



# Synthesis and characterization of polyimide-coated carbon nanotubes

Fei a., D. a., G. \*, J. a., L. L. a., Q. a., H. F. a., K. H. a.

**ARTICLE INFO**

*Article history:*  
 Received 26 October 2012  
 Accepted 9 December 2013  
 Available online 20 January 2013

*Keywords:*  
 Synthesis  
 Surface  
 Functionalization  
 Polyimide

**ABSTRACT**

Highly dispersed carbon nanotubes (CNTs) were synthesized via a chemical method using a polyimide (PI) coating. The PI-coated CNTs were characterized by UV–vis, FTIR, SEM, and TGA. The PI-coated CNTs showed a higher thermal stability than the pure CNTs. The PI-coated CNTs were used as a conductive filler in a polyimide matrix. The PI-coated CNTs showed a higher thermal stability than the pure CNTs. © 2013 Elsevier B.V. All rights reserved.

## 1. Introduction

Carbon nanotubes (CNTs) have attracted much attention because of their unique structure and excellent properties [1,2]. They have been widely used in various fields, such as electronics, composites, and catalysis [3,4]. However, the poor dispersibility of CNTs in a matrix is a major obstacle for their practical applications [5,6]. Recently, surface functionalization of CNTs has been proposed to improve their dispersibility [7–10]. A variety of functional groups, such as hydroxyl, carboxyl, and amino groups, have been used for the functionalization of CNTs [11]. However, the functionalization process often leads to the damage of the CNT structure [12,13].

Highly dispersed CNTs were synthesized via a chemical method using a polyimide (PI) coating. The PI-coated CNTs were characterized by UV–vis, FTIR, SEM, and TGA. The PI-coated CNTs showed a higher thermal stability than the pure CNTs. The PI-coated CNTs were used as a conductive filler in a polyimide matrix. The PI-coated CNTs showed a higher thermal stability than the pure CNTs.

## 2. Materials and methods

For the synthesis of PI-coated CNTs, a solution of 1:1 molar ratio of 4,4'-oxydianiline (ODA) and pyromellitic dianhydride (PMDA) was prepared. The solution was then mixed with a CNT solution. The mixture was then heated at 160 °C for 6 h. The PI-coated CNTs were then washed with distilled water and dried at 30 °C for 24 h. The PI-coated CNTs were then characterized by UV–vis, FTIR, SEM, and TGA. The PI-coated CNTs showed a higher thermal stability than the pure CNTs. The PI-coated CNTs were used as a conductive filler in a polyimide matrix. The PI-coated CNTs showed a higher thermal stability than the pure CNTs.

\* Corresponding author. Tel.: +86 373 3325058; fax: +86 373 3328507.  
 E-mail addresses: gongfeng@nwnu.edu.cn (F. Gong), gongfeng1819@163.com (F. Gong).

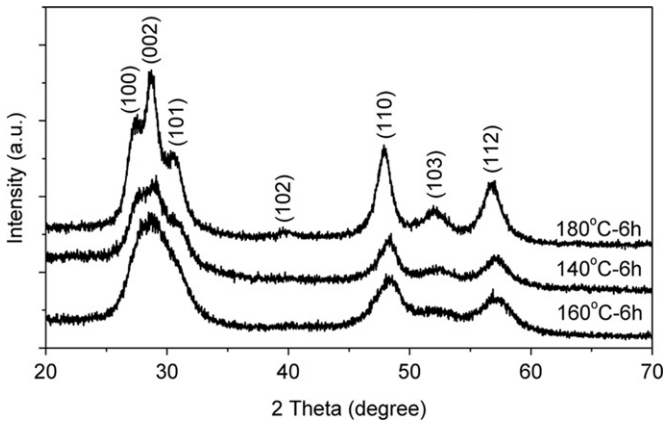


Fig. 1. XRD patterns of S-140, S-160, and S-180.

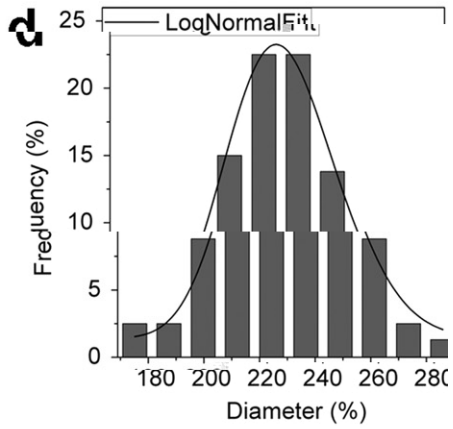
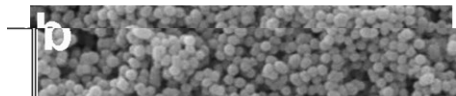
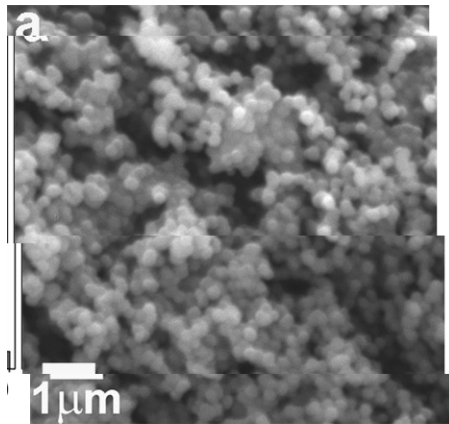
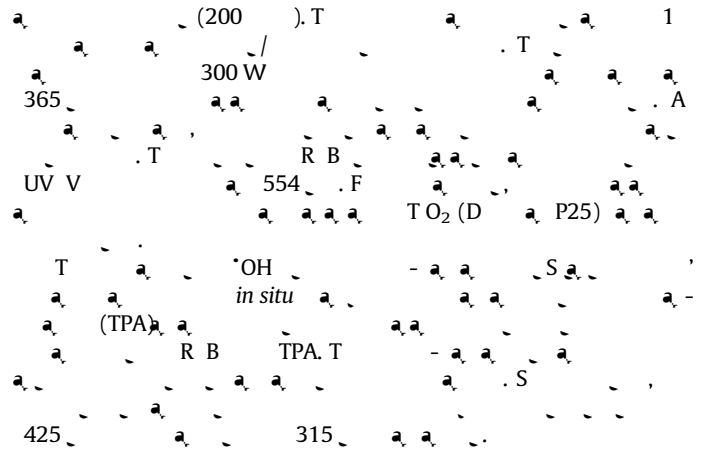


Fig. 2. (a) SEM image of S-140, (b) SEM image of S-160, (c) SEM image of S-180. (d) Histogram of particle diameter distribution for S-140, (e) Histogram of particle diameter distribution for S-160.

3. Results and discussion

RD (F. 1), 27.18, 28.64, 30.50, 39.62, 47.75, 52.02, 56.53 (100), (002), (101), (102), (110), (103), (112) (JCPDF 36-1450).

SEM (F. 2), S-140, S-160, S-180, 230.3, 169.7, 233.5, T, S-160, S-140, S-180.

BET, SSA, S-140, S-160, S-180, 108.0, 2/ , T, SSA, S-160, S-140, S-180, 131.2, 222.4.

12, 24, 160 °C, F, (F. 3), 12, 24, 6, H, 203.1 (12), 268.5 (24) (F. 3), 6, T.

UV (F. 4), 339, S-140, 326, S-160, 340, S-160, S-140, S-180, T, S-160, S-140.

R B (F. 4), UV, 120, S-160, 96.6%, 140 (28.8%), S-180 (44.1%), P25 (75.7%), T, S-160, SSA, S-140, S-180, R B, S-160, R B (F. 4), F, (ICP MS), 2+, S, F, (\*OH), 14, T, \*OH, S.

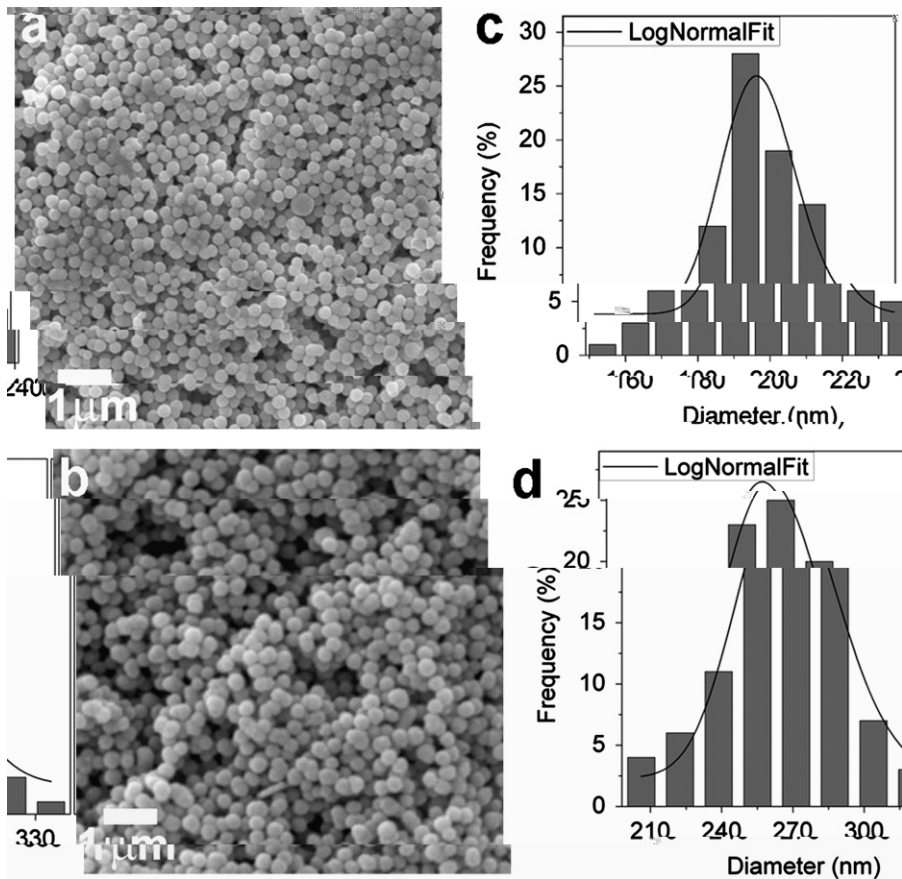


Fig. 3. (a) SEM image of S-120 nanoparticles at 160 °C. (b) SEM image of S-24 nanoparticles at 160 °C. (c) Histogram of S-120 diameter distribution. (d) Histogram of S-24 diameter distribution.

$S^+ \rightarrow S(e_{cb}^- + h_{vb}^+)$  (1)



**4. Conclusions**

The study shows that the UV irradiation of the S-140 and S-180 samples leads to the formation of  $\cdot OH$  radicals. The concentration of these radicals is significantly higher in the S-140 sample compared to the S-180 sample. This is attributed to the higher absorption of UV light by the S-140 sample.

**Acknowledgments**

The authors would like to thank the National Natural Science Foundation of China (21171051, 21271066, U1204516) and the State Key Laboratory of Environmental Chemistry (IRT1061) for their financial support. The authors also thank the State Key Laboratory of Environmental Chemistry (114200510004) for their support.

**References**

1 M. N. Ba, P. M. P. Ba, MK. E. E. S. 2005;61:105-13.  
 2 V. A. AK, RR, B. P. J. E. M. 2012;93:154-68.

- 7 C. D. Hall, F. R. G. L. D., M. W., *Materials Letters* 2010;2:2062–4.
- 8 G. H. L. W., L. S., E. Q., L. A., M. L. 2012;74:26–9.
- 9 G. W., J. A., D. F., V. K., M., A. C. E. C. 2012;14:1185–8.
- 10 L. H. J., T. C. R., L. J. J. M. C. 2011;21:16621–7.
- 11 M. A., M. A., R. S., M. ACS A. M., I. A. 2010;2:1817–23.
- 12 A., H. W., Q. C. C. 2010;46:8941–3.
- 13 A., H. A., GC, A. JQ. J. A. C. S. 2004;126:6874–5.
- 14 I. A., K., F. A., V. A., T. H., K. E. C. 2000;2:207–10.
- 15 A., W., S., FN. J. A. C. S. 2008;130:12566–7.