

Application of Carbon Nanotubes as Template for Self-assembled Nanowires

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The aim of this research is to investigate the method of white X-ray irradiation(WXI) for forming nano particles or wires mostly inside multi-walled carbon nanotubes(MWCNTs). WXI approach which uses the energy of light to react with MWCNTs in aqueous solution has not yet been found. This study is mainly focusing on white X-ray irradiation technique which illustrates MWCNTs can be used as template for self-assembled nanowires. WXI synthesis technique is compared with the traditional method of heat treatments for various structures of nano hybrid materials. The research indicates that the traditional heat treatment results in nano particles being on the surfaces of MWCNTs; while the WXI keeps them inside MWCNTs. Accordingly, a model of light-heat transformation for MWCNTs is proposed to explain the mechanism of reaction inside MWCNTs. It is also found that the approach of WXI can fill nanoparticles inside MWCNTs in a comparatively shorter time.

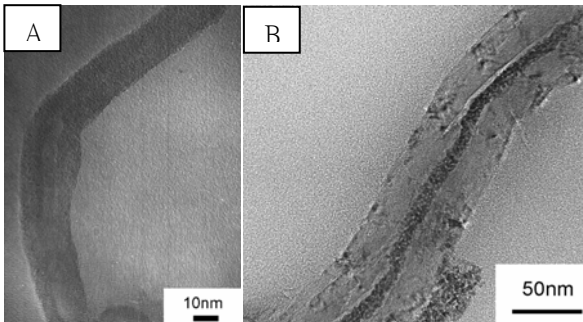


Fig. 1(A) is the high resolution transmission electron microscopy (HRTEM) image of purified MWCNT. The image shows that the surface of purified MWCNT is clear, and it is a hollow tube after treatment by nitric acid solution and oxidation. The inner and outer diameters are about 10 nm and 40 nm, respectively. **Fig. 1(B)** is the HRTEM images of SnO₂/MWCNTs-I, it is found that nanoparticles, with sizes of about 5 nm, filled mostly in the tunnel of MWCNT.



Fig. 2: According to the HRTEM image, the lattice spacing of these nano particles is 0.32 nm, which is corresponding to the lattice spacing of SnO₂ in (110)

plane.

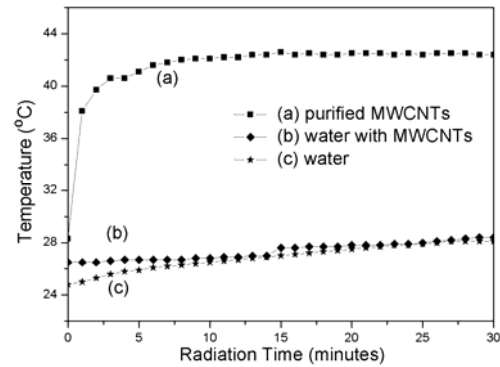


Fig. 3

In order to explain the mechanism that nano SnO₂ particles form in different positions of MWCNTs, the temperature of purified MWCNTs, water with MWCNTs, and water in various WXI time is measured. The results of this experiment, shown in Figure 3, illustrate that both the temperatures of water and water with MWCNTs arise slightly even after irradiation for 30 minutes.

However, the temperature of purified MWCNTs arises substantially under irradiation for 1 min, which means the MWCNTs have the property to absorb the white X-ray and transform it into the heat and therefore increase the temperature of MWCNTs greatly.

- [1]S. Iijima, Nature (London) **354**, 56–58 (1991).
- [2]M. Meyyappan, Carbon Nanotubes: Science and Applications edited, ISBN: 0849321115.
- [3]P. M. Ajayan and Sumio Iijima. Nature **361**, 333–334 (1993).
- [4]C. Guerret-Plécourt, Y. Le Bouar, A. Lolseau, and H. Pascard, Nature **372**, 761–765 (1994).
- [5]P. M. Ajayan, Prog. CrystalGrowth and Charact. **34**, 37–51 (1997).
- [6]Mingqui Lru and John M. Cowley, Carbon **33**, 225–232 (1995).
- [7]D. Ugarte, T. Stöckli, J. M. Bonard, A. Châtelain, and W. A. de Heer, Appl. Phys. A **67**, 101–105 (1998).
- [8]Sheng Wei Wu, Jin Xue Guo, Yu Lan Li, Xuan Huang, and Wen Xin Li, Nanotechnology **14**, 1203–1207 (2003).
- [9]X. P. Gao, Y. Zhang, X. Chen, and G. L. Pan, J. Yan. Carbon **42**, 47–52 (2004).
- [10]Hansoo Kim and Wolfgang Sigmund, Journal of Crystal Growth **276**, 594–605 (2005).