Current-Induced Cleaning of Adsorbates from Suspended Single-Walled Carbon Nanotube Diodes

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Single-walled carbon nanotubes (SWNT) are prime candidates for future applications, including nanoelectronic and nanophotonic devices. Because of their large surface-to-volume ratio compared to that of a bulk seminconductor, however, carbon nanotubes are very sensitive to their environment. Others have already established that the electronic properties of SWNTs can be dramatically changed by exposure to air, particularly oxygen or water.

In this paper,[1] we show that the electronic and optical properties of *p-n* diodes fabricated with suspended semiconducting SWNTs degrade over time with exposure to ambient conditions, mainly due to adsorption onto the tube's suspended part, which creates band-gap states. We provide the first correlation between electronic states that arise from adsorbates, which we measure directly from photocurrent spectroscopy, and their impact on diode performance. Specifically, we show that the ideality factor, one of the fundamental parameters used to measure defect states in a *p-n* diode, increases with the degree of adsorbate coverage. We also demonstrate a simple technique—current annealing—that can thermally reverse such degradation. Current annealing, which can be carried out in air at room temperature, returns device electrical and optical properties to their original characteristics.

1. A. Malapanis, E. Comfort, and J. U. Lee, Applied Physics Letters, 98 (2011).