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Formation of Monodispersed Polystyrene Particles by Spontaneous Emulsion Polymerization into Silica Particle Solutions without Surfactants

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Introduction

Polymer particles are often prepared by polymerization in microemulsions and emulsions, in which a monomer droplet is formed in the presence of surfactants. Recently, soap-free polymerization has become popular as a technique for the preparation of mono-dispersed polystyrene (PS) particles with charged surfaces without the surfactants. The emulsions have also been prepared with solid particles instead of regular molecular surfactants, and it is categorized as a surfactant-free emulsion. We report here the polymerization of styrene using a lipophilic initiator in an O/W emulsion stabilized by unmodified mono-dispersed silica particles under static condition without any stirring and surfactant.

Experimental

Styrene in the presence of AIBN was suspended in aqueous solution with 1wt% or less of silica particles (average diameter: 450nm). After the elimination of oxygen, the polymerization reaction was conducted for 24 h at 60℃ statically without mixing the two phase solution consisting of an O/W emulsion (lower phase) and excess styrene phase (Figure1).

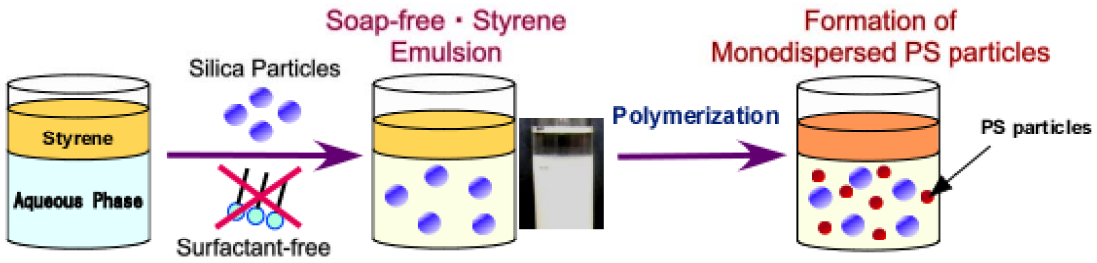

Figure 1. Polymerization scheme of monodispersed PS particles formed in styrene emulsion with silica particles.

Results and Discussions

Surprisingly, monodispersed PS particles with 200nm average diameter newly-formed by polymerization were observed with template silica particles in the solution, a shown in Figure 2. Furthermore, the emulsion consisted on silica and PS particles after polymerization was very stable and no sedimentation was observed even after several weeks, although obvious sedimentation was observed in silica dispersed solution after several days. The PS particles which were prepared by polymerization with non-ionic initiator, AIBN, have no charged units on the surfaces.

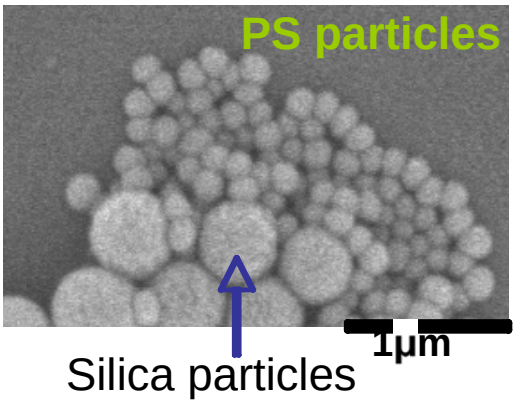

Figure 2. SEM image of PS particles including silica particles in the solution after polymerization.

In the presentation, we will discuss the formation mechanism of mono-dispersed PS particles and the stabilization mechanism of the silica/PS mixed particle solution.

Reference

S. Kawano, S. Nishi, M. Sakata, and M. Kunitake, *Chemistry Letters*, *36*, 6 (**2007**).

Key Words: Soap-free emulsion, monodispersed particles, polystyrene, polymerization