Preparation of Composite Nanofibers Array via a Plasma Sputtering Process

C.-T. Hsieh,[z] J.-M. Chen, and R.-R. Kuo

Materials Research Laboratories, Industrial Technology Research Institute, Hsinchu 310, Taiwan, R.O.C.

[z] Corresponding author,
TEL: 886-3-5915510
FAX: 886-3-5820039
E-MAIL: chientehsieh@itri.org.tw

Abstract

Since the discovery of carbon nanotubes (CNTs) synthesized by an arc-discharge,[1] such quasi-one-dimensional materials are believed to be the promising candidates for the use of chemical gas sensors,[2] field-emission displays[3,4] and nanoelectronics. Recently, template synthesis for preparing ceramic or oxide nanofibers, such as SnO_2, ZnO and SiO_2, was gradually applied in some particular applications. In usual, a porous membrane made from anodic alumina oxide (AAO) or polymer is employed as template. The membrane has a large quantity of nano-channels, and is suitable for synthesizing well-defined CNFs. Our pioneer study[5] has developed a simple technique to fabricate CNFs at low cost. The CNFs are grown by pyrolysis of epoxy solution in AAO membrane. By using our method, it is easy to control the mean length and diameter of the "hollow" nanofibers with a high porosity.

To enhance some unique characteristics, several semiconductor nanoparticles such as SnO_2, CdSe, SiO_2, and ZnS have been bound to the surfaces of CNTs. Here we report for the first time that metal nanoparticles of Ni could be bond to ours CNFs through a simple plasma sputtering route. Our approach can be illustrated in Fig. 1. Firstly, a well-aligned CNFs array, which has an average diameter of 100 nm for each single CNF, was employed as a template. Secondly, nickel nanoparticles are deposited on the tip of opened CNFs via a plasma sputtering. Finally, nano-Ni is heated, then flowed into tubular-type CNFs in a home-made furnace at inert atmosphere. The heat treatment is performed at 1073 K for 2 hr.

Figs. 2(a) and 2(b) showed the top-view and the dip angle of 45° view for the composite nanofibers array, respectively. It can be observed that all Ni nanorods with as a length of 1 μm are embedded into the CNFs, and the diameter of the nanorods is estimated about 100 nm. This demonstrates that our simply synthesis successfully fabricate the metal/CNFs membrane. Fig. 3 illustrates XRD pattern for the composite nanofiber array, indicating that all peaks correspond to C, Ni, and Si substrate. It believes that other tanstion metals/CNFs composite nanofibers array can be synthesized via the procedure for applicable fields in future.

1 S. Iijima, Nature (London) **354**, 56 (1991).
2 J. Kong, N. R. Franklin, C. Zhou, M. G. Chapline, S. Peng, K. Cho, and H. Dai, Science **287**, 622 (2000).
3 Y. Chen, S. Patel, Y. Ye, D. T. Shaw, and L. Guo, Appl. Phys. Lett. **73**, 2119 (1998).
4 A. Wadhawan, R. E. Stallcup II, and J. M. Perez, Appl. Phys. Lett. **78**, 108 (2001).
5 C.-T. Hsieh, J.-M. Chen, R.-R. Kou, Y.-H. Huang, Appl. Phys. Lett. **84**, 1186-1188 (2004).

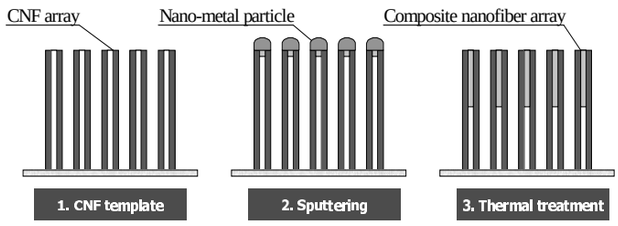

Fig. 1 Flowchart of the preparation of the composite nanofibers array.

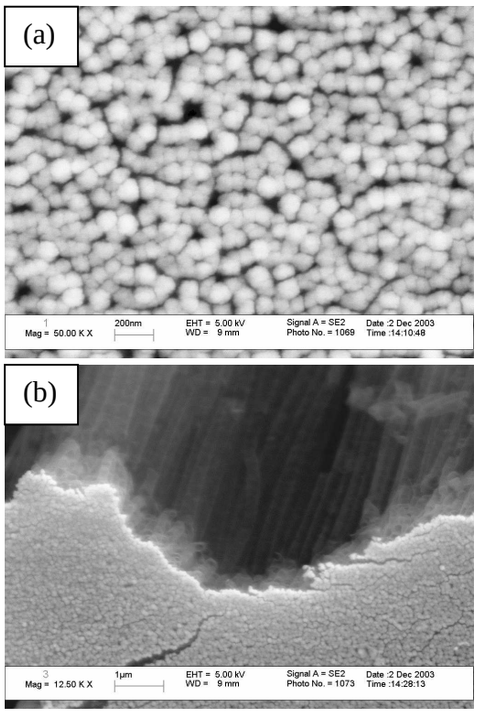

Fig. 2 SEM images of the Ni/CNFs nanofibers array.

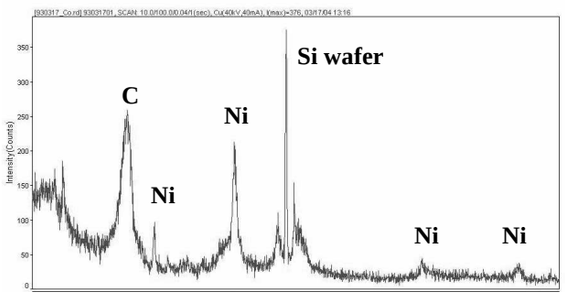

Fig. 3 XRD pattern of the Ni/CNFs nanofibers array.