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High mobility ambipolar MoS_2 field-effect transistors

WENZHONG BAO, XINGHAN CAI, DO HUN KIM, MICHAEL FUHRER, University of Maryland, CENTER FOR NANOPHYSICS AND ADVANCED MATERIALS, UNIVERSITY OF MARYLAND TEAM — Unlike graphene, single and multilayer MoS2 have a 1-1.8eV band gap, which makes MoS2 an promising candidate for future semiconducting industry. However many groups have observed poor charge carrier mobility for thin MoS_2 crystals deposited on silicon dioxide substrates. Here we report on MoS_2 field effect transistors on SiO_2 and on polymethyl methacrylate (PMMA) dielectric. We measure the conductivity in a four-probe configuration as a funcation of carrier density controlled by the back gate electrode. For multilayer MoS_2 on SiO_2, the mobility is on order 10-60 cm^2/Vs, and independent of thickness (5-80 nm), and most devices exhibit unipolar n-type behavior. In contrast, multilayer MoS_2 on PMMA shows mobility increasing with thickness, up to $500 cm^2/Vs$ (electrons) and 400 cm^2/Vs (holes) at thickness $\sim$50 nm. We observe activated temperature dependence of the resistance consistent with optical phonon scattering-limited resistance in the highest mobility devices. The dependence of the mobility on thickness for thicknesses up to 70 nm is unexpected, and points to a long-range dielectric effect of the bulk MoS_2 in increasing mobility.

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