影響鐵奈米材料之粒徑大小分佈及其穩定性之因子探討

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摘要

四氧化三鐵（Fe304）磁性奈米粒子具有超順磁性、高飽和磁化量及高有效表面積等特性，披覆葡聚醣界面活性劑，以修飾其團聚特性及生物相容性等問題，目前已廣泛的被運用在生物醫學的研究與應用領域上，例如，腫瘤治療、靶向藥劑、基因篩選或細胞分離、核磁影像檢測等。由於粒徑大小分佈和穩定性會影響到磁性奈米粒子作為生醫材料的體外可用性，以及體內生物相容性、細胞毒性及載體作用等。本研究旨在探討其粒徑大小分佈及影響其穩定性之因子。包含反應莫耳濃度、反應溫度、pH 值、粒子型態及粒徑分佈與製備後樣品保存時間及不同溫度環境等參數之探討。結果發現在高溫 90℃±5℃；pH 值為 10-12；反應時間 2 小時可產生出純度佳的 Fe304，披覆葡聚醣條件反應溫度 80℃±5℃；反應時間 2 小時為最適化條件;四氧化三鐵磁性奈米鐵粒子保存在 4℃、22℃、37℃、43℃及 47℃溫度下 2 天內，可獲得良好的超順磁性且粒徑大小穩定、分佈均勻。粒徑大小介於 123.5±25.56 nm 的範圍。披覆葡聚醣界面活性劑(one-step process)在 4℃、22℃、37℃、43℃及 47℃範圍 7 天內皆有很好穩定性，粒徑大小界於 135.3±25.06nm 的範圍。披覆葡聚醣界面活性劑(two-step process）在 4℃、22℃、37℃約 5 天內皆有很好穩定性，粒徑大小界於 156.6±24.13 nm 的範圍，於第 3 天後可發現逐漸產生不穩定團聚現象，七天內大幅團聚增至約 210nm 大小。

關鍵字：磁性奈米粒子、葡聚醣、粒徑分佈、穩定性

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Study on the influence factors of particle size distribution and stability of Fe_3O_4 magnetic nanoparticles

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Abstract

Fe3O4 magnetic nanoparticles (MN) were prepared by using chemical co-precipitation method and were coated with reduced dextran which can modify MN with biocompatibility and stability. Furthermore, to ensure desirable qualities, all MN compounds obtained in this study were examined by superconducting quantum interference device, X-ray diffraction, fourier transform infrared spectroscopy, ultraviolet–visible spectroscopy, scanning electron microscope and energy-dispersive X-Ray Spectroscopy. We found that Fe3O4 MN with high purity could be obtained with the following reaction condition: 90°C ± 5°C; pH value of 10-12; 2 hours reaction time. On the other hand, one-step and two-step synthesis pathways were used to coat Fe3O4 MN with reduced dextran with the reaction temperature of 80°C ± 5°C and 2 hours reaction time. The data of size distribution of MN shows its characteristics and stabilities can be maintained for 2 days at 4°C, 22°C, 37°C, 43°C and 47°C, respectively. The average size of such MN is ca. 123.5 ± 25.56 nm; The dextran@MN derived from one-step synthesis pathway is able to hold stabilities and non-agglomeration for 7 days at 4°C, 22°C, 37°C, 43°C and 47°C, respectively. The average size of the above dextran@MN is ca. 135.3 ± 25.06 nm; Although the dextran@MN by two-step synthesis pathway retained stabilities and good characteristics for 5 days at 4°C, 22°C and 37°C, respectively, it started to aggregate at the third day post synthesis and the sizes grown to over 210 nm at the seventh day. The average size of such dextran@MN by two-step method is ca. 135.3 ± 25.06 nm.

Key words: magnetic nanoparticles、dextran、particle size distribution、stability