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Electronic properties of individual defects in carbon nanotubes and semiconductor nanowires by Scanning Probe Microscopy

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Using Scanning Gate Microscopy (SGM), individual atomic defects in a nanotube can be visualized as a decrease in the current through the nanocircuit, since defects are depleted for tip voltages that are related to the local electronic structure of the defect. Here, the interaction between a carbon nanotube and a point charge is studied using both atomistic first principles modeling and continuum electrostatic methods. Results are compared and extrapolated to real tip geometries to simulate the interaction of the scanning tip with an adjacent nanotube. Comparison with experiment suggests that the gate voltage dependence of the image contrast is a direct measure of the difference in Fermi energies at these defects. A crucial factor in SGM is the tip radius and an approach for the unambiguous determination from SPM data is presented. This analysis is extended to SGM measurements on semiconductor and oxide nanowires and relative contributions of surface states and bulk dielectric screening to SGM response are determined.

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