Supplementary Information

Enhanced Carrier Transport by Transition Metal Doping in WS_2 Field Effect Transistors

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FIGURES

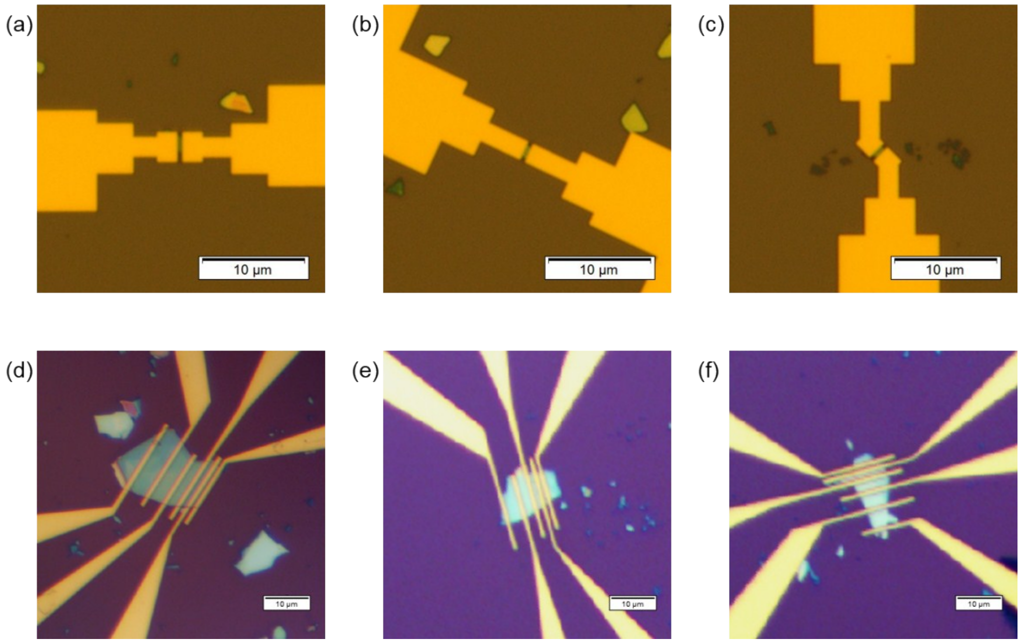

Fig. S1 Optical microscopy images of the representative devices in this work, including (a) pristine WS_2 FET, (b) Cu-doped WS_2 FET, (c) Cu-contact WS_2 FET, (d) pristine WS_2 TLM device, (e) Cu-doped WS_2 TLM device, and (f) Cu-contact WS_2 TLM device. Scale bar: 10 μm. It is noted that both the FET and TLM devices have the non-uniform channel geometry and thus the inconsistent contact conditions. We calculated the current density with the averaged the channel width for each measurement to minimize these deviations.

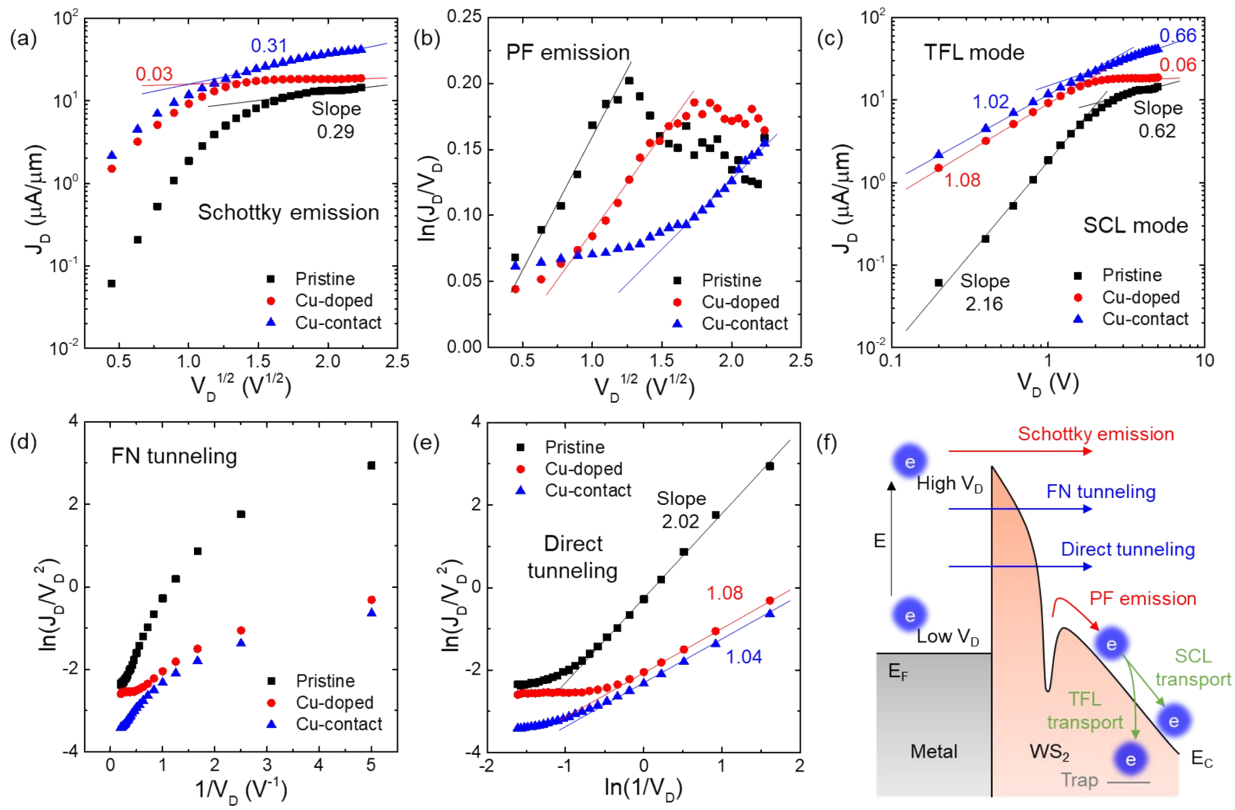

Fig. S2 *IV* characteristics of WS_2 FETs at on state (V_G = 30 V) based on the output curves. Various models, including (a) Schottky emission model, (b) PF emission model, (c) TFL/SCL model, (d) FN tunneling model, and (e) direct tunneling model were used for comparative investigation. (f) Energy band diagram at the metal-semiconductor interface illustrates the mechanisms of the carrier injection and transport.

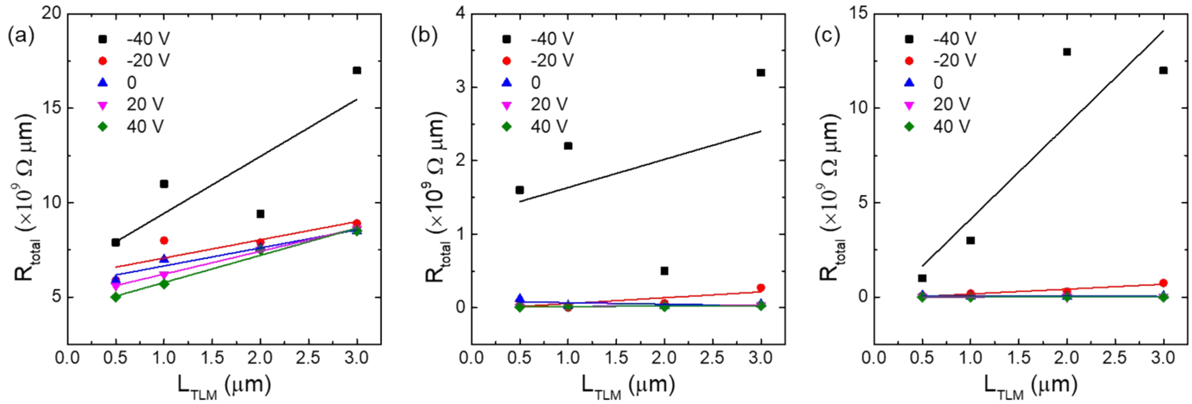

Fig. S3 Room-temperature TLM measurement at V_D = 1 V for (a) pristine WS_2, (b) Cu-doped WS_2, and (c) Cu-contact WS_2. Here R_{total} is the total resistance and L_{TLM} is the spacing distance ranging from 0.5 to 3 μm.

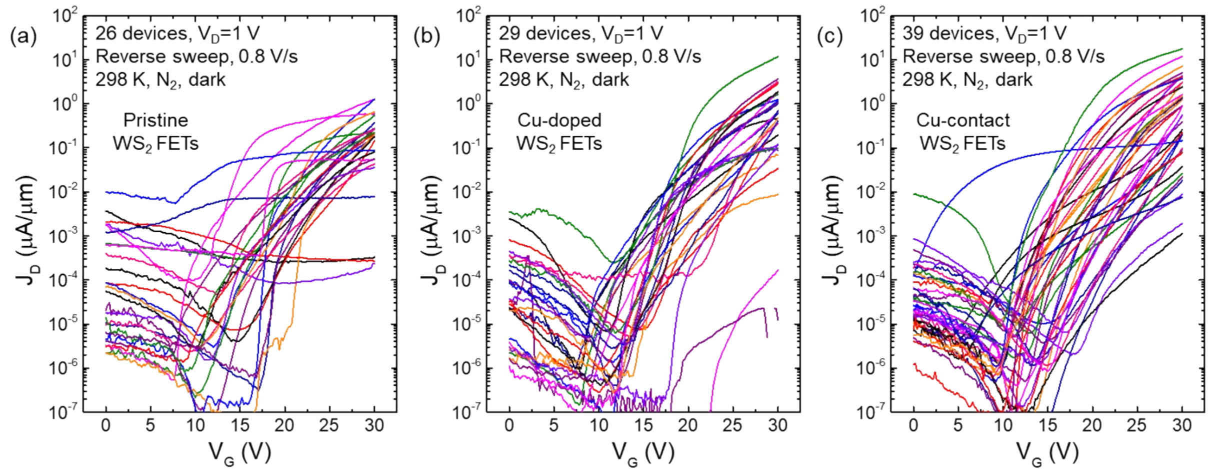

Fig. S4 The transfer characteristics for (a) 26 pristine WS_2 FETs, (b) 29 Cu-doped WS_2 FETs, and (c) 39 Cu-contact WS_2 FETs.

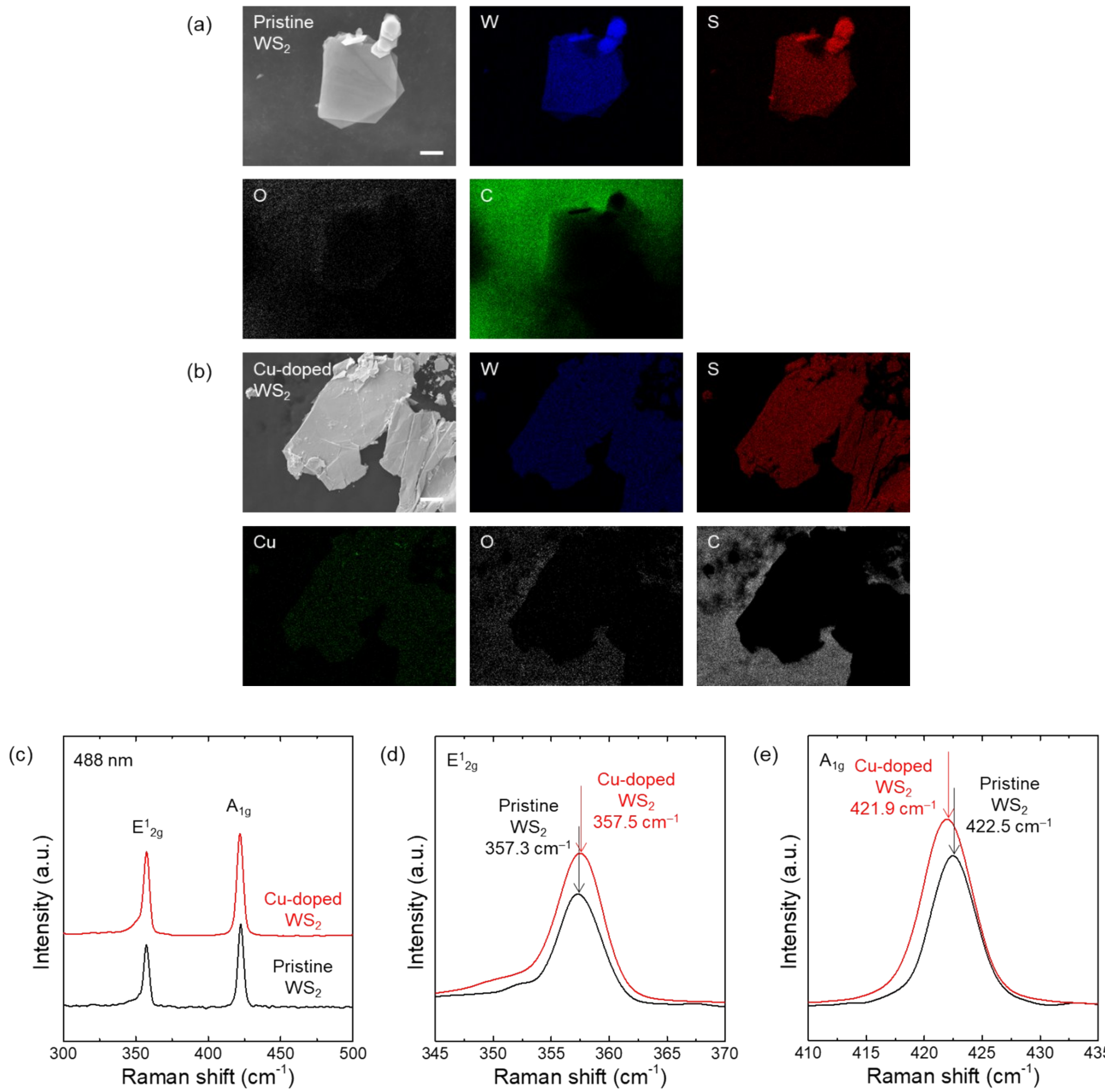

Fig. S5 (a, b) SEM and EDX elemental mapping of a synthesized pristine WS_2 flake and a Cu-doped WS_2 flake transferred on the carbon tape surface. Scale bar: 2 μm. (c-e) Raman spectroscopy of the pristine and Cu-doped WS_2.

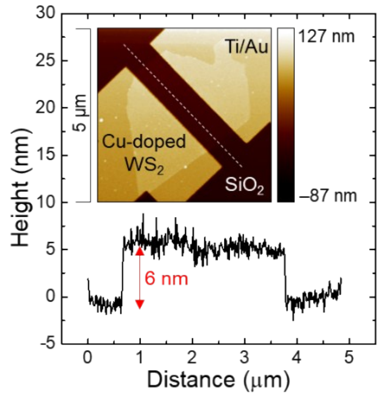

Fig. S6 AFM mapping image of a back-gate FET using the exfoliated Cu-doped WS_2 flake as the channel (inset) and the cross-section profile of the channel.