SYNTHESIS OF MULTI-WALLED CARBON NANOTUBE/POLYANILINE COMPOSITES BY IN-SITU ANILINE POLYMERIZATION

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Introduction

Since the discovery in 1991[1], carbon nanotubes have attracted more and more interest for their distinguished properties and promising future applications. Carbon nanotubes are of great interest for many reasons. For example, they can be used as supports for metal catalysts. As tubular structures, they have unusual capillary properties. Mechanically, carbon nanotubes are significantly stiffer than currently commercially available carbon fibers, and can therefore be used to strengthen composite materials or atomic force microscope tips. Theoretical calculations of their electronic structure indicate that single-walled carbon nanotubes are either metallic conductors, or semiconductors, depending on the diameter and helicity of the individual tubes. Because of their mesoscopic structure, carbon nanotubes may exhibit quantum effects arising from their small diameter (≤10nm). The preparation and properties of carbon nanotubes have been studied efficiently [1-5]. Polyaniline (PANI) is unique among conducting polymers, primarily due to its high chemical durability and reversible control of conductivity both by protonation and by charge-transfer doping. The dispersion of carbon nanotubes into PANI matrix for the fabrication CNT/PANI composites has stimulated significant interest among researchers [6-8]. In this paper we prepared multi-walled carbon nanotube/Polyaniline composites by in-situ aniline polymerization.

Experimental

The multi-walled carbon nanotubes (MWNT) were prepared by catalytic decompose of benzene using floating transition method at 1100~1200℃. Benzene was used as carbon source and iron as catalyst with sulfur.

The MWNT was dipped in aniline/HCl solution for 10 h at 0 ^{o}C, which led to the adsorption aniline on the surface of MWNT. A solution of ammonium peroxydisulfate dissolved in 1 M hydrochloric acid was added dropwise. The polymerization process was carried out at 0 ^{o}C for 5 h.

Results and Discussion

Figure 1 shows the TEM image of multi-walled carbon nanotubes. The TEM image reveals that the carbon nanotubes are straight with diameter 30~80 nm, internal diameter 10~50 nm and length 50~100 μ m. Figure 2 shows the SEM and TEM images of MWNT/PANI composites. It can be seen that carbon nanotubes are packed underneath the polyaniline layer. Figure 3 shows the FT-IR spectra of MWNT/PANI composites. The absorption at 3060, 1564.13, 879.98, 1110.41, 1481.58 cm^{-1} are characteristic of the various vibration modes of the C-H and C-C bonds of the aromatic nuclei. The absorption at 3460 cm^{-1} corresponds to the stretching of the N-H bonds. The band 1297.62 cm^{-1} is assigned to the stretching of the C-N bonds of the aromatic amines.

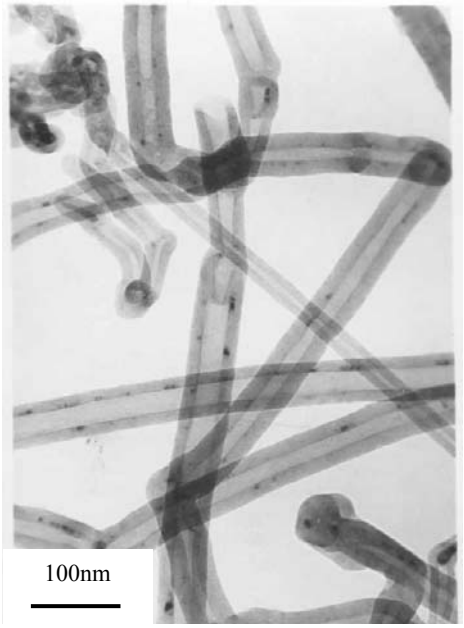

Figure 1. TEM image of MWNT

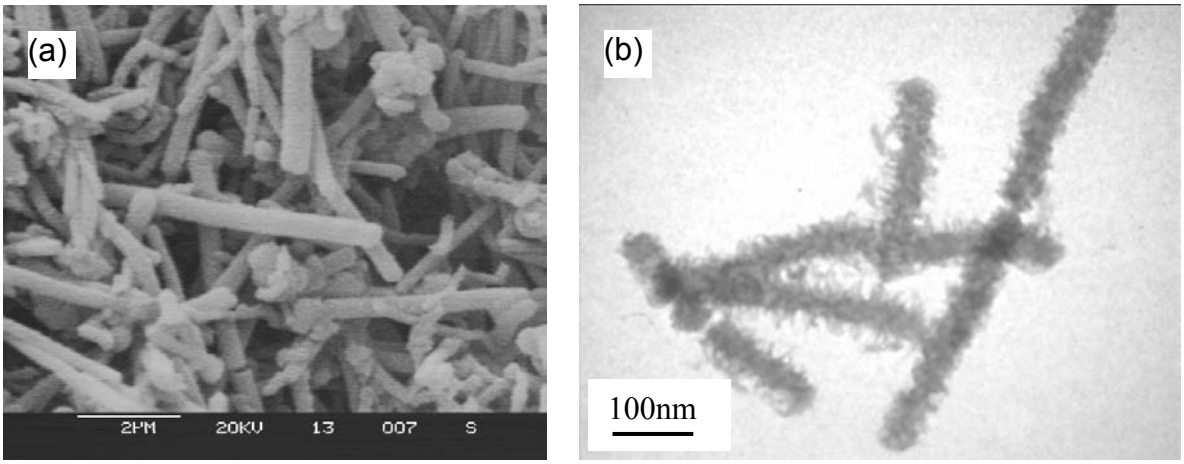

Figure 2. SEM (a) and TEM (b) images of MWNT/PANI composites

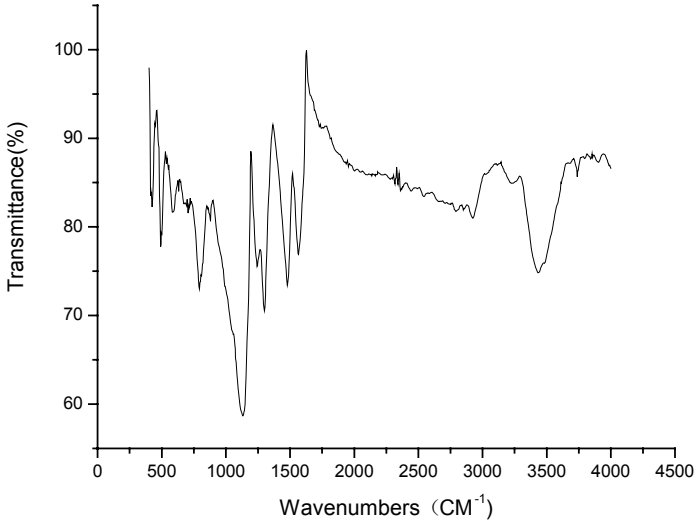

Figure 3. FT-IR spectra of MWNT/PANI composites

Figure 4 exhibits the structural order of the MWNT and MWNT/PANI composites. Comparing X-ray diffraction patterns of the MWNT with that of MWNT/PANI composites, it becomes clear that, from a structural point of view, additional order has been introduced. The spectra for MWNT/PANI composites clearly reveal two new diffraction peaks. TGA is a useful method for testing the thermal stability of composites. Figure 5 shows a comparison of mass losses of MWNT and MWNT/PANI composites. MWNTs are very stable and no significant decomposition takes place in the range of 30-500 ^{o}C. MWNT/PANI composites displays a sudden decrease in mass of 10% at a temperature of 250 ^{o}C, which is corresponds to the breakaway of dopant. After that, a steady decrease in mass occurs in the range of 250-680 ^{o}C.

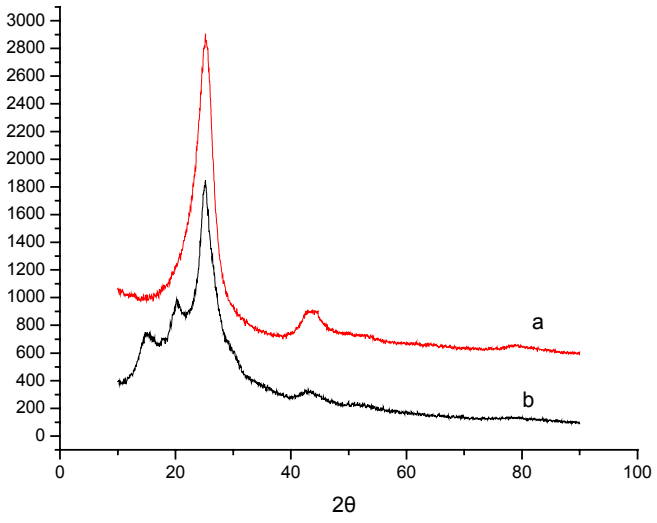

Figure 4. XRD patterns of MWNT (a) and MWNT/PANI (b) composites

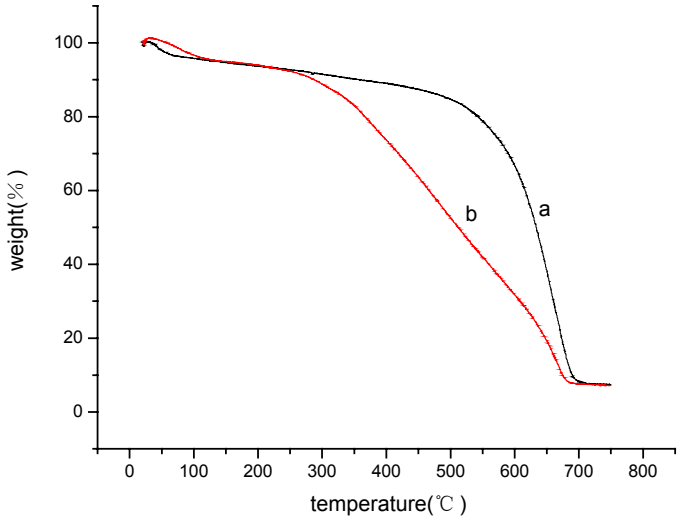

Figure 5. Thermogravimetric analysis for MWNT (a) and MWNT/PANI (b) composites

Conclusions

The multi-walled carbon nanotubes were prepared by catalytic decompose of benzene using floating transition method at 1100~1200℃. Benzene was used as carbon source and iron as catalyst with sulfur. The multi-walled carbon nanotube/Polyaniline composites have been prepared by in-situ aniline polymerization. The physical properties of PANI, such as morphology, thermal stability, crystallinity, have been improved. MWNT/PANI nano composites may be useful in electronics and other fields. The microwave complex permittivity and permeability of the nano MWNT/PANI composites are being investigated.

References

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