UPGRADING MULTI WALL CARBON NANOTUBES BY SUPERCRITICAL WATER OXIDATION

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Abstract :

Functionalization of multi wall carbon nanotube(MWCNT) by the partial oxidation in supercritical water has been studied. MWCNT particles have non-polar surface characteristic and agglomerate together very easily. Although MWCNT particles have very powerful mechanical, thermal and electrical properties, these advantages can not be realized unless they are dispersed and mixed with substrates homogeneously. To enhance the miscibility with polar media, non-polar surfaces of MWCNT have to be changed.
However, since CNT particles agglomerate together, it is very difficult to modify surfaces of CNT particles uniformly. The properties of water vary dramatically at the critical point(T= 374°C, P=22.1MPa). Supercritical water(SCW) behaves as an organic solvent. Furthermore, SCW is miscible with gaseous oxygen and can penetrate to small micro-pores very well. These miscible and penetrating characteristics of SCW can support uniform partial oxidation of MWCNT particles. It was demonstrated in the previous study[1] that the side walls of MWCNT could be functionalized by SCW with diluted HNO_3 solution. In SCW, opening and thinning of MWCNT particles were observed both in the presence and absence of oxygen[2].
In this study, MWCNT has been partially oxidized by hydrogen peroxide solution and nitric acid in SCW to endow the polarity to the side wall. To determine the effects of temperature, reaction time, type and amount of oxidants on the partial oxidation of MWCNT, the screening test of statistical design of experiments has been applied. These experiments were conducted by using an autoclave batch reactor of 300mL volume.
The side walls of MWCNT were destroyed and became amorphous structure as shown in Fig. 1. However, the nanotube structure remained inside like a sheath although the surface of MWCNT was partially destroyed. These phenomena have been analyzed by Raman and FT-IR spectra. From the Raman spectrum, the disordered spike could be found at the high frequency side of graphite lattice. Functional groups of ether and hydroxyl in modified MWCNT were identified by the analysis of FT-IR as shown in Fig.2. The enhancement of miscibility of modified MWCNT with polar solvents was confirmed also.

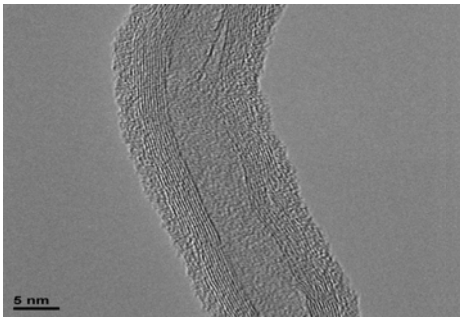

Fig.1. TEM image of modified MWCNT.

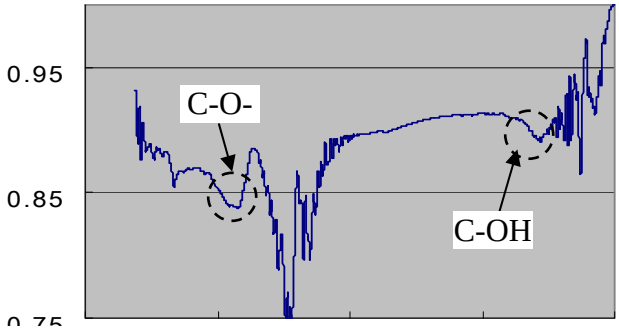

Fig.2. FT-IR spectrum of modified MWCNT.

References

[1] K.C. Park, T. Hayashi, H. Tomiyasu, M. Endo, M.S. Dresselhaus, *J .Mater. Chem.* **2005**, 15, 407 - 411
[2] J.-Y. Chang, A. Ghule, J.-J. Chang, S.-H. Tzing, Y.-C. Ling, *Chem. Phy. Lett.* **2002**, 363, 583 - 590