MAR05-2004-000769

Abstract for an Invited Paper
for the MAR05 Meeting of
the American Physical Society

Carbon nanotube electronics and opto-electronics

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Carbon nanotubes (CNTs) have ideal properties for applications in nano/opto-electronics. Strong emphasis has been placed on the fabrication of CNT field-effect transistors (CNTFETs) with very promising results. CNTFETs, however, still have weak points. Specifically, charge-transfer at the CNT-metal interfaces leads to the formation of Schottky barriers. Also, upon scaling of the gate insulator, unipolar CNTFETs turn ambipolar (a-CNTFETs) with large OFF currents. I will discuss how we eliminated these problems by chemical (charge-transfer doping), or electrostatic doping of the contact regions. The resulting CNTFETs have excellent characteristics. a-CNTFETs are particularly valuable in photonics. When electrons and holes are injected from the opposite terminals of a a-CNTFET, a fraction of them recombine radiatively, producing a single CNT light source. Unlike conventional p-n diodes, a-CNTFETs are not doped and there is no fixed p-n interface. By spatially resolving the emission we show that the light can be translated along the CNTFET by varying the gate voltage. Study of the properties of the emission as a function of applied bias provides new insights on the electrical transport in CNTs. Stationary light spots are also observed. Finally, single CNT photoconductivity spectra and theoretical modeling are used to understand the nature of the excited states of the CNTs. In collaboration with: J. Appenzeller, J. Chen, M. Freitag, C. Klinke, Y.-M. Lin, V. Perebeinos, J. Tersoff, J. Tsang.