Investigations on carbon nanotubes supported metal catalysts

Kwang Pill Lee[a,b], Anantha Iyengar Gopalan[a,b,c], Sang Ho Kim[a,b] and Se Hee Lee[a]

[a]*Dept. of Chemistry Graduate School, Kyungpook National Univ., Daegu 702-701, Korea*

[b]*Nano Practical Application Center, Daegu, 704-230, Korea*

[c]*Dept. of Industrial Chemistry, Alagappa Univ., Karaikudi-630003, Tamil Nadu, India*

1. Introduction

Detailed investigations of the physical and chemical properties of conducting polymer/carbon nanotubes (CP/CNTs) composites are of interest nowadays, because these materials have a great potential in technological applications such as: plastic transistors and logic gates [1], organic light emitting diodes [2], optoelectronic devices [3] or antistatic coatings [4], etc. Up to now, a special attention was devoted to composites based on polyaniline (PANI) and single-walled (SWNTs) or multi-walled (MWNTs) carbon nanotubes [3,5-8]. Applications of such composites in devices require the use of one dimensional (1D) nanostructures and thus synthesis of nanoscale composite materials (nanotube, nanorods, nanowires, nanofibres) has attracted considerable attention. 1D nanocomposites have been synthesized both chemically and electrochemically through polymerizationof the monomer from hard templates such as the channels of microporous membranes , zeolites [by employing soft templates such as surfactants..

More recently a different method has been reported for the synthesis of nanofibres by using gamma rays in a templateless fashion. . Here we demonstrate that metal nanoparticles also can be incorporated into the conducting polymer nanostructure present over the surface of the CNTs. Polyaniline/CNT nanocables were produced in a templateless' fashion in a one step stage with a simultaneous incorporation of metallic naoparticles. Gamma irradiation induced polymerization of aniline dispersed in CNT in the presence of metalilc solution was performed to achieve such a hydrid nanostructure. The hybrid nanostructure having the presence of CNT/conducting polymer nanocable and metal nanoparticles is expected to have the synergic performances and applications in nanoelectronic devises.

Experimental

Properly functionalized SWNT or MWNT were dispersed in aqueous medium containing a surfactant, monomer (aniline) and metal salt (gold, palladium, platinum). The solution

was then purged with nitrogen gas to remove the dissolved oxygen and irradiated by gamma-ray of Co-60 source. A blue green dispersion was obtained. The dispersion was analyzed by various measurements including HVTEM from the Korea Basic Science Institute, Daejon.

2. Results and Discussion

HVTEM images (Fig. 1) give direct evidence for the formation of PANI-SWNT nanocables and assembly of Au nanoparticles on PANI-SWNT nanocables. The outer diameter of the nanocables could be tuned to several nanometers by altering the experimental conditions. Gold nanoparticles with uniform size of about 7 nm were found to be dispersed on the surface of the PANI-SWNT nanocables. Due to the hydrophillbic environment created on the surface of the PANI, gold nanoparticles were found to be strongly bound on the surface. In the absence of the sheath of PANI over SWNT, the hydrophobic surface of SWNT can not accommodate gold nanoparticles.

We have obtained further evidences for the formationof SWNT/PANI nanocables from UV-Visible spectroscopy. Sharp peaks at 320 and 450 nm (Fig. 2), which correspond to the pi-pi* transition and polaronic transition of the amine units in PANI respectively, supports the formation of PANI on the surface of SWNT. Also, evidence for the incorporation of Au nanoparticles was obtained from UV-Vis absorption spectroscopy. A peak centered around 530 nm characterizes the presence of gold nanoparticels.incorporation of Au nanoparticles.

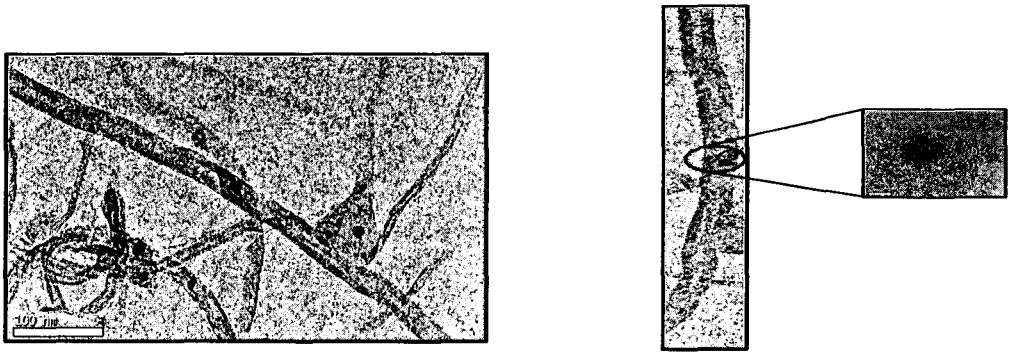

Fig. 1. HVTEM images showing the morphology of SWNT/polyaniline nanocables and decoration of gold nanoparticles on SWNT/polyaniline nanocables.

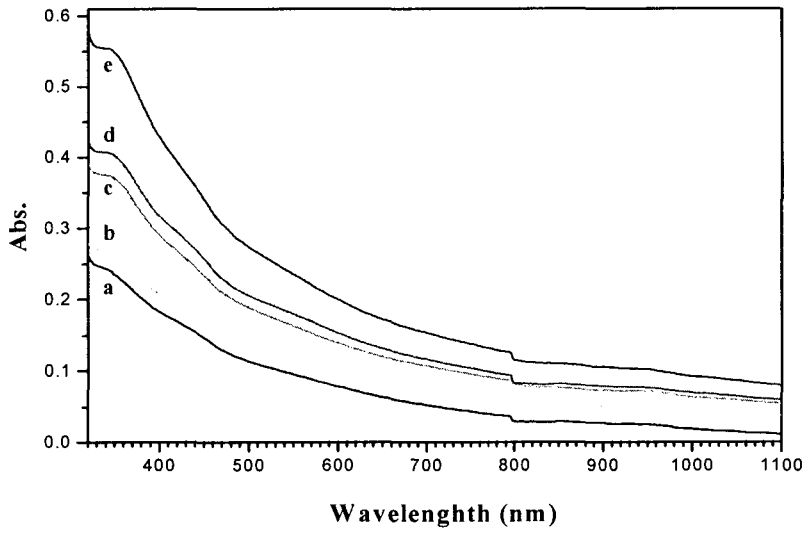

Fig. 2. UV-Visible spectraobtained from the aqueous dispersions of SWNT/PANI nanocables with gold nanoparticles prepared by gamma ray induced polymerization. Spectra represent the aqueous dispersions obtained at different conditions.
(a) 36 mL of SWNT/CTAB/aniline solution + 4 mL of Au solution(2KGy),
(b) 25 mL of SWNT/CTAB/aniline solution + 2 mL of Au solution + 2 mL H_2O(10KGy),
(c) 36mL of SWNT/CTAB/aniline solution + 2 mL of Au solution + 2 mL H_2O(10KGy),
(d) 36mL of SWNT/CTAB/aniline solution + 4 mL of Au solution(10 KGy) (e) 36 mL of SWNT/CTAB/aniline solution + 1 mL of Au solution + 3 mL H_2O(10 KGy)

In summary, gold nanoparticles were decorated on the surface of SWNT/PANI nanocables by simple and clean radiation induced process. HVTEM provides direct evidence for the morphology of anchoring gold nanoparticles over SWNT/PANI nanocables. This hybrid nanocables are expected to have potential applications in the direction of sensors and catalystsand in electronic devise.

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