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ORIGINAL RESEARCH

Hybrid hydrogel based on pre-gelatinized starch modified with glycidyl-crosslinked microgel

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Abstract

Hybrid hydrogels based on pre-gelatinized starch were synthesized by inverse emulsion polymerization through modifying the starch with a glycidyl-crosslinked microgel. Glycidyl-crosslinked microgel is a special latex with high ability to impart hydrophilic characteristics to various substrates. Glycidyl-crosslinked microgel latexes with various structures were synthesized, and the effect of latex type on swelling capacity of the hybrid hydrogels based on pre-gelatinized starch was investigated. The highest swelling capacity was achieved for a pre-gelatinized starch modified with a glycidyl-crosslinked microgel latex based on poly(acrylic acid, sodium acrylate, acrylamide, 2-acrylamide-2 methyl propane sulfonic acid) (AA–SA–AM–AMPS). The swelling values of this hybrid hydrogel in distilled water and saline solution were 52.4 and 28.8 g/g, respectively. A key advantage of these hybrid hydrogels is that starch constitutes 64% of their structure. Given the fact that such hybrid hydrogels display low absorbency under load (AUL), they were surface crosslinked using microwave heating instead of conventional heating. Ethylene glycol diglycidyl ether was used as surface crosslinker. The AUL of the surface crosslinked hybrid hydrogels was increased by 85%. The hydrogels were characterized using FTIR, thermogravimetric analysis, scanning electron microscopy, and rheological measurements.

Keywords Hydrogel · Inverse emulsion polymerization · Pre-gelatinized starch · Surface modification · Surface crosslinking

Introduction

Starch is the second most readily available natural polymer [1]. As a polysaccharide, it consists of repeating D-glucopyranose units, linked together with α-1,4 and α-1,6 glycosidic bonds [2]. Pre-gelatinized starch is a modified starch that, in addition to its solubility in cold water, it possesses a high water holding capacity. It is a preferred starch, which is used in industry to avoid highly viscous gels [3]. The potential advantages of using starch in its gelatinized state have been extensively reviewed [4].

Superabsorbent hydrogels are hydrophilic polymer networks that can absorb and retain large amount of water and aqueous solutions [5, 6], and have been used in both hygienic and non-hygienic applications extensively [7]. Superabsorbent hydrogel structures can be synthetic, natural, or synthetic-natural hybrid [5]. Hybrid hydrogels are mostly prepared through graft polymerization of acrylic monomers such as acrylic acid and acrylamide, 2-acrylamido-2-methyl propane sulphonic acid (AMPS) onto natural polymers [5, 6]. Although hybrid hydrogels can be prepared based on proteins or polysaccharides, those based on polysaccharides are being extensively used due to their variety and accessibility, low price, and remarkable rheological properties in aqueous media [8–10].

Preparation of hybrid hydrogels through graft polymerization has several shortages such as low grafting efficiency, homopolymerization of acrylic monomers, low content of natural component, and low absorbency under load (AUL). A lot of work has been done on hybrid hydrogels containing natural polymers such as collagen [11], starch [12], carrageenan [13], agarose [14], and chitosan [15].

Glycidyl-crosslinked microgels have been recently prepared using inverse emulsion polymerization of acrylic monomers and diglycidyl chemicals as crosslinker. These

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