CARBON NANOTUBE ELECTRONICS AND OPTOELECTRONICS

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Carbon nanotubes (CNTs) have properties that strongly recommend them for applications in both nano- and opto-electronics. [1] Although a variety of different electronic devices based on CNTs have been demonstrated, most of the emphasis has been placed on CNT field-effect transistors (CNTFETs). These devices have in many respects characteristics superior to conventional devices. However, they also pose a set of new challenges. These include understanding the new 1D transport physics, the increased electrical noise [2], the Schottky barriers at CNT-metal contacts [3], their ambipolar character [4], the new scaling laws [5], and finding technical solutions [6] to these problems. Both single nanotube devices and multi-component single nanotube circuits [7] will be discussed. Our initial efforts to self-assemble CNTFET devices will also be discussed [8].

We are also evaluating CNTFETs as electro-optical devices. We have used ambipolar (a-) CNTFETs to simultaneously inject electrons and holes from the opposite terminal of the FET. A fraction of these recombines radiatively to produce an electrically-excited, single nanotube molecule light source [9]. Unlike conventional p-n diodes, a-CNTFETs are not doped and there is no fixed p-n interface. Thus, the emitting region can be translated at will along a CNT channel by varying the FET gate voltage [10]. We have found that much stronger localized electroluminescence can be generated at defects or inhomogeneities that introduce potential drops [11]. The emission is the result of intra-molecular impact excitation of electron-hole pairs by the hot carriers. Localized electroluminescence provides a high brightness IR source and a novel probe of defects, charging, and inhomogeneities which are otherwise difficult to observe. The reverse process of recombination, i.e. the photogeneration of carriers in a single nanotube CNTFET channel [12], will also be discussed.

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