Preparation and Surface Charge Characterization of Polystyrene Particles and Powders with Carboxyl and/or Poly(ethylene glycol) Groups

Bae Joong Kim[(1)], **Seong Hun Kim**[(1)], **Ki Hong Park**[(2)]
(1) Center for Advanced Functional Polymers, Department of Fiber & Polymer Engineering, Hanyang University, Seoul 133-791, South Korea
(2) Optoelectronics Material Research Center, Korea Institute of Science and Technology, Seoul 136-791, South Korea

Abstract

Cross-linked polystyrene (PS) particles with carboxyl and/or poly(ethylene glycol) units on surface were formed by an emulsifier-free emulsion polymerization using styrene, methacrylic acid (MA), and poly(ethylene glycol) dimethacrylate (PEG-diMMA) at pH 7, and followed by freeze-drying to give the corresponding powders. Monodisperse polymer particles could be obtained at a concentration of PEG-diMMA 1 mol% relative to styrene. Zeta potential of polymer surface was measured to be 91 mV at a polymer of PEG-diMMA 1 mol% and was dropped as the content of MA increased.

Introduction

Emulsifier-free emulsion polymerization has been known to one of useful methods to give monodisperse polymer particles with a diameter of less than 1 ㎛.[1] Latex polymer colloids with submicrometer diameter are important in many areas of technology, such as paint and coatings, ceramics processing, and electrophoretic particles. The stabilization of emulsion can be achieved by enhancement of surface zeta potention and/or steric hindrance on surface.[2] In this study, MA and poly(ethylene glycol) dimethacrylate were used as comonomers. The COOH and PEG groups of comonomers were expected to increase the surface charge of polystyrene particles. In addition, we expected that poly(ethylene glycol) dimethacrylate not only acted as an emulsifier but also acted as a cross-linker.

Experimental

Styrene and MA were distilled under reduced pressure before use. Distilled water was used and HCl or NaOH solution was utilized to adjust the pH in all experiments. PEG-diMMA, divinyl benzene (DVB), and potassium persulfate (KPS) were used without further purification. The structures of PS particles were confirmed by FT-IR spectroscopy, and the particle size and distribution the PS particle was observed by SEM and particle analyzer. Zeta potential of polymer surface was measured in dielectric medium by means of ELS-8000 dynamic light scattering.

Results

Monodisperse polymer particles could be obtained at a concentration of PEG-diMMA 1 mol% relative to styrene. With an increase of PEG-diMMA content over 1 mol%, the monodispersity of the particle size became worse, the particle-shape became more irregular and the particle-surface became more roughened. Stable colloidal polymer solution could be obtained at a concentration of MA 5~10 mol% relative to styrene with PEG-diMMA 1 mol% at pH 7. As the ratio of [MA]/[PEG-diMMA] increased, the shape of the PS particles became seriously irregular with a decrease of their size. Zeta potential of polymer surface was measured to be 91 mV at a polymer of PEG-diMMA 1 mol% and was dropped as the content of MA increased.

Conclusions

PS particles and powders with COOH and/or PEG units on surface were successfully synthesized by emulsifier-free emulsion polymerization using PEG-diMMA and MA at pH 7. The PS powders prepared in this study possessed high zeta potential and high mobility in dielectric medium. We discuss herein what ingredients are responsible for zeta potential of the polymer particles.

References

1. G. Zhang, X. Li, M. Jiang, and C. Wu, Langmuir, **16**, 9205 (2000).
2. D. Y. Lee and J. H. Kim, J. Appl. Polym. Sci., **69**, 543 (1998).