmetry makes valleys equivalent and restrict further application. So a Janus structure 1T-CrS_2FCl is constructed to introduce energy valley polarization. After considering SOC in ferromagnetic 1T-CrS_2FCl, we can destroy the equivalence between energy valleys and apply a perpendicular electric field to tune the band structure. With electric field we can attain tunable QAH conductance. Our research provides are instructive for the discovery of magnetic topological materials and the research of novel spintronic devices.



Pic.1 Electronic properties and topological properties of 1T-CrS_2F_2. (a) The spin-polarized band without considering SOC, and the inset shows the quadratic crossover between conduction and valence bands near K'.(b) The triangular warping structure in the ferromagnetic band. (c) Band structure and the quantum anomalous Hall effect of 1T-CrS_2F_2 with SOC considered. (d) Two metallic edge states between the conduction band and the valence band.