Electrostatic doping of graphene on an ultrathin $h$-BN dielectric

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Conductivity measurements on gated graphene devices exhibit a square root dependence of the Fermi level on the back gate voltage. The minimum conductivity is not measured at zero back gate voltage but is found at an offset $V_D$ that results from charge transfer between the graphene sheet and the dielectric|metal substrate. The same behavior has recently been shown by measurement of the work function of gated graphene. The doping level depends on the work function of the metal substrate, the susceptibility of the dielectric buffer layer, the device dimensions and the back gate voltage. We present a simple analytical model that describes the square root dependence of the doping level in a gated graphene device that takes these four quantities into account. The change of the graphene work function with respect to the gate voltage is directly related to the doping level. The modeled doping level is compared with DFT-LDA calculations for metal|h-BN|graphene heterostructures in a static electric field and found to agree very well.
