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Electric-field control of magnetism in a few-layered van der Waals ferromagnetic semeconductor

Manipulating a quantum state via electrostatic gating has been of great importance for many model systems in nanoelectronics. Until now, however, controlling the electron spins or, more specifically, the magnetism of a system by electric field tuning has proven challenging[1–4]. Recently, atomically thin magnetic semiconductors have attracted significant attention due to their emerging new physical phenomena[5–13]. However, many issues are yet to be resolved to convincingly demonstrate gate-controllable magnetism in these two-dimensional materials. Here, we show that, via electrostatic gating, a strong field effect can be observed in devices based on few-layered ferromagnetic semiconducting $Cr_2Ge_2Te_6$. At different gate doping, micro-area Kerr measurements in the studied devices demonstrate bipolar tunable magnetization loops below the Curie temperature, which is tentatively attributed to the moment rebalance in the spin-polarized band structure. Our findings of electric-field-controlled magnetism in van der Waals magnets show possibilities for potential applications in new-generation magnetic memory storage, sensors and spintronics.

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Figures

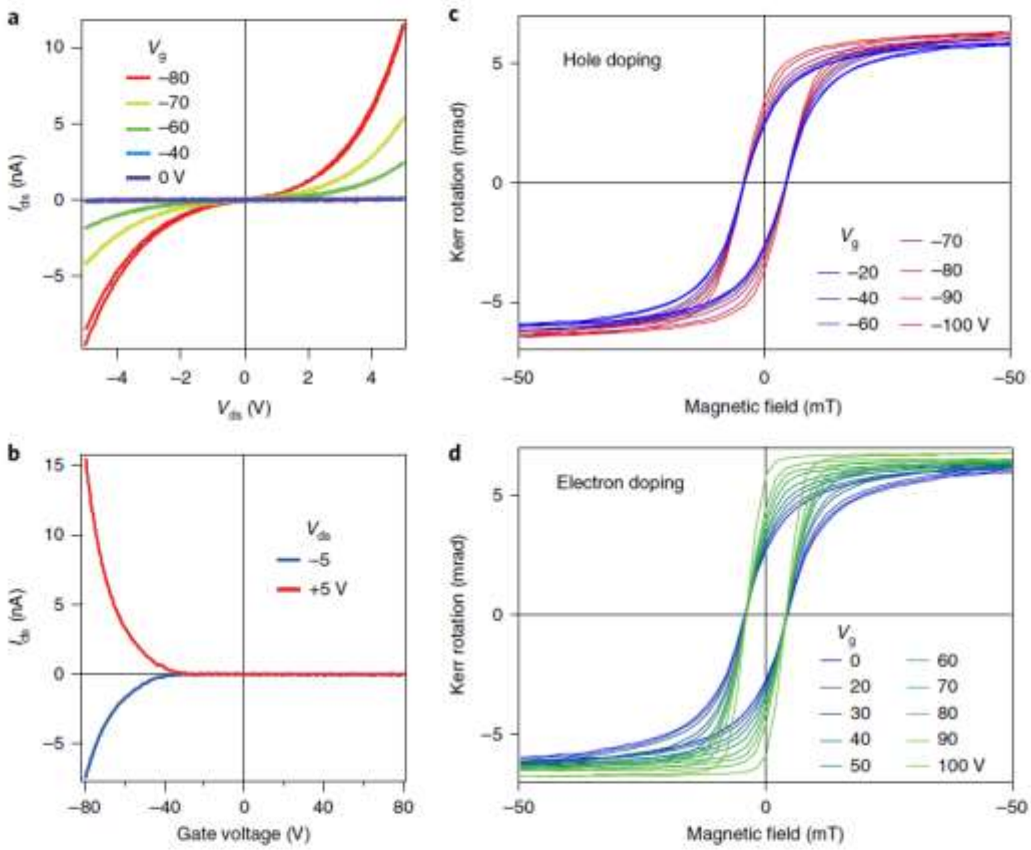

Figure 1: Kerr measurement of BN-encapsulated 3.5 nm $Cr_2Ge_2Te_6$ sample with solid Si gate. a, I–V characteristics of the same device with five different fixed Si gate voltages measured at 40 K. b, Field-effect curves at 40 K with V_{ds} = - 5 and + 5 V (blue and red, respectively).c,d, Kerr angle measured at 40 K for negative (c) and positive (d) gate voltages respectively.