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Velocity Saturation in Semiconducting Carbon Nanotubes YUNG-FU CHEN, M. S. FUHRER, Department of Physics and Center for Superconductivity Research, University of Maryland, College Park, MD 20742-4111, USA — Charge transport in individual semiconducting single-walled nanotubes (SWNTs) with Schottky barrier contacts has been studied at high bias voltages. We observe nearly symmetric ambipolar transport, and find that both electron and hole currents may significantly exceed 25 μA, thought to be the limiting current in metallic SWNTs due to optical phonon emission. The current for a ballistic ambipolar nanotube field-effect transistor has been calculated carefully, treating the potential and the charge of the nanotube self-consistently, and including electron-hole recombination. The result is directly compared with the experimental transport data, and it is found that the current may be as high as one-fifth that expected for a ballistic nanotube field-effect transistor, even for nanotubes with lengths of tens of microns. The high-bias behavior in semiconducting nanotubes is better explained by velocity saturation, rather than current saturation. We propose a charge-controlled current model of transistor operation, with maximum saturation velocity v_s of 1.8 $\times$ 10^7 cm/s, which explains the magnitude of both the differential conductance under symmetric bias and the transconductance.

Department of Physics and Center for Superconductivity Research, University of Maryland, College Park, MD

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