Development of the Spray-type Polymeric Material for Radioactive Contamination Measurement of the Wall

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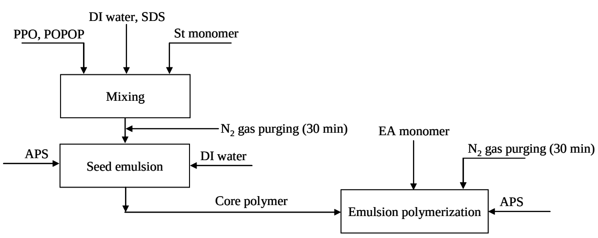
1. Introduction

New approaches to detection, prevention and remediation environmental damage are important for protection of the environment. Procedures must be developed and implemented to reduce the amount of waste produced in chemical processes, to detect the presence and/or concentration of contaminants and decontaminate fouled environments [1]. In this work, the poly(styrene-*co*-ethyl acrylate) [poly(St-*co*-EA)] core-shell composite polymer for measurement of the radioactive contamination was synthesized by the method of emulsion polymerization. Core-shell polymers of organic/organic pair that has two different properties within a particle were prepared. Organic composite systems, in which scintillator particles are disperse into the polymer matrix, are new classes of radiation detection materials.

2. Methods and Results

2.1 Emulsion Polymerization

The morphology of the poly(St-*co*-EA) composite emulsion particle was core-shell structure, with polystyrene (PS) as the core and poly(ethyl acrylate) (PEA) as the shell. Core-shell polymers of styrene (St)/ethyl acrylate (EA) pair were prepared by sequential emulsion polymerization in the presence of sodium dodecyl sulfate (SDS) as an emulsifier using ammonium persulfate (APS) as an initiator. The polymer was made by impregnating organic scintillators, 2,5-diphenyloxazole (PPO) and 1,4-bis[5-phenyl-2-oxazol]benzene (POPOP). Related tests and analysis confirmed the success in synthesis of composite polymer. Preparation method was given in Scheme 1.



Scheme. 1 Two-step polymerization method for emulsion preparation

2.2 Measurements

The core-shell polymeric emulsion for measurement of the radioactive contamination was prepared using emulsion polymerization. Fourier Transform Infrared Spectroscopy (FTIR), Differential Scanning Calorimetry (DSC), Thermogravimetry Analysis (TGA), Transmission Electron Microscopy (TEM) were employed to investigate the structures and properties of the composite polymers. Also the radiation detection ability of the polymeric emulsion was evaluated with the organic scintillator contents.

2.3 Morphology and Particle Size of Emulsion

In our seeded emulsion polymerization system, such as the polymerization of ethyl acrylate with PS latex particles as seeds and $(NH_4)_2S_2O_8$ as the initiator, the PS polymer chains were initiated by $NH_4S_2O_8$; and the functional group (SO^-_4) at the end of polymer chains were hydrophilic, but the polymer chains were hydrophobic. So the hydrophilic group SO^-_4 would anchor on the surface of polymer particles, and the reaction loci were on the surface layer.

The morphology of the poly(St-*co*-EA) composite polymer synthesized by the method of emulsion polymerization. From the transmission electron micrograph in Fig. 1, it can be seen that core-shell structure was successfully formed in the composite particle. Core-shell materials consist of a core structural domain covered by a shell domain. Clearly, the entire surface of PS core was covered by PEA. The inner region was a PS core and the outer region was a PEA shell.

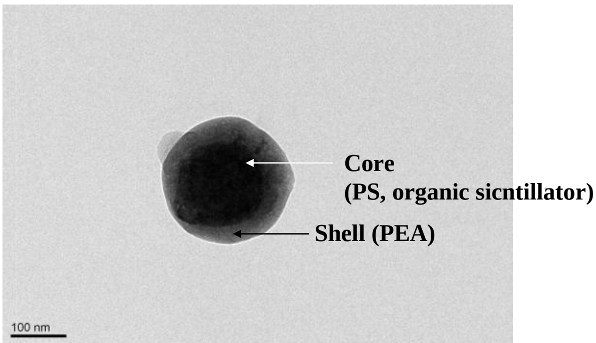


Fig. 1 TEM image of poly(St-*co*-EA) polymer emulsion particle

Fig. 2 illustrates the particles size of the poly(St-*co*-EA) polymer emulsions with various weight ratios of styrene. The average particle size distribution showed similar in the range 350-360 nm.

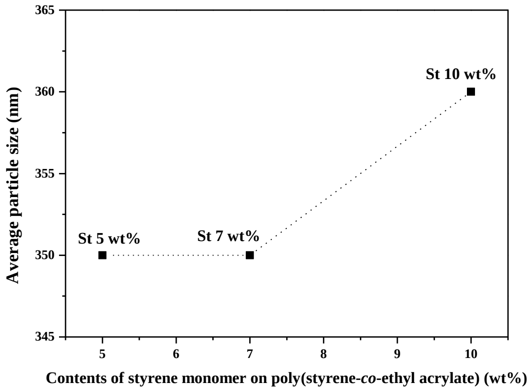


Fig. 2 Average particle size of poly(St-*co*-EA) emulsions with various weight ratios of styrene

3. Conclusions

In this paper, the composite polymer to detect radioactive contamination from large surfaces was prepared by using emulsion polymerization. The core-shell structure was confirmed by glass-transition temperature analysis and particles morphology. The poly(St-*co*-EA) polymer had two different glass-transition temperature. The chemical transformations of poly(St-*co*-EA) polymer were monitored by absorption spectroscopy (FT-IR). The scintillation properties were evaluated by pulse height of the copolymer emulsions. The detectable capacity of poly(St-*co*-EA) composite polymer emulsion showed a good performance for radioactivity.

REFERENCES

1. H. Neil Gray, Betty Jorgensen, Donald L. McClaugherty and Andrew Kippenberger, Smart Polymeric Coatings for Surface Decontamination, *Ind. Eng. Chem. Res*. 2001, 40, 3540-3546.