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Electrons, holes, and electron-hole junctions in carbon nanotubes

PAUL MCEUEN, LASSP, Cornell University

Carbon nanotubes possess an unusual band structure consisting of symmetric electron and hole subbands separated by a gap determined by the nanotube's chirality, diameter and any external perturbations. Here, we study the properties of both electrons and holes in these one-dimensional subbands. Capacitance measurements are used to directly probe the van Have singularities in the density of states and the energies of the electron and hole subbbands[1]. Electrical[2] and photocurrent measurements are employed to investigate the properties of nanotube p-n junctions. These measurements directly yield the nanotube bandgap and show fascinating step-like behavior in the reverse-bias region. Finally, measurements of p-n-p nanotube quantum dots are presented where the bandgap is tuned to zero by an external magnetic field. These experiments illustrate just a few of the exciting opportunities available in electron-hole nanotube devices. [1] S. Ilani, L.A. Donev, M. Kinderman, and P.L. McEuen, Nature Physics 2, 687 (2006). [2] K. Bosnick, N. Gabor, and P. L. McEuen; Appl. Phys. Lett. 89, 163121 (2006)