Coexistence of semimetallic phase and semiconducting phase in WTe_2 alloy

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The layered semimetal WTe_2 has been received a lot of attention because of the observation of a non-saturating and extremely large positive magnetoresistance, which can be one of the excellent candidates for magnetic memory and spintronic device. In order to apply to tunable high-performance device effectively, WTe_2 is required to demonstrate band-gap engineering by alloying different materials like bulk semiconductor. WTe_2 is distinguished from other transition-metal dichalcogenides (TMDs) by the existence of an exceptional semimetallic distorted octahedral structure (Td). Therefore, we can take advantage of region, which has the coexistence of the Td phase and the H phase, in various aspect such as easy to make ohmic junction and tune for the transport properties by band-gap engineering.

In this research, we introduce $W_{1-x}M_xTe_2$ (M = Re, Mo) and $WSe_{2(1-x)}Te_{2(x)}$ crystals to confirm coexistence possibility of coexistence phase. We obtained ohmic contacts between Ti/Au metal electrodes and the layered WTe_2 alloys by chemical and physical surface treatments. In transport measurement, we observed that magnetoresistance is decreased dramatically, and transverse resistivity tendency is changed. These results indicate that the electron-hole concentration symmetry is broken, which illustrates the first step of making coexistence state. This coexistence phase can open up an exciting opportunity not only for developing devices induced by gate-controlled phase transition but also for understanding their fundamental physical properties of Wyle semimetals.