

Nano capsule Is Made of a Polymeric Layer

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Description

All of these fractionated copolymers have a unimodal distribution and moderate PDI. The thermal properties of the P (DEVP-co-CEMA) copolymers are investigated by TGA and differential scanning calorimetry (DSC) measurements. Single glass transition temperature (T_g) appears in the DSC profiles differing from the existence of two T_gs in the blend of poly (diethyl vinylphosphonate) and poly (2-chloroethyl methacrylate), which indicates the random structure of the copolymers. The MALDI-ToF mass analysis further reveals that DEVP and CEMA units are randomly distributed in the copolymer chains. The few reports show that vinylphosphonate monomers fail to homopolymerize to high molecular weight products by the method of radical polymerization (especially for diethyl vinylphosphonate (DEVP)), which usually lead to low yields and provide polymers of low molecular weight. In the case of radical copolymerization, the final results were either unsuccessful or afforded insufficient characterization. Arcus reported the copolymerization of DEVP with styrene initiated by tert-butyl hydroperoxide and determined the reactivity ratios of this monomer pair. For relatively low DEVP contents in the copolymers, DEVP is reluctant to enter the growing polymer chain as compared to styrene. Except for styrene, radical copolymerizations of DEVP with ethylene glycol dimethacrylate, methyl methacrylate, acrylonitrile, and trimethoxyvinylsilane are achieved, but afford inadequate characterization.

Co-polymerizations

Therefore, radical copolymerizations of DEVP with other monomers to get relatively high DEVP-containing copolymers with clearly characterized structure are still a significant and challenging issue. Vinylphosphonate is one of the simplest vinyl monomers with the phosphonate groups at the side chain. Since the late 1940s, different routes for vinylphosphonate synthesis have been reported. Among these techniques, coordinative-anionic polymerization and living rare earth metal-mediated group transfer polymerization are efficient to generate poly(vinylphosphonates) with higher molecular weight and higher conversions. Except for poly(vinylphosphonic acid) (which can be obtained in high yield and moderate molecular weight by free radical polymerization), relatively few investigations into the homo and copolymerization of vinylphosphonate monomers

via radical polymerization have been reported. Phosphorus-containing polymers are particularly attractive for their extensive application in fuel cells, flame retardant, and the biomedical field. Phosphorus-containing polymers include genetic materials DNA and RNA, and synthetic polymers functionalized at the main chain and those functionalized at the side chain. The structures and molecular characteristics of the obtained products are characterized by ¹H NMR, FTIR, and SEC analysis. The self-assembly behavior of the copolymers in aqueous solution is preliminarily investigated. They are vesicular frameworks made of a polymeric film which epitomizes an inward fluid center at the nanoscale. Nanocapsules have numerous utilizations, including promising clinical applications for tranquilize conveyance, food upgrade, nutraceuticals, and for self-recuperating materials. The advantages of exemplification techniques are for assurance of these substances to ensure in the unfavorable condition, for controlled discharge, and for exactness targeting. Nanocapsules can conceivably be utilized as MRI-guided nanorobots or nanobots, despite the fact that difficulties remain. The ordinary size of the nanocapsule utilized for different applications ranges from 10-1000 nm. Notwithstanding, contingent upon the planning and utilization of the nanocapsule, the size will be more specific.

Nanocapsule structure comprises of nanovesicular framework that is shaped in a center shell game plan. The shell of an ordinary nanocapsule is made of a polymeric layer or covering. The kind of polymers utilized is of biodegradable polyester, as nanocapsules are frequently utilized in natural frameworks. The monomer 2-chloroethyl methacrylate (CEMA) is of special interest as halogen-functionalized comonomer for easy modification and post cross-linking. With initiating haloalkyl groups, graft copolymers can be prepared via atom transfer radical polymerization ATRP. The chlorine atoms can be readily substituted by nucleophiles, for instance, azide groups, and then followed by click coupling of alkyne end-functionalized polymers to gain new properties. Therefore, CEMA is a potential comonomer for DEVP to broaden the applications of phosphorus-containing polymers. To date, to the best of our knowledge, there is no report on the copolymerization of DEVP with CEMA. What is more, due to the existence of both hydrophobic units (CEMA) and hydrophilic units (DEVP), the copolymers are able to self-assemble into nanoparticles in aqueous solution, which are promising in the fields such as microreactors and encapsulation of guest molecules. The

modified copolymers show great potential in biomedical fields for polyphosphonates and proved to be high biocompatibility and adjustable degradability.

Chemical Incorporation

Meanwhile, the chemical incorporation of a phosphorus-containing flame retardant into a methacrylate polymer via copolymerization may eliminate the leaching and heterogeneous problems associated with the additive approach. Herein, we synthesize a series of amphiphilic random copolymers, namely poly (diethyl vinylphosphonate-co-2-chloroethyl methacrylate) (P(DEVP-co-CEMA)), through free radical copolymerization using benzoyl peroxide (BPO) as initiator. Copolymers with relatively narrow molecular weight distribution are isolated through precipitation fractionation for the detailed investigation. The structures of the copolymers are confirmed by ^1H NMR, ^{31}P NMR, Fourier transform infrared (FTIR), and MALDI-ToF mass analysis. The thermal properties of P(DEVP-co-CEMA) copolymers are determined by differential scanning calorimetry (DSC) and thermogravimetric analyses (TGA) measurements. Preliminary investigations on self-assembly behaviors of the copolymers in water are also performed, and the nanoparticles formed in water are observed by TEM. Experimental Materials Triethyl phosphite (98.0%, Aladdin Reagent, China), ethylene bromide (99.0%, Aladdin Reagent, China), triethylamine (Sinopharm Chemical Reagent, China), benzene (Sinopharm Chemical Reagent, China), methacryloyl chloride (J&K Chemical Reagent, China), and 2-chloroethanol (Shanghai Nanxiang Reagent, China) were used as received. BPO (Shanghai Lingfeng Chemical Reagent, China) was recrystallized from methanol twice before use. THF was refluxed

over potassium/benzophenone ketyl before use. All the other chemicals were used as received unless otherwise specified. Synthesis of CEMA 2-chloroethanol (10 mL) and triethylamine (22 mL) were dissolved in THF (50 mL), and then methacryloyl chloride (15 mL) was added slowly under argon atmosphere while cooling the solution in an ice bath.

The reaction mixture was stirred for 48 h at room temperature and then filtered. Mesoporous silica nanocapsules are a well-known and leading nanocontainers' system applied in several fields (corrosion protection, antifouling, drug delivery). However, it has been already reported that the monomeric cationic surfactant hexadecyltrimethylammonium bromide (CTAB), used as a template in the synthesis of these nanocapsules, should be replaced because of being a source of nanocapsules' toxicity. In this work we investigate the replacement of CTAB with dimeric surfactants, known as gemini surfactants. Works already available in the literature show that gemini surfactants tend to exhibit lower toxicity to fresh water and marine species than their conventional analogues. Therefore, this study can be envisaged as a safe-by-design approach to silica nanocapsules synthesis by replacing a commercial surfactant (CTAB) with a gemini surfactant (QSB2-12). Nanocapsules prepared using both surfactants were fully characterized by different techniques (BET, FTIR, DLS, TGA, SEM), while the short-term exposure effect was evaluated towards four marine species (the green microalgae *Nannochloropsis gaditana* and *Tetraselmis chuii*, the diatom *Phaeodactylum tricornutum*, and the microcrustacean *Artemia salina*). A nanocapsule is a nanoscale shell produced using a nontoxic polymer.