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Slow charge carrier dynamics in atomically thin devices

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Charge carrier dynamics in atomically thin semiconductors is a critical concern in the formation of electronic and optoelectronic devices. In particular, understanding the dynamics involved in trapping and emission of charges from gap states, and the process of recombination across heterostructures is of utmost importance for the informed design of efficient devices. In semiconducting Transition metal dichalcogenides, large hysteresis observed during gate sweeps is analysed through current transient measurements of MoTe2 field-effect transistors, during the emission stage of the pulse. Careful analysis of the transient behaviour demonstrates that the mechanism of threshold voltage transients governs the current response to charge trapping and can be attributed to changes in resistivity of the entire channel. We find that the dynamic behaviour of the trapped charges is significantly different than that experienced in conventional devices, a fact which carries dramatic implication on the performance of 2D devices. To further understand the effect of trapped charges on device performance, we study the formation of Schottky barriers between different metals and MoTe2. We find a strong dependence of the Schottky barrier height on the back gate, and an increase in barrier height with decrease in metal work function that gives strong indication to the pinning of the Fermi level at the contact, which approaches the Bardeen limit.B

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