ULTRA-BROADBAND PHOTODETECTORS BASED ON MACROSCOPICALLY-ALIGNED ULTRA-LONG SINGLE-WALLED CARBON NANOTUBES

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Optoelectronic devices based on carbon nanomaterials provide new opportunities for basic and applied studies. Strong Coulomb interactions among 1-D carriers and excitons in single-walled carbon nanotubes (SWNTs) are expected to significantly enhance light absorption, carrier generation, and transport. Here, we demonstrate that a two-terminal device consisting of macroscopically-aligned, ultralong SWNTs acts as a photodetector in an extremely wide spectral range covering the visible, near-infrared, and mid-infrared. We used films of SWNTs grown via chemical vapor deposition and laid down on Si/SiO_2 substrates. Metallic electrodes were then deposited with distances of 50 µm between contacts. Scanning photocurrent and photovoltage measurements, together with in-situ imaging, were successfully made at wavelengths of 658 nm and 1350 nm with a focal-point diameter of ~1 µm; local photocurrent or photovoltage as high as 333 nA/mW and 1350 µV/mW have been achieved. A careful analysis of the observed position-dependent response suggests the presence of a built-in potential at the nanotube-electrode interface. Furthermore, we explored this effect to design detectors with asymmetric contacts using different metal electrodes such as Au, Pd, Ag, and Ti. This allowed us to observe significant photoresponse under global illumination, obtaining a photovoltage of 6.5 µV/mW under visible excitation, as well as go to the mid-infrared range. We detected photoresponse signal up to 3.2 µm wavelength using an optical parametric oscillator and are collecting data using quantum cascade lasers operating at 10 µm. Hence, these devices are very promising for potential solar cell as well as broadband photodetector applications.