Random Network Carbon Nanotube Thin-Film Transistors: Properties and Pathways

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Random networks of single-wall carbon nanotubes placed between electrodes were investigated for use in thin-film transistors. The nanotube film is conductive based on inter-nanotube contacts, and the transport properties are dependent on the network density and the electronic properties of the contacts and the constituent nanotubes. Low-density films exhibit semiconducting p-type behavior with field-effect mobilities of ~ 10 cm^2/Vs and on/off transistor ratios of ~ 10^5. Increasing the film density transitions the behavior to narrow bandgap p-type material with the field-effect mobility exceeding 100 cm^2/Vs and a high off-state current. These results indicate that random networks of carbon nanotubes can serve as a new electronic material for the thin-film transistors without the requirement of precision assembly of the nanotubes. In order to understand and improve the network electronic properties the current pathways through the network have been studied using an atomic force microscope. Electric force microscopy and scanning probe-based gating microscopy allows us to map the current pathways and to identify the critical active gate regions. This information leads us to an understanding of how the network density, the nanotube transport properties and the inter-nanotube junctions combine to determine the transport properties of this material.

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