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Conducting Polymer Nanotube and Nanowire: Synthesis, Characteristics, and Applications to Transistor and Field Emission Nano-tip

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As the rapid increase of the use of nanomaterials for biosensor, microelectronics, photonics, battery cathodes, nano-tip of field emission display (FED), capacitor, etc., many researches have been focused on synthesis and applications of nanoscale inorganic and organic materials. Conducting or semiconducting polypyrrole, poly (3,4-ethylenedioxythiophene), and polyaniline nanotubes and nanowires were synthesized by using nanoporous template through electrochemical polymerization method. By using various dopants, solvents, polymerization times, applied currents, and doping levels, we controlled the length and electrical properties of conducting polymer nanotube (CPNT) and nanowire (CPNW). From SEM and TEM photographs and UV/Vis absorbance spectra, the formation of CPNT and CPNW was confirmed. We observed that the formation of tube or wire and the length of the systems were determined by polymerization time, applied current and dopant used. DC conductivity and I-V characteristics of CPNT and CPNW samples were controlled by doping level, dopant, and de-doping solvent. From I-V characteristic curves with gate bias for CPNT samples, the conductance increases with increasing negative gate bias, while the conductance decreases as positive gate bias increases, implying p-type transistor characteristics. We fabricated the field emission cell of CPNT and CPNW as nano-tips, and the field emission properties based on Fowler-Nordheim tunneling model are comparable with those of carbon nanotubes. The field enhancement factor is estimated to be 1300. Based upon the results, we suggest that the CPNT and CPNW samples are promising nanomaterials for microelectronics.