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Conducting Polymer Nanotubes and Nanowires: Synthesis, Characterization, and Applications to Microelectronics

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Conducting polymers have been applied to various electronics including transistor, photonics, battery cathodes, capacitor, charge transport layer, EMI shielding, anti-static materials, sensors, light emitting diode, etc. The principle of conducting mechanism of π-conjugated polymers is introduced, and the fabrications and applications of conducting (or semiconducting) polymer nanotubes (CPNTs) and nanowires (CPNWs) are presented.

Conducting (or semiconducting) polypyrrole (PPy), polythiophene (PT), poly (3-methylthiophene) (P3MT), polyaniline (PAN), and poly (3,4-ethylenedioxythiophene) (PEDOT) nanotubes and nanowires were synthesized by using Al₂O₃ nanoporous template through electrochemical polymerization method. The length and electrical properties of CPNTs and CPNWs could be controlled by using various dopants, solvents, polymerization times, applied currents, and doping levels. We obtained the CPNTs and CPNWs with the diameter of 50–200 nm. From SEM and TEM photographs and UV/Vis and FT-IR spectra, the formation of CPNTs and CPNWs was confirmed. From I–V characteristic curves with gate bias, we observed p-type transistor characteristics in the systems. Based upon temperature dependence of DC conductivity of the systems, the nano-size effect of conducting polymers is discussed. We fabricated the field emission cell of CPNT and CPNW as nanotips, and the field emission properties based on Fowler–Nordheim tunneling model are comparable with those of carbon nanotubes.[1] The results of single nanowire polymer transistor will be presented. For semiconducting polymer nanotubes and nanowires such as P3MT, we observed PL spectra. The hybrid double walled nanotubes of PPy (or PT) and inorganic magnetic Ni were synthesized, and their characteristics are also presented. We suggest that the CPNT and CPNW samples are promising nanomaterials for microelectronics.


Keywords: conducting polymer, nanotube, nanowire