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Fabrication and characterization of temperature-, pH- and magnetic-field-sensitive organic/inorganic hybrid poly (ethylene glycol)-based hydrogels

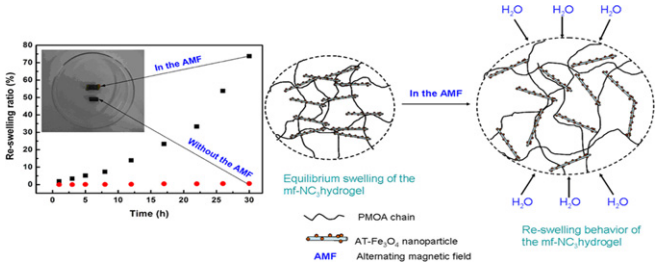
Yang Wang, Aijuan Dong, Zhicheng Yuan, Dajun Chen *

State Key Laboratory for Modification of Chemical Fibers and Polymer Materials, College of Materials Science and Engineering, Shanghai 201620, People's Republic of China

HIGHLIGHTS

- A new kind of magnetic nanoparticle was prepared *via* co-precipitation technique.
- Novel multiple stimulus-responsive hydrogels were prepared by *in situ* polymerization.
- The mf-NC hydrogels have T/pH/magnetic sensitivity and good mechanical properties.
- The mf-NC hydrogel can continue swelling under an alternating magnetic field.

GRAPHICAL ABSTRACT



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ABSTRACT

In this paper, we successfully fabricated a new kind of multiple stimulus-responsive organic/inorganic hybrid hydrogels by combining dual stimuli-responsive poly (2-(2-methoxyethoxy) ethyl methacrylate-co-oligo (ethylene glycol) methacrylate-co-acrylic acid) (PMOA) hydrogel with magnetic attapulgite/Fe_3O_4 (AT–Fe_3O_4) nanoparticles. First, the magnetic nanoparticle was prepared *via* co-precipitation technique in aqueous suspension of purified attapulgite. The obtained AT–Fe_3O_4 nanoparticles were characterized by Fourier transform infrared spectroscopy, X-ray diffraction, field emission scanning electron microscopy and vibrating sample magnetometer. Compared with pure attapulgite, the AT–Fe_3O_4 exhibited better superparamagnetic properties. Then, the AT–Fe_3O_4 was introduced into the dual-responsive (temperature and pH) PMOA hydrogel network by *in situ* polymerization. The morphology, responsive behaviors and tensile properties of the prepared hydrogels were systematically characterized by field emission scanning electron microscopy, vibrating sample magnetometer, swelling/re-swelling behaviors and tensile testing. The results showed that the AT–Fe_3O_4 nanoparticles were well dispersed in the hydrogel matrix, and the multi-functional AT–Fe_3O_4/PMOA nanocomposite hydrogels had not only temperature/pH sensitivity and good mechanical properties, but also magnetic functionality. The tunable superparamagnetic behavior of these hydrogels depended on the amount of AT–Fe_3O_4. In addition, the multi-functional AT–Fe_3O_4/PMOA nanocomposite hydrogels can continue to swell under an alternating magnetic field after equilibrium swelling in deionized water.

1. Introduction

Smart hydrogels are three-dimensional network structure that change their physical and (or) chemical properties in response to external environmental stimuli [1–3], such as temperature, pH, pressure, electric field, magnetic field and light and so on. Due to the

* Corresponding author. Tel.: +86 21 67792891; fax: +86 21 67792855.
E-mail address: cdj@dhu.edu.cn (D. Chen).

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