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Polyampholyte poly[2-(dimethylamino)ethyl methacrylate]-*star*-poly (methacrylic acid) star copolymers as colloidal drug carriers

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ABSTRACT

Herein, polyampholyte star copolymers have been prepared *via* a two-step reversible addition-fragmentation chain transfer (RAFT) polymerization combined with disstilation presipitation polymerization (DPP). We have used arm-first approch where poly[2-(dimethylamino)ethyl methacrylate] (PDMAEMA) arms have been synthesized in three different molecular weights. Then, PDMAEMA arms have been used as macroRAFT agent in DPP of MAA to prepare crosslinked core by *N*,*N*'-methylenebisacrylamide (MBA). Nuclear magnetic resonance (^{1}H NMR), differential scanning calorimetry (DSC), and gel permeation chromatography (GPC) have been used to confirm the accuracy of the synthesized star polyampholytes. The effect of pH on the self-assembly behavior of PDMAEMA-*star*-PMAA star copolymers has been investigated by dynamic light scattering (DLS) and field emission scanning electron microscopy (FE-SEM). Also the cloud point (turbididity behavior) of the star polyampholytes has been investigated by UV–vis spectroscopy. Result indicated that, morphologies containing spherical, rod-shaped, and worm-like structures with different sizes have been obtained by chenging pH value. Also, doxorobicin (DOX) release behavior has been exmined for star polyampholytes at disparate pH values. Results showed that release amount was higher at pH = 1 than that at pH = 7 with high amount of DOX release.

1. Introduction

Drug delivery systems can control the locality and rate of drug release, which is leading to increasing the effectiveness of the drug release, easier absorption, hindering toxic side effects, and availability to the objective site [1,2]. The ability to control drug release time with drug entry is very important in the medical industry [3,4]. Polymeric carriers play an important role in drug delivery systems by encapsulating the drug and releasing it at specific location and/or time [5,6]. Stimuli-responsive polymers have received a great attention in recent years because of responding to small environmental factors such as pH, light, temperature, etc. [7–10]. These polymers are suitable for nano- and bio-applications including used in smart surfaces [11,12], drug delivery [13–15], and separation systems [16–18]. pH-responsive polymers are divided into two categories, polyelectrolytes and polyampholytes. Polyelectrolytes are containing both cationic and anionic groups in theirs structure and therefore protonation or deprotonation occurs with changing in pH of environment [19,20] while the polyampholytes have basic and acidic groups together in theirs structure [21–23].

Polymers with individual structures, such as star, dendritic, block, and graft structures have attracted considerable attention for their application in medical devices, drug delivery, tissue engineering, gene delivery, diagnosis, and antibacterial/ anti-sediment biomaterial [24–29]. Star polymers are containing at least three arms (macromolecular chains) radiating from a central core, which can be atoms, nanogels, branched macromolecules, small molecules, nanoparticles, etc. Their unique properties from the aspect of the relationship between numbers of arms, arm molecular weight, and solution viscosity have been caused more attention to them [30–32]. They have exclusive topological structures and interesting chemical / physical properties, including low viscosity in dilute solutions because of their fewer arm entanglements, encapsulation capability due to their 3D globular structures. Peripheral and internal active groups provide a convenient way to introduce a variety of valuable features and increase the

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