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High-Field Transport and Velocity Saturation in Synthetic Monolayer MoS_2 KIRBY SMITHE, SAURABH SURYAVANSHI, CHRIS ENGLISH, ERIC POP, Stanford University — Understanding drift velocity saturation of charge carriers at high lateral fields is essential for practical applications of two-dimensional materials. Here, we measure drift velocity saturation in monolayer MoS_2 grown by chemical vapor deposition as a function of temperature for the first time. We select few-μm long devices such that contact resistance is negligible, and bias the device in strong accumulation to maintain uniform lateral electric field. The drift velocity is extracted from the measured current and the calculated charge density. Though data were taken from 80 to 300 K ambient, devices self-heat by up to 150 K at high bias. Thus, we capture the temperature dependence of drift velocity by fitting the data with a model including the population of dominant phonons. The raw data reveal that the drift velocity saturates at lateral fields >4 V/μm, up to 1.2x10^6 cm/s (2x10^6 cm/s) at 300 K (80 K) ambient. However, our model suggests that the true saturation velocity would be 50% to 60% higher if self-heating were eliminated, i.e. 2x10^6 cm/s (3x10^6 cm/s) at 300 K (80 K). These results shed light into high-field transport of monolayer 2D materials, revealing the strong role of electron-phonon scattering and of self-heating in terms of limiting current flow.

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