Jiang, S. et al. (2013). Enhanced drug loading capacity of polypyrrole nanowire network for controlled drug release.
Synthetic Metals, 163: 19 – 23.
http://dx.doi.org/10.1016/j.synthmet.2012.12.010

Enhanced drug loading capacity of polypyrrole nanowire network for controlled drug release

Shuhui Jiang, Yanan Sun, Xin Cui, Xiang Huang, Yuan He, Shan Ji, Wei Shi and Dongtao Ge

Abstract

For a conducting polymer (CP) based drug release system, drug loading is often accomplished by a doping process, in which drug is incorporated into polymer as dopant. Therefore, the drug loading capacity is relatively low and the range of drugs can be loaded is limited. In the present work, a polypyrrole (PPy) nanowire network is prepared by an electrochemical method and it is found that the micro- and nano-gaps among the individual nanowires of the PPy nanowire network can be used as reservoir to store drugs. Therefore, the drug loading capacity is dependent on the volume of these micro- and nano-vacancies, instead of the doping level. The range of loaded drugs also can be theoretically extended to any drugs, instead of only charged dopants. In fact, it is confirmed here that both hydrophilic and lipophilic drugs can be loaded into the micro- and nano-gaps due to the amphilicity of the PPy nanowire network. As a result, both drug loading capacity and the range of drugs can be loaded are significantly improved. After being covered with a protective PPy film, controlled drug release from the prepared system is achieved by electrical stimulation (cyclic voltammetry, CV) and the amount of drug released can be controlled by changing the scan rate of CV and the thickness of the protective PPy film.

1. Introduction

Nanostructured conducting polymers (CPs) have been one of the focus research topics in the field of nanoscience for a number of years. To date, numerous nanostructures of CPs, such as nanowire, nanowire network, nanorod, nanotube, nanoparticle, and nanobelt have been synthesized and studied [1–4]. Among these CP nanostructures, nanowire networks of CPs, for example, polypyrrole (PPy) nanowire network, have attracted a great deal of interest due to their wide applications in the fields of biosensors, energy source, and electronics [3,4]. However, there are few reports on the use of PPy nanowire work for controlled drug release. Recently, our group extended the application of PPy nanowire network to this field, obtaining an effective drug release system with high adenosine triphosphate (ATP) release efficiency [5].

References

[1] J. Stejskal, I. Sapurina, M. Trchova, Progress in Polymer Science 35 (2010) 1420.
[2] D. Li, J.X. Huang, R.B. Kaner, Accounts of Chemical Research 42 (2009) 135.
[3] C. Li, H. Bai, G.Q. Shi, Chemical Society Reviews 38 (2009) 2397.
[4] H.D. Tran, D. Li, R.B. Kaner, Advanced Materials 21 (2009) 1487.
[5] X.N. Ru, W. Shi, X. Huang, X. Cui, B. Ren, D.T. Ge, Electrochimica Acta 56 (2011) 9887.
[6] Y. Cho, R.B. Borgens, Langmuir 27 (2011) 6316.
[7] D. Svirskis, J. Travas-Sejdic, A. Rodgers, S. Garg, Journal of Controlled Release 146 (2010) 6.
[8] D.T. Ge, R.C. Qi, J. Mu, X.N. Ru, S.M. Hong, S. Ji, V. Linkov, W. Shi, Electrochemistry Communications 12 (2010) 1087.
[9] Y.H. Li, R.J. Ewen, S.A. Campbell, J.R. Smith, Journal of Materials Chemistry 22 (2012) 2687.
[10] C.Y. Wang, P.G. Whitten, C.O. Too, G.G. Wallace, Sensors and Actuators B: Chemical 129 (2008) 605.
[11] R. Wadhwa, C.F. Lagenaur, X.T. Cui, Journal of Controlled Release 110 (2006) 531.
[12] D.T. Ge, X.D. Tian, R.C. Qi, S.Q. Huang, J. Mu, S.M. Hong, S.F. Ye, X.M. Zhang, D.H. Li, W. Shi, Electrochimica Acta 55 (2009) 271.
[13] S. Geetha, C.R.K. Rao, M. Vijayan, D.C. Trivedi, Analytica Chimica Acta 568 (2006) 119.
[14] D.T. Ge, X.N. Ru, S.M. Hong, S.H. Jiang, J. Tu, J. Wang, A.F. Zhang, S. Ji, V. Linkov, B. Ren, W. Shi, Electrochemistry Communications 12 (2010) 1367.
[15] L. Leprince, A. Dogimont, D. Magnin, S. Demoustier-Champagne, Journal of Materials Science: Materials in Medicine 21 (2010) 925.
[16] L.D. Li, C.B. Huang, Journal of the American Society for Mass Spectrometry 18 (2007) 919.
[17] J.C. Wu, W.M. Mullett, J. Pawliszyn, Analytical Chemistry 74 (2002) 4855.
[18] G. Bidan, C. Lopez, F. Mendes-Viegas, E. Vieil, A. Gadelle, Biosensors and Bioelectronics 10 (1995) 219.
[19] K. Kontturi, P. Pentti, G. Sundholm, Journal of Electroanalytical Chemistry 453 (1998) 231.
[20] M. Pyo, J.R. Reynolds, Chemistry of Materials 8 (1996) 128.
[21] B.C. Thompson, S.E. Moulton, R.T. Richardson, G.G. Wallace, Biomaterials 32 (2011) 3822.
[22] X.L. Luo, X.T. Cui, Electrochemistry Communications 11 (2009) 402.
[23] L.M. Lira, S.I. Cordoba de Torresi, Electrochemistry Communications 7 (2005) 717.