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Growing carbon nanotubes on carbon nanofibers

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Abstract

Carbon nanotubes were grown on the carbon nanofibers by a gas phase thermal decomposition method using Ni particles as a catalyst and SDS as a surfactant.

Keywords: carbon nanotubes; carbon nanofibers; network; Catalyst;

Introduction

Carbon nanotubes (CNTs) and carbon nanofibers(CNFs) have received increasing attention in the scientific community due to their unique chemical reactivity, electrical conductivity, optical activity, and mechanical strength [1,2]. In particular, as materials for the electrodes of electrochemical devices, CNTs and CNFs have caught many researchers' attention because of their excellent characteristics of chemical stability, low mass density, low resistivity, and large surface area. It is believed that the construction of a tight network of CNTs and CNFs may be advantageous to improve the electrical conductivity of the electrode materials [3]. Our goal is to make a tight and regular network consisting of CNTs and CNFs by a simple chemistry method. Here we report the preliminary progress, which depicted that CNTs were grown on the CNFs.

Experimental

CNTs were synthesized by decomposing a hydrocarbon gas on catalytic Ni, Co particles deposited on the CNFs(VGCF-H). Prior to Ni, Co deposition to grow CNTs, the CNFs were first pre-treated in concentrated HNO_3 at 110℃ for 1h with continuously stirring. The CNFs were then centrifuged, rinsed with distilled water, filtered and dried at 50℃ in a drying oven. Subsequently, the dried powder was immersed into 3mL of 0.01 $mol \cdot L^{-1}$ $Ni(NO_3)_2 \cdot 6H_2O$ solution containing of 0.01$mol \cdot L^{-1}$ sodium dodecyl sulfate (SDS) for 2h, then filtered and dried at 50℃ in a drying oven. These Ni^{2+} ions are reduced on the CNFs by heating the Ni^{2+}-seeded CNFs at 300℃ in atmosphere for 10 min. The growth of CNTs was then carried out at 700℃ for 30 min

in 45%N_2, 45%H_2 and 10%C_2H_2 in a tubular furnace.

The above-mentioned procedure was followed except that dodecylbenzenesulfonic acid (DBA) was used instead of SDS as a surfactant. Furthermore, $Co(NO_3)_2 \cdot 6H_2O$ was also used instead of $Ni(NO_3)_2 \cdot 6H_2O$ as a precursor of the catalyst.

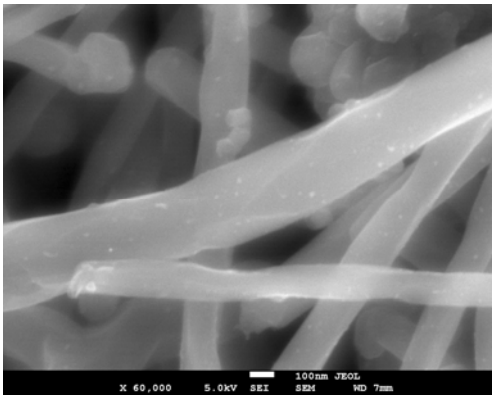

Fig. 1 SEM micrograph of Ni nanoparticles on CNFs..

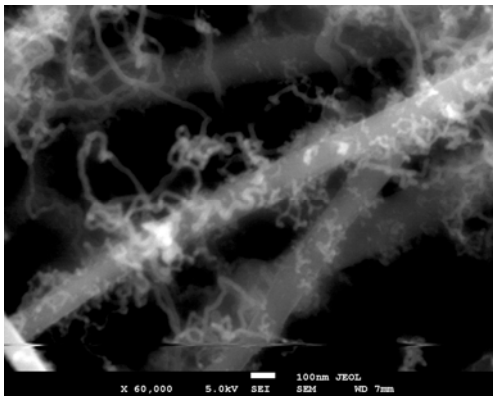

Fig. 2 SEM micrograph of CNTs grown on the CNFs.

Results and Discussion

The best result was obtained by using Ni particles as a catalyst and SDS as a surfactant. From Fig.1, the diameters of the nanofibers range from 100nm to several hundred nanometer. Ni particles with a size of about 20 nm were thinly scattered on the surfaces of CNFs. Few Ni particles maybe result from the light concentration of the Ni^{2+} in the precursor solution and the smooth surfaces of CNFs. After decomposition reaction (Fig. 2), each nanofiber was irregularly twined by a lot of curved CNTs with a diameter of about 20nm and different lengths. These may be contributed to the irregular sizes and inhomogeneous distribution on the CNFs of the Ni particles, and the synthesis conditions such as the annealing temperature and the concentration of H_2.

Conclusion

CNTs were grown on the CNFs by a gas phase thermal decomposition method using Ni particles as a catalyst and SDS as a surfactant. Many efforts still need to make to grow uniform and straight CNTs on CNFs for a preparation of constructing a network.

References

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