Investigation on the Electrochemistry of Several Biomolecules at the SWNT-Modified Electrodes

Jianxiu Wang,[1] Meixian Li,[1] Zujin Shi,[1] Nanqiang Li[1] and Zhennan Gu[1]

[1] Peking University
College of Chemistry and Molecular Engineering
Beijing 100871
P. R. China

Carbon nanotubes are attractive nanomaterials combining high surface area, high electrical conductivity, good chemical stability and significant mechanical strength [1]. Utilization of these properties has resulted in a broad range of potential applications such as scanning probes [2], electron field emission sources [3], actuators [4], and nanoelectronic devices [5]. Depending on their atomic structure, carbon nanotubes behave electrically as a metal or as a semiconductor [6-8]. When used as electrode material, carbon nanotubes have the ability to promote electron-transfer reactions [9-11]. In recent years, our research group has investigated the electrochemistry of several biomolecules at the single-wall carbon nanotubes (SWNTs) modified electrodes, and the details are as follows:

A dispersion of SWNTs in N,N-dimethylformamide was cast on a glassy carbon or a Au electrode to form a carbon nanotube modified electrode.

(1) The SWNT-modified electrodes show electrocatalytic activity toward oxidation of several biomolecules such as 3,4- dihydroxyphenylacetic acid (DOPAC), norepinephrine and uric acid, dopamine, epinephrine and ascorbic acid. [12-14]. The results indicate that DOPAC undergoes EC process. In the mixed solution of DOPAC and 5- hydroxytryptamine, the two oxidation peaks can be separated about 162 mV at the SWNT-modified electrode. Furthermore, under controlled condition, the SWNT-modified electrode can separate the electrochemical responses of uric acid, norepinephrine and ascorbic acid in the mixed solution.

(2) Cytochrome c shows a pair of well-defined redox waves at an activated SWNT-modified electrode [15]. Moveover, interaction of cytochrome c with adenine was characterized by electrochemical and spectral methods.

(3) Natural and denatured fish sperm DNA shows the same electrochemical response at the SWNT-modified electrode [16], indicating that structural and conformational changes of natural DNA at the SWNT.

Above results suggest that SWNTs have the ability to promote electron- transfer reactions. They show the possibility of potential application in biosensors.

ACKNOWLEDGEMENTS

This project was supported by the National Natural Science Foundation of China (No. 29835110 and No. 20105001) and Laboratory Foundation of Electroanalytical Chemistry of Changchun Institute of Applied Chemistry of Chinese Academy of Sciences.

REFERENCES

[1] P. M. Ajayan, Chem. Rev. 1999, 99, 1787.

[2] H. Dai, J. H. Hafner, A. G. Rinzler, D. T. Colbert, R. E. Smalley, Nature 1996, 384, 147.

[3] W. A. De Heer, A. Chatelain, D. Ugarte, Science 1995, 270, 1179.

[4] R. H. Baughman, C. X. Cui, A. A. Zakhidov, Z. Lqbal, J. N. Barisci, G. M. Spinks, G. G. Wallace, A. Mazzoldi, D. De Rossi, A. G. Rinzler, O. Jaschinski, S. Roth, M. Kertesz, Science 1999, 284, 1340.

[5] S. Tans, A. Verschueren, C. Dekker, Nature 1998, 393, 49.

[6] R. Saito, M. Fujita, G. Dresselhaus, M. S. Dresselhaus, Appl. Phys. Lett. 1992, 60, 2204.

[7] J. W. G. Wilder, L. C. Venema, A. G. Rinzler, R.E. Smalley, C. Dekker, Nature 1998, 391, 59.

[8] T. W. Odom, J. L. Huang, P. Kim, C. M. Lieber, Nature 1998, 391, 62.

[9] P. J. Britto, K. S. V. Santhanam, V. Alonso, A. Rubio, P. M. Ajayan, Adv. Mater. 1999, 11, 154.

[10] P. J. Britto, K. S. V. Santhanam, P. M. Ajayan, Bioelectrochem. Bioenerg. 1996, 41, 121.

[11] J. J. Davis, R. J.Coles, A. O. H. Allen, J. Electroanal. Chem. 1997, 440, 279.

[12] J. X. Wang, M. X. Li, Z. J. Shi, N. Q. Li, Z. N. Gu, Electrochimica Acta, 2001, 47, 651.

[13] J. X. Wang, M. X. Li, Z. J. Shi, N. Q. Li, Z. N. Gu, Electroanalysis, 2002, 14, 225.

[14] J. X. Wang, M. X. Li, Z. J. Shi, N. Q. Li, Z. N. Gu, Microchemical Journal, in press.

[15] J. X. Wang, M. X. Li, Z. J. Shi, N. Q. Li, Z. N. Gu, Anal. Chem., 2002, 74, 1993.

[16] J. X. Wang, M. X. Li, Z. J. Shi, N. Q. Li, Z. N. Gu, submitted.