Electrolyte-Gated Flexible Graphene Schottky Barrier Transistors

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We demonstrate a new device architecture for flexible vertical Schottky barrier(SB) transistors and logic gates based on graphene–organic semiconductor–metalheterostructures and ion gel gate dielectrics. The vertical SB transistorstructure was formed by (i) vertically sandwiching a benchmark p-type pentacene or n-type N,N´-dioctyl-3,4,9,10-perylenedicarboximide (PTCDI-C_8)organic semiconductor layer between graphene (source) and metal (drain)electrodes and (ii) employing a separate coplanar gate electrode bridged withthe vertical channel through an ion gel. The channel current was modulated bytuning the Schottky barrier height across the graphene–organic semiconductorjunction under an applied external gate bias. The high specific capacitance ofthe ion gel gate dielectrics enabled the work function of the graphene to bereadily modulated using a voltage below 1 V. Consequently, the devices showedwell-behaved p- and n-type characteristics under low-voltageoperation (< 1 V), yielding high current densities (> 100 $mAcm^{-2}$) and on–off currentratios (> 10^3). The simple structure of the unit transistorenabled successful fabrication of low-power logic gates based on assemblies ofdevices such as the complementary inverter, NAND, and NOR circuits on a plasticsubstrate. The simple, scalable, and room-temperature deposition of bothorganic semiconductors and gate dielectrics integrated with transparent andflexible graphene opens up new opportunities for realizing future transparent,flexible, and low-power organic electronics.