Carbon based optoelectronic devices and sensing in the shortwave infrared

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Carbon nanotubes (CNTs) are direct band gap materials that are not only useful for nanoelectronic applications, but also have the potential to make significant impact on the developments of nanoscale optoelectronic devices. In particular CNTs have been investigated for various electronic and optoelectronic device applications, such as light-emitting diodes [1,2], photodetectors and photovoltaic (PV) cells [3,4]. Semiconducting single-wall CNTs (SWCNTs) can efficiently absorb and emit light. The unique band structure of SWCNT suggests that multiple subbands absorptions can contribute to optoelectric properties. By combining sufficient nanotubes with different diameters, it was also demonstrated that it is possible to gain a nearly continuous absorption response within a broad spectral range (from UV to infrared) to match the solar spectrum [5]. In addition, extremely efficient carrier multiplication (CM) effect has been observed [6], which may potentially lead to a higher energy conversion efficiency than that defined by the Shockley-Quiesser limit. More recently, efficient photovoltage multiplication was realized via introducing virtual contacts in CNTs, making the output photovoltage of CNT based solar cells a tunable quantity via choosing the diameter of the tube and the number of virtual contacts introduced in the device [7]. This technique has been utilized to build high performance infrared photodetectors [8-10] and sensors for shortwave infrared [11], and for developing optoelectronic communications between nanoelectronic circuits using carbon nanotube based optoelectronic devices [12].

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