Supporting Information

Direct evidence for charge compensation induced large magnetoresistance in thin WTe_2

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I. Effect of carriers' mobilities on the gate tunable magnetoresistance

As both electron and hole mobilities change during the process of gate tuning, it is important to analyze the contribution of mobility to the gate-dependence of MR. Based on the two-band theory shown in the main text, The dominant effect of the carriers' mobilities on the MR arises from $\mu_e\mu_h$. Thus we extracted the gate dependence of $\mu_e\mu_h$ and compared it with the variation of MR, with results shown in Fig. S1. Similar to the MR, the $\mu_e\mu_h$ reaches a maximum at a certain gate voltage (about – 5 V). But, the $\mu_e\mu_h$ curve is asymmetric around the gate voltage of – 5V, and change rate of $\mu_e\mu_h$ at left side is much larger than that at right side, which is inconsistent with the near symmetric variation of the MR curve. Moreover, the change of MR (60%) cannot be compensated by the relative small reduction in $\mu_e\mu_h$ (13%). On the contrary, the variation of n_e/n_h curve is symmetric similar to the MR curve. The MR reaches the maximum at n_e/n_h=1 and drastically decreases when n_e/n_h deviates from 1. These results indicate that the feature of MR curve mainly depends on the carrier density. The maximum of the MR (>10000 %) at charge compensation point suggests that electron-hole compensation gives rise to the large non-saturating magnetoresistance in WTe_2.

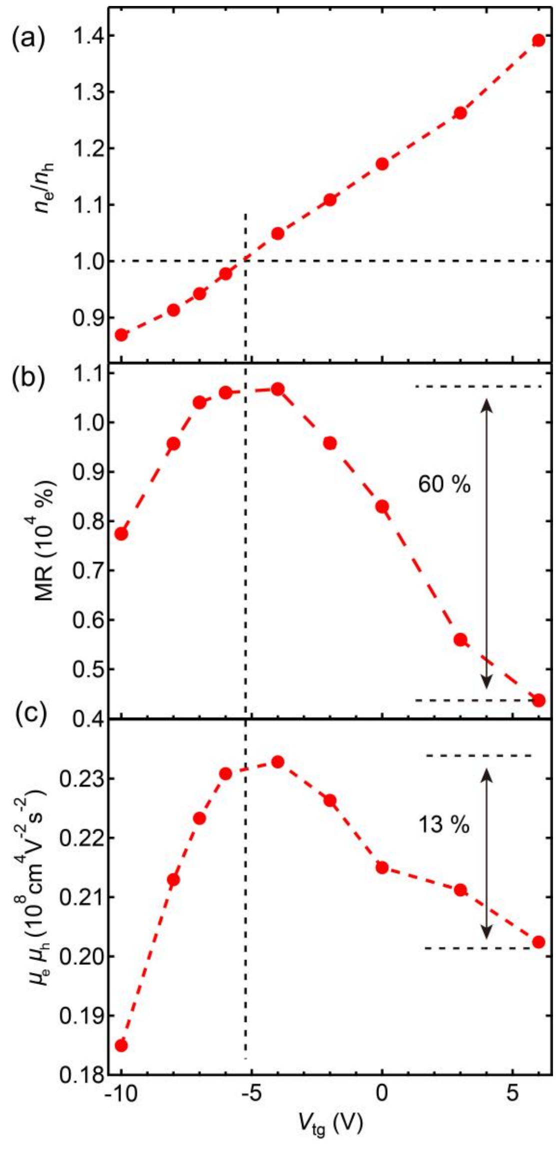

Fig. S1. The relative contribution of the carrier densities ratio (n_e/n_h) and carrier mobility ($\mu_e\mu_h$) to the gate-tunable magnetoresistance.

II. The effect of the ratio of carrier density on the MR

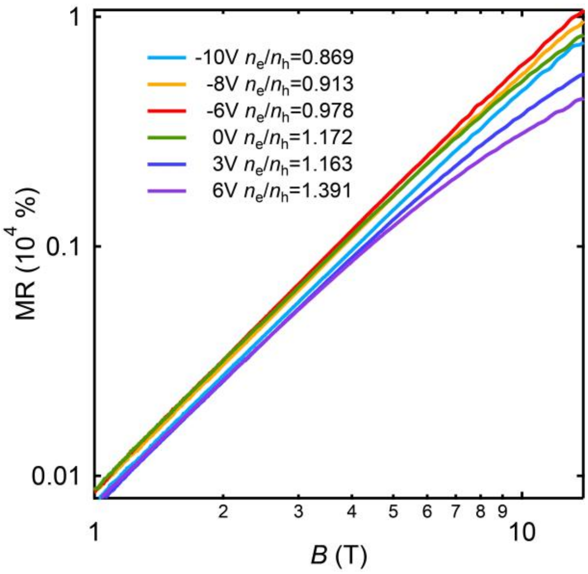

Fig. S2: MR(B) versus magnetic field with double-log plot at different gate voltages. The MR(B) curves increase with saturation near the charge compensation (n_e/n_h~1), but the increasing rate becomes small at high field when n_e/n_h is far away 1, indicating that the non-saturating MR in WTe_2 is attributed to the charge compensation.

III. Two-band theory analysis of the magnetoresistance and the Hall resistivity curves at different temperatures

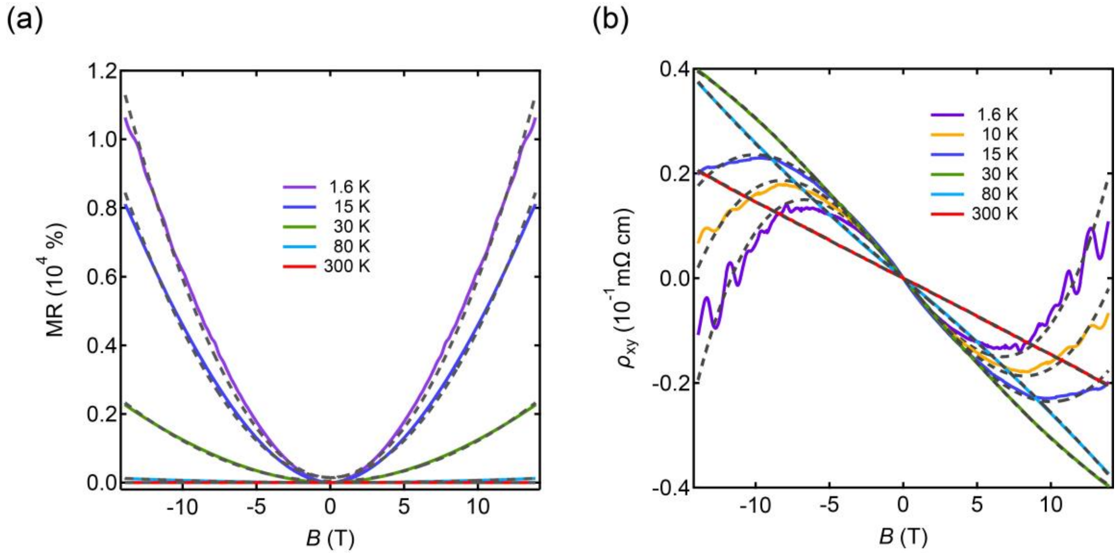

Fig. S3. Two-band theory analysis of the magnetoresistance (a) and the Hall resistivity (b) curves at different temperatures. The dashed lines are fitted curves which agree with the experimental data (solid lines) well.

IV. Temperature-dependence of the magnetoresistance at different gate voltages

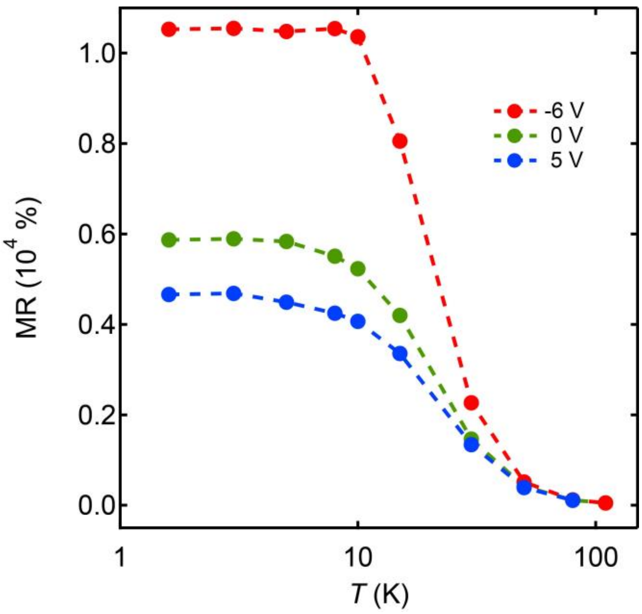

Fig. S4. Temperature-dependence of the magnetoresistance (*B*=14 T) at different gate voltages. The MR tends to saturate at low temperature for different gate voltages, which may be attributed to the electron-electron scattering as discussed in the main text.

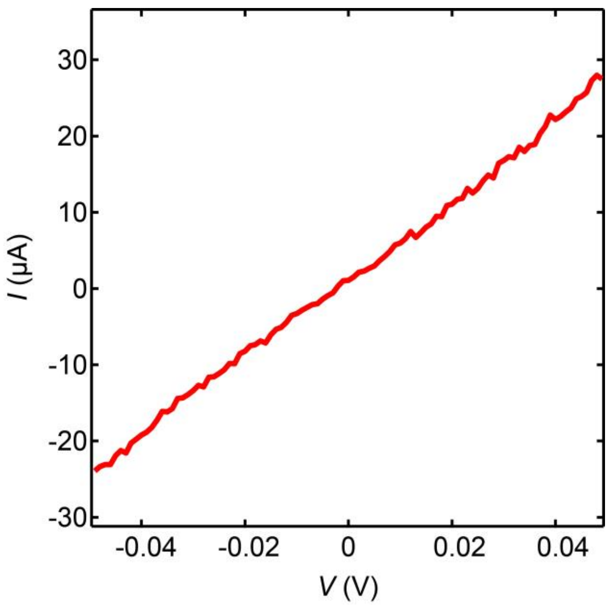

Fig. S5. Contact resistance of the thin film device at 1.6 K. The I-V curve measured by two-point method shows that the contact resistance is about 2000 Ω.