Highly porous and magnetic targeted poly(ε-caprolactone)/Fe_3O_4 hydrogel microspheres

Xiaotong Zheng, Haibo Wang, Jun Ke and Huawu Shao*

Natural Products Research Center, Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu, China.
Fax: 86-28- 8522 2753; Tel: 86-28- 8535 6511; E-mail: shaohw@cib.ac.cn

Highly porous and magnetic targeted poly(ε-caprolactone)/Fe_3O_4 hydrogel microspheres

Abstract A highly porous and magnetic targeted poly(ε-caprolactone) (PCL)/Fe_3O_4 hydrogel microsphere was prepared by the imprinting process of adding and removing of small molecules glucose. The hydrogel microspheres showed the properties of controlled release and magnetic targeting of drug in physiological environment. In addition, another important characteristic of the hydrogel microspheres was that the starting PCL/Fe_3O_4 hydrogel contained highly porous structure. It was an advantage for use in drug delivery system and cell therapy that the highly porous gel could effectively adsorb or release small molecules drugs in unswelling state.

Introduction

Hydrogel microspheres have been used primarily in the pharmaceutical field as carriers for delivery of various drugs, peptides and proteins [1]. PCL represented good biocompatibility, nontoxicity and drug permeability so that it had been used as gel carrier in drug delivery systems [2]. Moreover, Fe_3O_4 nanoparticles were potential uses magnetic drug targeting and MRI for clinical diagnosis, etc [3].

Furthermore, the introduction of highly porous structures in PCL/Fe_3O_4 hydrogel microspheres has opened possibilities for the development of smart drug delivery platforms [4]. In this paper, highly porous and magnetic targeted PCL/Fe_3O_4 hydrogel were prepared and investigated.

Materials & Methods

Linear PCL (*Mw* = 50 kDa) was purchased from BrightChina Industrial co., Ltd (Shenzhen, Guangdong, China). The molecular weight and its distribution were determined by gel permeation chromatography (GPC). The Fe_3O_4 nanoparticles modified by glucose with an average size of 8 nm were synthesized according to a chemical coprecipitation method. Glucose ($[\alpha]_D^{20}$ = +52.5°~+53.0°) was purchased from Kelong Chemical Reagent Company (Chengdu, China).

Pre-weighed linear PCL with 3 wt % of benzoyl peroxide (BPO) was dissolved in CH_2Cl_2. Then, glucose-grafted Fe_3O_4 and glucose were dissolved in distilled water at different concentrations with ultra-sonication for 30 min. Subsequently, the Fe_3O_4/glucose mixed solution was dropped in PCL solution by a high-speed homogenizer and stirred at 70 °C for 30 min under the protection of nitrogen. Later, the completely dried composite was washed by distilled water refluxing at 55 °C for 1 h under vacuum. Finally, the highly porous PCL/Fe_3O_4 hydrogel microspheres were obtained.

Results & Discussion

Scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), vibrating sample magnetometer (VSM) and Fourier transform infrared spectroscopy (FTIR) were carried out to examine the porous morphology of composites, crystallization, dispersibility, magnetism and interaction of nanocomponents.

Fig. 1 showed the schematic illustration of obtaining highly porous PCL/Fe_3O_4 hydrogel microspheres by removing of small molecules glucose and controlled release changing in physiological environment. The highly porous PCL/Fe_3O_4 composites were obtained by the washing process of PCL/Fe_3O_4/Glucose composites at refluxing temperature for 1 h under vacuum in order to remove glucose. It could be seen from Fig. 2a. Moreover, the hole diameter and specific surface area of highly porous PCL/Fe_3O_4 hydrogel microspheres before and after swelling in physiological environment displayed distinct change.

Conclusion

This study showed that PCL/Fe_3O_4 hydrogel microspheres possessed the highly porous structure. Significantly, the hydrogel microspheres showed the properties of controlled adsorption or release of small molecules drugs and magnetic targeting of drug in physiological environment. Thus, the PCL/Fe_3O_4 hydrogel could be potential candidate as smart microspheres in drug delivery field.

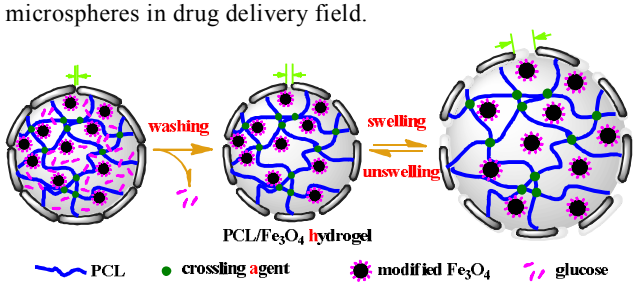

Fig. 1. Schematic illustration of obtaining highly porous PCL/Fe_3O_4 hydrogel microspheres by removing of small molecules glucose and controlled release changing in physiological environment.

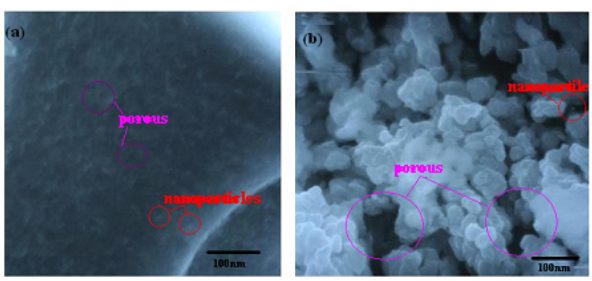

Fig. 2. SEM images of (a) PCL/Fe_3O_4 hydrogel microspheres with stationary highly porous structures, (b) changing porous PCL/Fe_3O_4 hydrogel microspheres swelled in physiological environment.

References

1 M. E. Byrne, K. Park, L and N. A. Peppas, *Advanced Drug Delivery Reviews*, 2002, **54**, 149-161.
2 Y. Xiao, S. Zhou, L. Wang, X. Zheng and T. Guo, *Composites: B*, 2010, **41**, 537-542.
3 X. Zheng, S. Zhou, Y. Xiao, X. Yu, X. Li and P. Wu, *Colloids and Surfaces B*, 2009, **71**, 67-72.
4 P. Colombo, *Science*, 2008, **332**, 381-383.