

ELECTRICAL PROPERTIES OF
ELECTROCHEMICALLY POLYMERIZED
POLYPYRROLE AND POLY (3M 4-
ETHYLENEDIOXYTHIOPHENE) NANOTUBES AND
NANOWIRES

B. H. Kim, D. H. Park, and J. Joo*
Department of Physics, Korea University,
Seoul 136-701, Korea

Nanotubes and nanowires of π -conjugated polypyrrole (PPy) and poly (3, 4-ethylenedioxythiophene) (PEDOT) were synthesized by using nanoporous template through electrochemical polymerization method. Dodecylbenzenesulfonic acid (DBSA) or tetrabutylammonium hexafluorophosphate (TBAPF₆) were used as dopant in electrolyte. Either a HF or NaOH solution was used to remove the Al₂O₃ template after polymerization. From the TEM and SEM photographs, we observed the formation of tube with diameter of 50 nm to 200 nm, length of ~ 50 μ m, and wall thickness of ~ 20 nm as shown in Fig. 1. The formation of tube or wire and the length including diameter of the nano-systems were determined by the conditions of polymerization, such as applied current, doping level, and polymerization time.

The dc conductivity (σ_{dc}) using four-probe method of one strand of PPy-TBAPF₆ nanotube treated HF dissolving solvent was $\sim 2 \times 10^{-1}$ S/cm, while that treated with NaOH dissolving solvent was $\sim 4 \times 10^{-3}$ S/cm at room temperature (RT). The $\sigma_{dc}(RT)$ of PEDOT-DBSA nanotubes treated with HF solvent was ~ 10 S/cm, while that treated with NaOH solvent was $\sim 2 \times 10^{-4}$ S/cm. The electrical properties varied with the use of different dissolving solvents to remove the template. The σ_{dc} and I - V characteristic curves as a function of temperature were measured on photolithography pattern from RT to ~10 K. we observed the different slopes of temperature dependence of σ_{dc} ($\sigma_{dc}(T)$) as shown in Fig. 2, in which $\sigma_{dc}(T)$ of the samples with diameter of 100 nm showed the strong T-dependence. The intrinsic magnetic and structural properties of conducting polymer nanomaterials with various sizes were also compared bulk materials synthesized in the same chemical conditions.

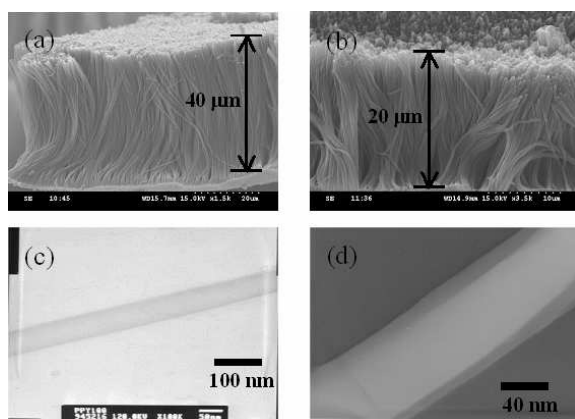


Fig. 1. SEM and TEM image of PPy-TBAPF₆ (a) nanowires (length: ~40 μ m, diameter: ~100 nm) and (b) nanotube, respectively. SEM and TEM image of PEDOT-DBSA (c) nanowires (length: ~20 μ m, diameter: ~50 nm) and (d) nanotube, respectively.

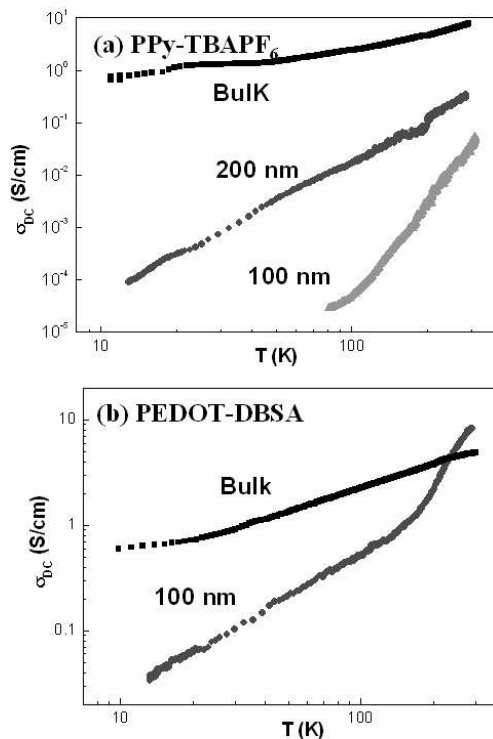


Fig. 2. Temperature dependence of σ_{dc} measured by 4-probe method of (a) PPy-TBAPF₆ nanowire and (b) PEDOT-DBSA nanowire

* Corresponding author: E-mail: jjoo@korea.ac.kr,
Tel;+82-2-3290-3103, Fax;+82-2-927-3292