

OF SURFMER OF HIGH MOLECULAR WEIGHT: POLY(ETHYLENE-OXIDE DIACRYLATE). COPOLYMERIZATION WITH ACRYLIC ACID

Reyes-González I¹, Prado-Alonso M², Renteria-Urquiza M³., Cortes J³., .

Flores M.J³, García-Enríquez S³. Jiménez-Amezcu R¹.,

¹) Dpto. de Ingeniería Química, ²) Dpto. de Química, ³) Dpto. de Matemáticas Centro Universitario De Ciencias Exactas E Ingenierías, Jalisco, MEXICO rosamjimenez@hotmail.com

Abstract

A novel type of surfmer of high molecular weight, poly(ethylene-oxide)diacrylate, was copolymerized with acrylic acid, synthesizing a new type of structured copolymer. Redoxpersulfate-bisulfite system was employed in autothermic extended surfacereactor. Comonomers ration and solution water amount were varied and their effects in swelling rate of dried polymer and its maximum water retention were determined. The copolymer was characterized Interest in self-organizing polymer gels has expanded over the past several years as investigators have recognized the ability to develop processing routes that yield materials with very well controlled structures and properties. The crosslinked hydrogels has a well defined structures and exhibit non-usual properties. They are soft, elastic, water insoluble and hydrophilic. These properties able them use in agriculture, medicine(1,2), separation devices, electronic actuators(3), templates for the synthesis the meso and microporous materials(4), and other applications.

Introduction

A novel type of surfmer of high molecular weight, poly(ethylene-oxide diacrylate), was copolymerized with acrylic acid, synthesizing a new type of structured copolymer. Redox persulfate-bisulfite system was employed in autothermic extended surface reactor. Comonomers ratio and solution water amount were varied, and their effects in swelling rate of dried polymer and its maximum water retention were determined. The copolymer was characterized, as well as its morphology was determined by light polarized microscopy. The mechanical properties were measured in a universal test apparatus, for different swelling histories and different

oils and other fluids as modifiers. Also the kinetic swelling by gravimetry was tested. The novel structured copolymer exhibit enhanced rubber properties.

Experimental

The monomer acrylic acid and the initiators, potassium persulfates, K₂S₂O₈ (KPS), and sodium bisulfite, NaHSO₃ (SBR), were 98, 99 y 100% pure, respectively, and were purchased from Aldrich Chemical, Ethylene-oxide diacrylate was purchased from Fluka and used for the synthesis of the crosslinking agent The hydrogels analyzed were synthesized by polymerization with the acrylic acid (6). The thermal history was following during the polymerization. All components except the initiator were mixture at 25 °C, after homogenization, the initiator was added. For some samples the final temperature reaches 100 °C. Next the initiator is added with a strict control of the polymerization temperature to 20 °C.

The swelling kinetics of the xerogels in distilled water were determined by gravimetry. The mesostructure was visualized by Light Polarized Microscopy (LPM) using a contrast media (Light Polarized Microscope BX50-P, with thermostated mechanical stage and photographic reflex 10x).

Results and Discussion

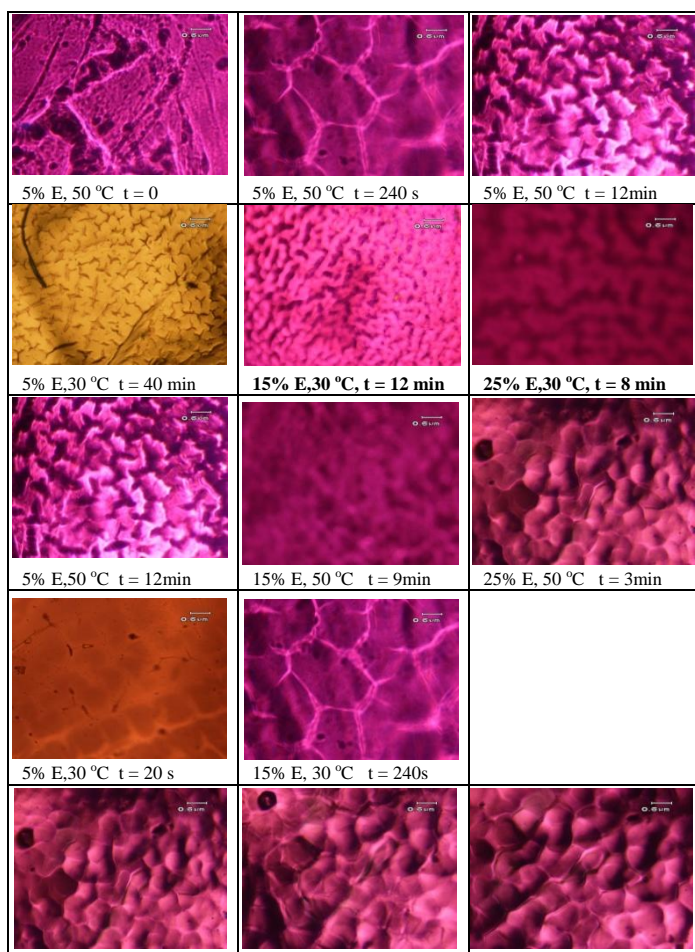
The novel type of surfmer of high molecular weight was polymerized with acrylic acid and the material generated had water trapped inside the polymeric network, the presence of water is mainly due to the aqueous media used for the polymerization reaction. This material did not lose their swelling capacity even after several

TGN

swelling cycles. The mesoscopic structure was visualized by LPM, the xerogels were swollen in 5 wt % glucose aqueous solution, which serves as a contrast media. The mesostructure can be distinguished as well-ordered polymeric domain and observed in the LPM, figure 1.

The mesoscopic domains were hexagonal-like structures, and the size of these domains decreases when increasing the crosslinking agent and temperature reaction. Also, these well-defined domains grow in size with the elapsed time after addition of solution.

The swelling behavior of the hydrogels for different concentration of crosslinking agent is showed in the figure 2, and 3. The graph of figure 2 illustrate the swelling ratio and the maximum swelling of the hydrogels and its linear behavior.



25% E, 50 °C t = 3min 25% E, 50 °C t = 8min 25% E, 50 °C t = 14min

Figure 1. Polarized light micrographs of swollen hydrogels as function of crosslinking agent concentration.

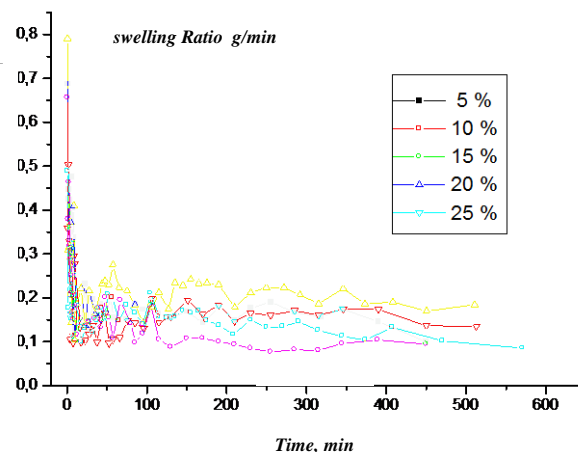


Figure 2. Ratio of swelling as function of crosslinking agent concentration.

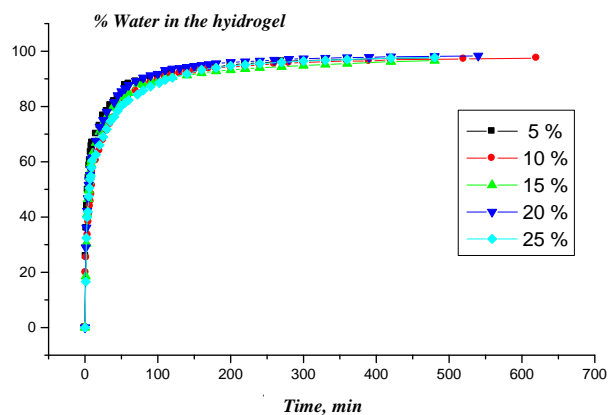


Figure3. % of water in the hydrogel as function of crosslinking agent concentration

Conclusion

We have synthesized acrylic acid hydrogel using a novel crosslinking agent which exhibit different structural characteristics at macroscopic scales. The novel oligomeric, Ethylene-oxide diacrylate, used as crosslinking agent induced the formation of regular structures producing unique materials that could have different applications. A critical concentration of crosslinking agent was determined, which is a reference point to produce a hydrogel with better structure characteristics. The structuration degree depends on temperature during the synthesis and the concentration of crosslinking agent. The synthesis condition affects deeply the equilibrium water intake capacity, swelling kinetic, morphology at macroscopic scale. The structured hydrogels exhibit large swelling capacity.

References

1. Okano, T. *Adv. Polym. Sci.* **1993**, *110*, 180-195.
2. Dong, L. C.; Hoffman, A. S. *J. Controlled Release* **1986**, *4*, 223-226.
3. De Rossi, D.; *et al.*, Eds. *Polymer Gels Fundamental and Biomedical Applications*; Plenum Press: New York, **1991**.
4. Freitas, R. F. S.; Cussler, E. F. *Chem. Eng. Sci.* **1987**, *42*, 97-106.
- 5.- Gehrke, S.K. *Adv. Polym. Sci.* **1993**, *110*, 83-144.
- 6.- H. Shott, *J. Macromol. Sci. Phys.* **1992**, *22*(3) 2-9
- 7.- I. Katime, J.L. Velada, R. Novoa, E. Díaz de Apodaca, J. Puig and E. Mendizábal, *Polym. Int.* **40**, 281 (1996)..
- 8.- Ureta, L.C, et al, *Langmuir* (2004), unpublished.