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1-over-f noise characterization of random-network single-walled carbon nanotube photodetectors

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The electronic properties of random networks of single-walled carbon nanotubes (SWCNTs) are probed by 1/f noise characteristics in a frequency range of up to 109 kHz as a function of bias voltages and the number of nanotubes deposited between asymmetrical-work function metal electrodes. The measured current-voltage characteristics of the devices exhibit rectifying and ohmic behaviour revealing Fermi-level depinning and pinning of the metal and one-dimensional contacts, respectively. The noise amplitude (A) characterizing the 1/f noise levels and the power-law exponents (β) of the devices are investigated in both reverse- and forward-bias voltages for different nanotube depositions at ambient temperature. In a few nanotube depositions, A is found relatively small (10ˆ-5 to 10ˆ-7) and the extracted β is exceeded 2 in the reverse bias, suggesting that charge-carrier trapping by the formation of the Schottky barrier is exhibited at the metal-nanotube contacts. Furthermore, as the number of nanotubes increases the device-channel resistance drops rapidly as the densely-packed inter-tube junctions are formed between the two electrodes. The observed A is found 1.5 times higher than that obtained in the devices with fewer nanotube depositions. This result shows that the 1/f noise of the SWCNT devices is dominated by the device resistance due to the inter-tube junctions under a finite bias. Our experimental observation agrees well with that of the previous works using carbon nanotube films for implementing hybrid-silicon Schottky barrier photodetectors.

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