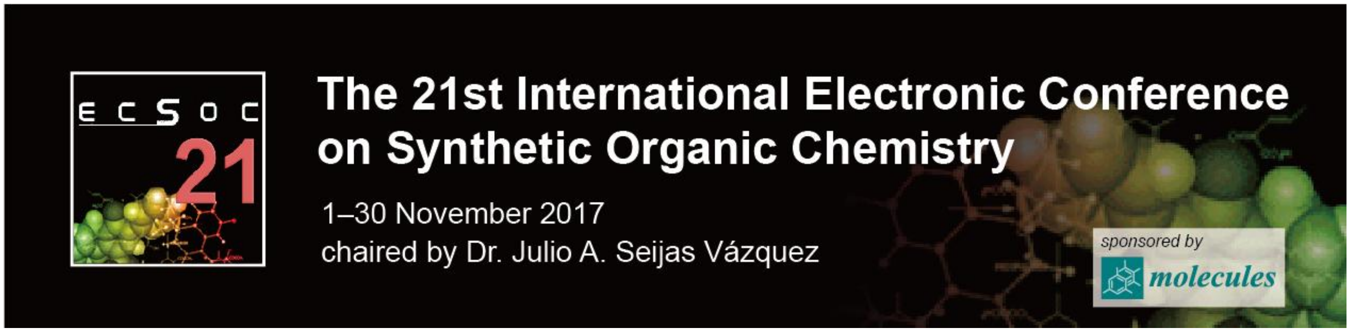

Gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposites: preparation and characterization

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Abstract: In the present study, gelatin/Fe_3O_4/ethylene glycol hydrocarbon gel nanocomposite was prepared by a simple method. First, Fe_3O_4 magnetic nanoparticles (MNPs) were synthesized by a co-precipitation method. Then to prepare the hydrocarbon gel nanocomposite, magnetic nanoparticles were dispersed in ethylene glycol and gelatin was added to the above solution. To study the morphology and characterization of the hydrocarbon gel nanocomposite, scanning electron microscopy (SEM), X-ray diffraction (XRD) and vibrating sample magnetometry (VSM) were obtained.

Keywords: hydrocarbon gel, Fe_3O_4, gelatin, nanocomposite

Introduction

In the recent years, the amount of attention to nanoscience paid by chemists, biologists and other fields. Scientists has been increased due to its novel and unique applications in various fields. Therefore, nanomaterials have attracted significant research interest in the chemical and pharmaceutical fields, due to their size effect, high specific surface area and unique structural properties [1-3].

Biohybrid nanostructured materials obtained by the assembly of polymers and inorganic solids are of remarkable interest due to the potential improvement of polymer properties including enhanced mechanical strength, weight reduction, increased heat resistance, and improved barrier properties and the variety of possible applications, from regenerative medicine to advanced functional materials [4-5].

Gelatin, which is obtained by chemical–thermal degradation of collagen is one of the most employed biopolymers. The numerous applications of gelatin range from packaging to health care, thanks to its biodegradability, excellent biocompatibility, plasticity, abundance, and low cost. Furthermore, gelatin is non-immunogenic and non-carcinogenic, and it displays low antigenicity. Gelatin-based films are thin, flexible, and transparent biodegradable materials, useful in engineering food, drug recover, and other applications. The main drawback of gelatin as a material is its poor mechanical performance [6-7].

In this study, gelatin/Fe_3O_4/ethylene glycol hydrocarbon gel nanocomposite was prepared by a simple method. Fe_3O_4 magnetic nanoparticles (MNPs) were synthesized by a co-precipitation method. Then to prepare the hydrocarbon gel nanocomposite, magnetic nanoparticles were dispersed in ethylene glycol and gelatin was added to the above solution. To study the morphology and characterization of the hydrocarbon gel nanocomposite, SEM, XRD, VSM were used.

Experimental

General

All the solvents, chemicals and reagents were purchased from Merck, Fluka and Aldrich. SEM images were obtained on a Sigma Zeiss. XRD measurements were carried out using a JEOL JDX–8030 (30 kV, 20 mA). Magnetic susceptibility measurements were performed using a Lake Shore VSM 7410.

Synthesis of Fe_3O_4 nanoparticles

The Fe3O4 nanoparticles were synthesized via the co-precipitation of $FeCl_3$.6H2O and $FeCl_2.4H_2O$ at a molar ratio of 2:1 in the presence of ammonia. In a typical reaction, 1.72 g $FeCl_2$ and 4.7 g $FeCl_3$ were mixed in 80 mL de-ionized water and heated to 80°C in a three necked flask. While vigorously stirring the reaction mixture, 10 mL of $NH_3{\cdot}H_2O$ was introduced by syringe and the heating continued for 40 min. Black precipitate was produced immediately by adding $NH_3{\cdot}H_2O$. The obtained Fe_3O_4 precipitate was washed repeatedly with de-ionized water until pH value decreased to 7 and then dried at 80°C in an oven.

Preparation of gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite

To prepare gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite, first, 0.1 g Fe_3O_4 nanoparticles were dispersed in 10 mL of ethylene glycol by ultrasonication for 10 min. Then, 1 g of gelatin was added under vigorous stirring. The suspension was cooled down to 5°C and held at that temperature 24h.

Results and discussion

First, gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite was prepared as described in the materials and method section.

To study the morphology and characterization of gelatin/ Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite, scanning electron microscopy (SEM), X-ray diffraction (XRD) and vibrating sample magnetometry (VSM) were used.

XRD patterns shown in Fig. 1. The peaks located at 2Ɵ = 30.12, 35.48, 43.12, 53.50, 62.62 and 74.09 are related to Fe_3O_4, nanoparticles and also the board peak presented at 2Ɵ around 22 is related to gelatin. Identified peaks in XRD patterns were assigned to the well-crystallized Fe_3O_4 (JCPDS 25-1402) nanoparticles.

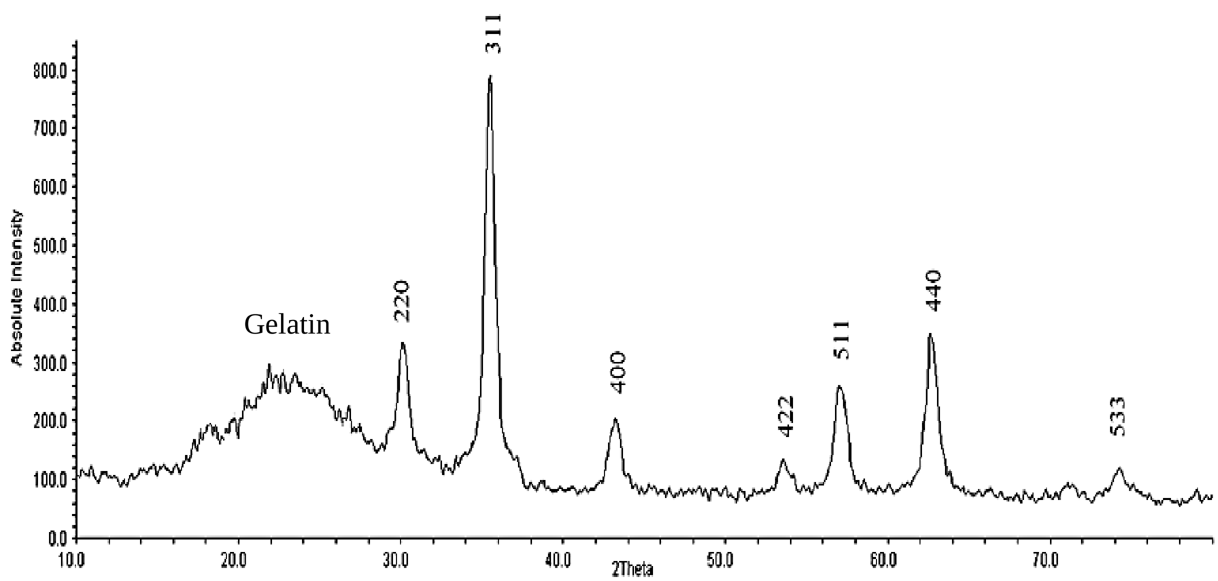

Fig. 1. XRD patterns of gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite

To determine the size and distribution of the nanoparticles, SEM images analysis was used. As can be seen in Fig. 1, nanoparticles have the spherical morphology and were dispersed properly on gelatin surface. To determine the size of the nanoparticles, 90 particles were used randomly. The particle size distribution was narrow and the sizes of most of the particles were about 30-40 nm (Fig. 2). In addition, the average size of the nanoparticles was about 38.43 nm.

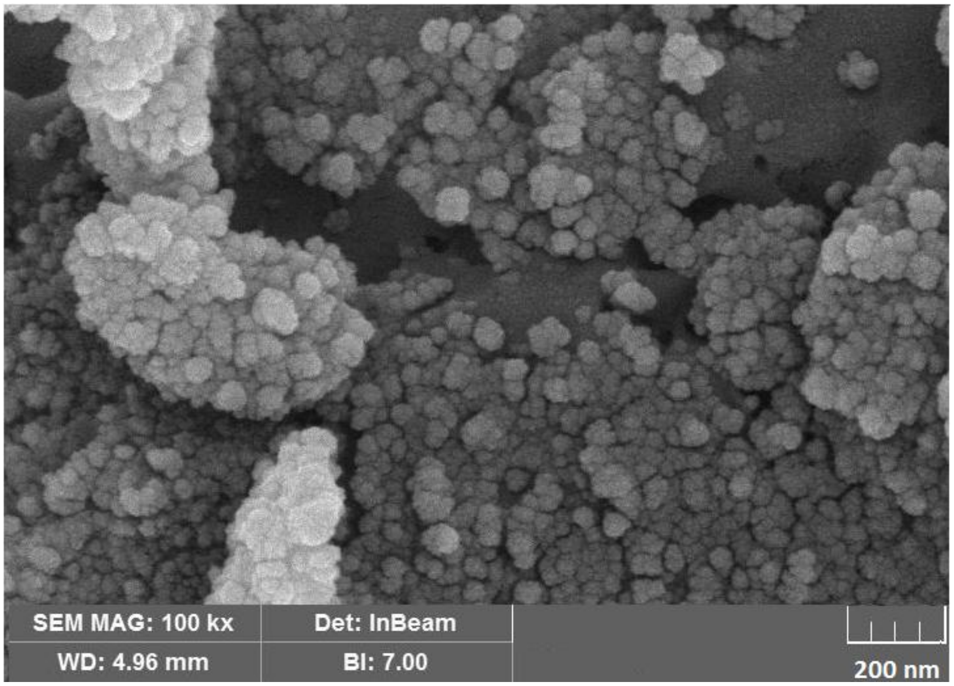

Fig. 2. SEM images of gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite

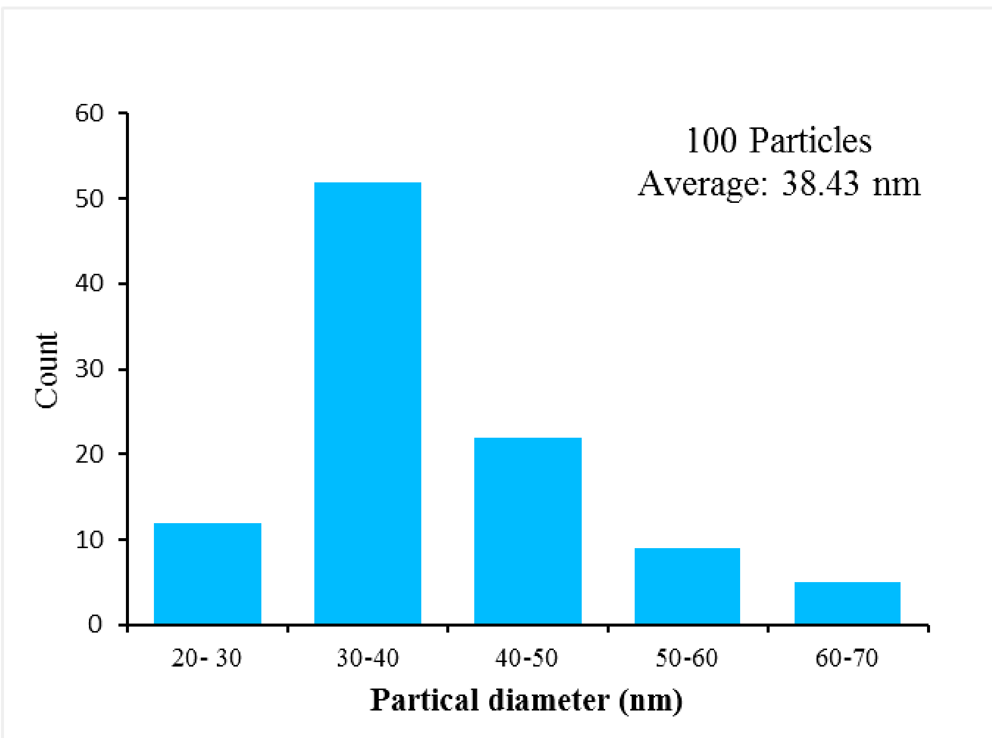

Fig.3. Distribution diagram of particles size of Fe_3O_4

The magnetic property of the nanocomposite was characterized using a vibrating sample magnetometer (VSM) at room temperature (Fig. 4). The magnetic property of the Fe_3O_4 nanoparticles are 46.7 emu g^{-1} [8]. The magnetic property of gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite is about 14.3 emu g^{-1}. This dropping in the magnetic potential is due to the addition of gelatin to the Fe_3O_4 nanoparticles. The obtained nanocomposite has a good magnetic potential and can be separated from the reaction medium easily by a magnet.

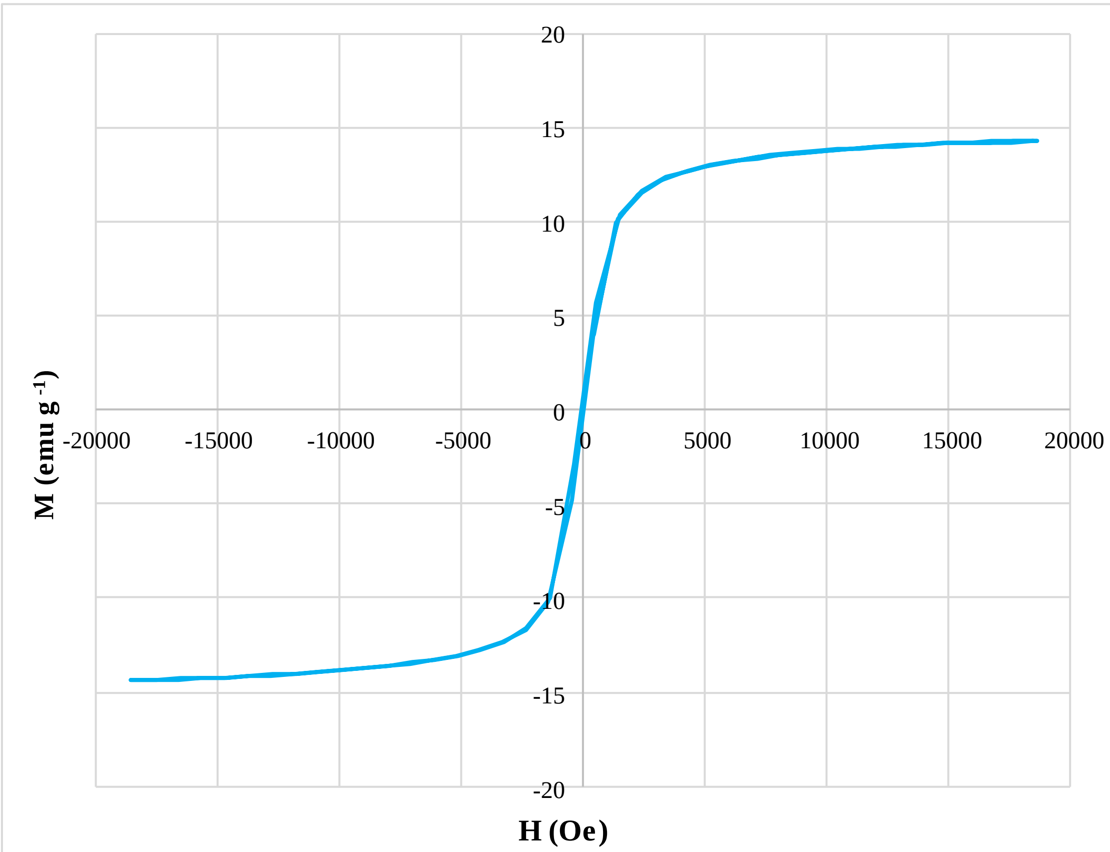

Fig. 4. VSM curve of gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite

Conclusions

In summary, we have prepared and characterized a gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite by a simple method. Various analytical techniques were used to characterize the nanocomposite. SEM images of the nanocomposite was indicated that the sizes of most of the particles were about 30-40 nm and the average size of the nanoparticles was about 38.43 nm. XRD pattern showed that all peaks are in agreement with well-crystallized Fe_3O_4. VSM curve showed, the magnetic property of gelatin/Fe_3O_4/ ethylene glycol hydrocarbon gel nanocomposite is about 14.3 emu g^{-1}.

Acknowledgements

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References

[1] Parak, W. J.; Nel, A. E.; Weiss, P. S. *ACS Nano*. **2015**, 9, 6637.

[2] Tyo, E. C.; Vajda, S. *Nat. Nanotechnol*. **2015**, 10, 577.

[3] Maleki, A.; Movahed, H.; Paydar, R. *RSC Adv*. **2016**, 6, 13657.

[4] Panzavolta, S.; Gioffrè, M.; Bracci, B.; Rubini, K.; Bigi, A. *J. Appl. Polym. Sci.* **2014,** *131*(11).

[5] Ray, S. S.; Okamoto, M. Prog. *Polym. Sci*. **2003**, 28, 1539.

[6] Bergo, P.; Sobral, P. J. A. *Food Hydrocolloids*. **2007**, 21, 1285.

[7] Boanini, E.; Bigi, A. J. *Colloid. Interf. Sci*. **2011**, 362, 594.

[8] Zhuang, L.; Zhang, W.; Zhao, Y.; Shen, H.; Lin, H.; Liang, J. Sci. Rep. **2015**, 5, 9320.