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ORIGINAL PAPER

Structure, swelling and mechanical behavior of a cationic full-IPN hydrogel reinforced with modified nanoclay

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Abstract Despite various applications of hydrogels, they have poor gel strength and low resistance against crack propagation which lead to the limitation of their applications. For overcoming this inherent weakness, the current study has focused on the simultaneous utilization of interpenetrating polymer network (IPN) structure and nanocomposite hydrogels. It is known that IPN and nanocomposite gels can improve gel strength. The combination of IPN and nanocomposite structure was developed in hydrogels for improving gel strength. For this purpose, bentonite was successfully modified with a cationic surfactant, (3-methacrylamidopropyl) trimethyl ammonium chloride (MAPTAC), as intercalate, and characterized by TGA, XRD and FTIR. Then we synthesized a novel full-interpenetrating polymer network (IPN) cationic hydrogel nanocomposite reinforced using the modified bentonite (MBe) nanoplatelets. The effect of MBe content on the chemical structure and mechanical properties was studied by means of XRD, FTIR, tensile and rheological measurements. Additionally, the swelling capacity of hydrogel networks was studied. The highest storage modulus for the swollen IPN nanocomposite hydrogel was obtained at 1 wt% of MBe. A similar trend was also demonstrated for the Young's modulus of the elastic full-IPN hydrogels as the storage modulus of rheological measurements. Therefore, the optimized network had only 1 wt% MBe nanosheets.

Keywords Cationic hydrogel · Nanocomposite · Full- interpenetrating polymer network · Organo-modified nanoclay

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Introduction

Polymeric hydrogels are well known as a group of hydrophilic soft and wet materials with the 3D network that have the ability of high water absorption and reversible volume phase transition by swelling and deswelling water in response to a wide range of stimuli, such as pH, temperature, ionic strength, light, the concentration of metabolite, electric and magnetic field and so forth [1]. Through these properties, hydrogels have several applications in various fields such as agriculture [2–4], drug-delivery systems [5–7], medical [8], and tissue engineering [9, 10] and so on. However, these hydrogels have displayed poor gel strength and low resistance against crack propagation which have limited their applications in tissue engineering [11]. This deficiency is due to heterogeneity of the network structure of these materials formed during the gelation process, low density of polymer chains in hydrogel matrix and small friction between the chains [11].

Thus, several methods have been considered to develop the mechanical strength of hydrogels including