Preparation of MWNTs/Poly Aryl Ether Ketones Nanocomposites by In Situ Polymerization

Nantao Hu(胡南滔), Ying Du(杜影), Hongwei Zhou, Guodong Dang(党国栋), Chunhai Chen*

Alan G. MacDiarmid Institute, Jilin University, Changchun 130012, P. R. China; E-mail: cch@jlu.edu.cn

Abstract. Multi-walled carbon nanotubes (MWNTs) modified poly aryl ether ketone (PAEK) nanocomposites were synthesized by in situ polymerization of monomers of interest in the presence of pre-treated MWNTs. This process enabled uniform dispersion of MWNT bundles in the polymer matrix. The resultant MWNTs-PAEK nanocomposite films were optically transparent and preliminary studies had been made. These MWNT-polymer nanocomposites are potentially useful in a variety of aerospace and terrestrial applications, due to their combination of excellent properties of MWNTs with PAEK.

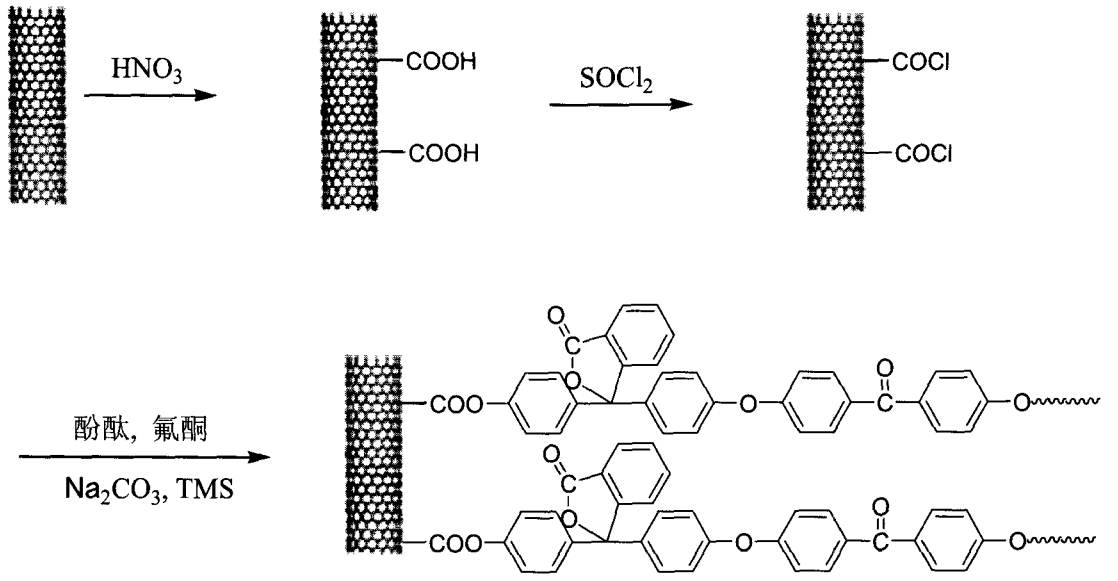
Keywords: Multi-walled carbon nanotubes; colorless PAEK; nanocomposites; in situ polymerization; poly aryl ether ketone

Introduction

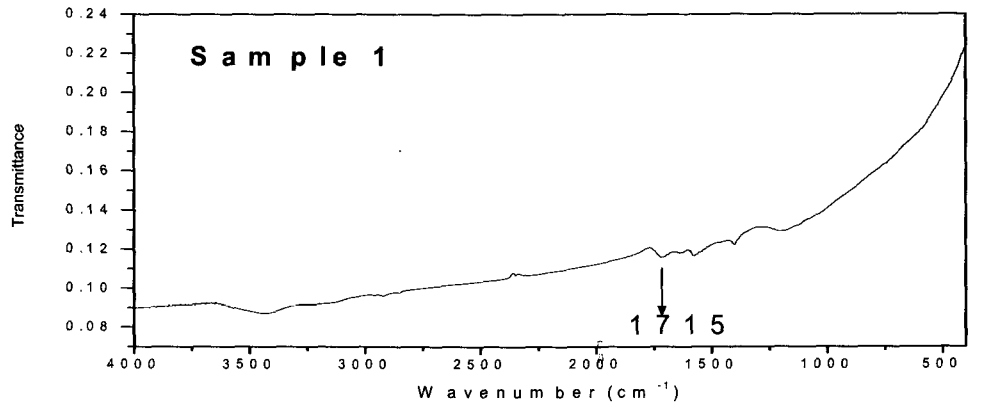
Carbon nanotubes (CNTs) have generated tremendous interest because of their unique combination of electronic, mechanical, chemical, and thermal properties. Many potential applications have been proposed in various fields, including electrochemical devices, field-emission devices, nanoscale electronic devices and sensors, among others. CNTs, however, have rarely been used as electrical or mechanical inclusions in a high performance polymer matrix because of the difficulty in achieving an efficient dispersion. This difficulty is primarily due to the non-reactive surface of CNT. Intrinsic surface area and high aspect ratio, often lead to significant agglomeration, thus preventing efficient transfer of their superior properties to the matrix. Although a number of studies have focused on the dispersion of CNTs, complete dispersion of CNTs in a high performance polymer has rarely been achieved. Especially dispersing CNTs into the PAEK, which exihibits outstanding mechanical properties and high temperature capabilities, has rarely been reported as far as we know.

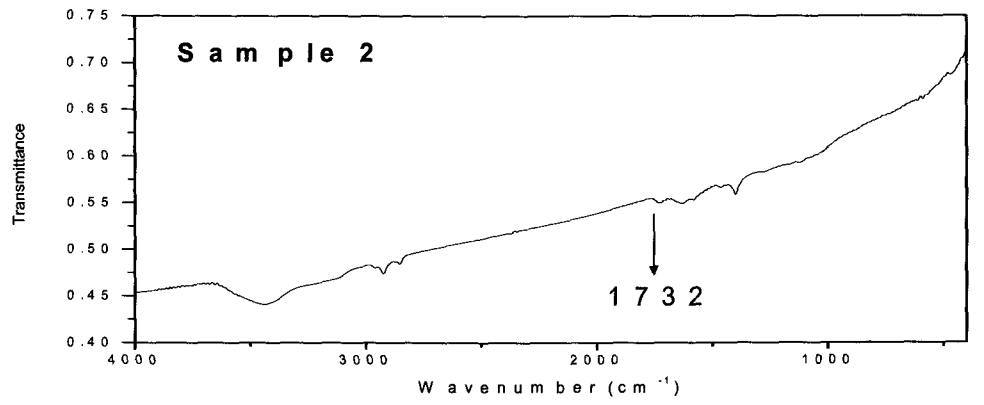
Therefore, in the present work, a process to efficiently disperse MWNT bundles in an aromatic polymer is reported. This process involves in situ polymerization of the monomers of interest in the presence of acylated MWNTs during the polymerization process. The acyl groups associated with the MWNTs attended the reaction through forming amide bonds. In our study, aromatic PAEK were used as a continuous medium to prepare MWNT modified PAEK nanocomposites. The goal of our work was to develop a method to completely disperse MWNT bundles into PAEK matrix on nanoscale level to produce efficiently MWNTs modified and optically transparent nanocomposite films.

Experimental Section



Results and Discussion:





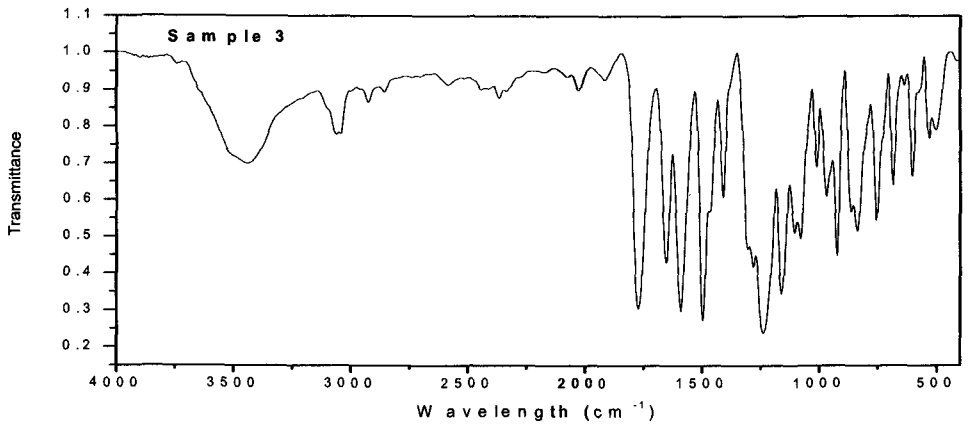


Figure 1. FTIR spectra of MWNTs after various treatments. Upper panel: Sample 1, purified MWNTs. Middle panel: Sample 2, acylated MWNTs. Lower panel: Sample 3, MWNTs-PAEK.

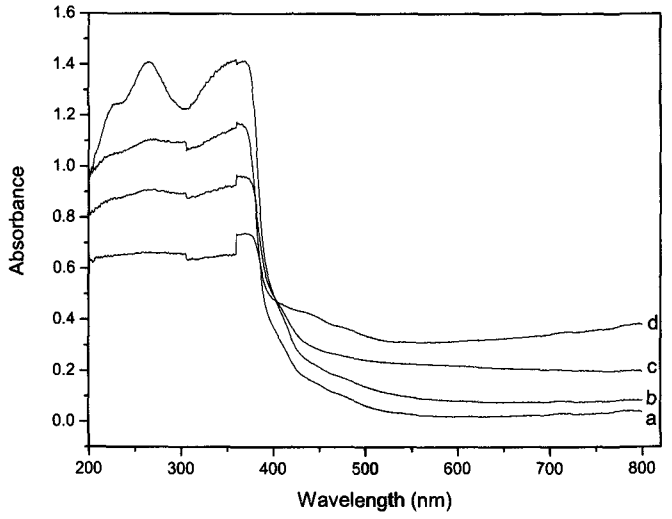


Figure 2. UV/Vis spectra of pure PAEK
(a), 0.1% MWNTs/PAEK (b), 0.2% MWNTs/PAEK (c), and 0.5% MWNTs/PAEK (d).

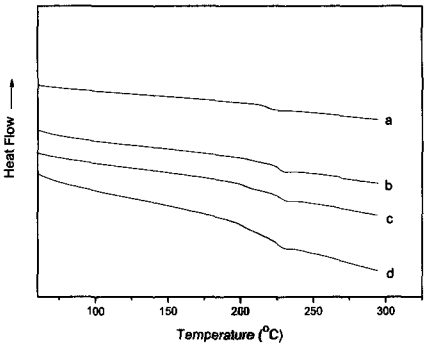


Figure 3. DSC curves of pure PAEK
(a), 0.1% MWNTs/PAEK (b), 0.2% MWNTs/PAEK (c), and 0.5% MWNTs/PAEK (d)

Table 1. The tensile properties of the MWNTs/PAEK nanocomposite films

CNT. wt%.	Modulus. GPa	Strength. MPa	Elong @break. %
0	1.9	16	4
0.1	2.0	19	4
0.2	2.1	18	6
0.5	2.1	22	9

. The results were obtained from the average of the data of the five samples. And the standard deviation of the obtained results was below 5%.

Conclusion

Multi-walled carbon nanotubes (MWNTs) reinforced PAEK nanocomposites were synthesized by in situ polymerization of monomers of interest in the presence of acylated MWNTs. The acyl groups associated with the MWNTs attended the reaction through forming ester bonds. This process enabled uniform dispersion of MWNT bundles in the polymer matrix. The resultant MWNTs/PAEK nanocomposite films were optically transparent with significant mechanical enhancement at a very low loading (0.5 wt %).The carbon nanotubes in the matrix are efficiently dispersed, which indicates that the nanotubes are efficiently dispersed by in situ polymerization, and the load can be transferred to the nanotubes during the loading process. The ongoing work will be focused on the electrical studies of these MWNTs/PAEK nanocomposite films.

References

[1]. C. Park, Z. Ounaies, K. A. Watson, R. E. Crooks, J. S. Jr, S. E. Lowther, J. W. Connell, E. J. Siochi, J. S. Harrison, T. L. S. Clair. Chem. Phys. Lett., 2002, 364, 303.

[2]. K. E. Wise, C. Park, E. J. Siochi, J. S. Harrison. Chem. Phys. Lett, 2004, 391, 207.

[3]. J. G. S. Jr, J. W. Connell, D. M. Delozier, P. T. Lillehei, K. A. Watson, Y. Lin, B. Zhou, Y.-P. Sun. Polymer, 2004, 45, 825.

[4]. L. Qu, Y. Lin, D. E. Hill, B. Zhou, W. Wang, X. F. Sun, A. Kitaygorodskiy, M. Suarez, J. W. Connell, L. F. Allard, and Y.- P. Sun. Macromolecules, 2004, 37, 6055

[5]. NT Hu, Zhou HW, Dang GD, Rao XH, Chen CH, Zhang WJ. Polymer International, 2007, 56, 655.