World Applied Sciences Journal 3 (1): 14-17, 2008
ISSN 1818-4952

Nanoparticles Preparation of Pyrrole and Styrene Copolymer in Aqueous Media

Hossein Eisazadeh

Faculty of Chemical Engineering, University of Mazandaran, P.O. Box 484, Babol, Iran

Abstract: Polypyrrole/Polystyrene (PPy/PS) copolymer was prepared in the aqueous solution using $FeCl_3$ and $(NH_4)_2S_2O_8$ as an oxidant in the presence of various surfactants such as sodium dodecylbenzenesulfonate and hydroxypropylcellulose. In this study, the PPy/PS copolymer was characterized in terms of conductivity, and morphology. The results indicate that the morphology, conductivity, yield, size and homogeneity of particles are dependent on the type of surfactants.

Key words: Copolymer · surfactant · morphology · conductivity

INTRODUCTION

Polymers are generally used in a wide range of applications often for their low cost, light weight and mechanical properties, or for the three characteristics combined. One of the main characteristics required for electrical and or/optical activities to occur in a polymer is a conjugated backbone which can be subject to oxidation or reduction by electron acceptors or donors. Due to delocalization of the λ electrons in conjugated polymers, chain rigidity is very often a predominant property and, as a result of this, an aggregated character of the chains is typical in such material. This results in intractability which has been one of the drawbacks in the field.

During the last decade there has been widespread interest in conducting polymers both for academic purposes and for potential applications. The insolubility in common solvents and infusibility of conducting polymers, in general, make them poorly processable either by solution technique or by melt processing methods [1, 2]. Improvement of these material properties can be achieved either by forming copolymers, or by forming conductive polymeric composites or blends with commercially available polymers or inorganic materials which offer better mechanical and optical properties, stability and processability [3-6].

From the beginning, interest in conducting polymers has it origins in the possible commercial applications of these materials. Foremost among the current commercial ventures are applications of conducting polymers in energy storage devices such as rechargeable batteries [7], conductive paint [8], removal of heavy metals [9, 10], electromagnetic interference (EMI) shieding [11], and biomedical applications [12], etc. In this study, Polypyrrole/Polystyrene copolymer was prepared in the aqueous solution using various surfactants

MATERIALS AND METHODS

Instrumentation: A magnetic mixer model MK20, digital scale model FR 200, scanning electron microscope (SEM) model XL30 were employed. The four point probe method was used to measure the volume resistivity of conducting polymer films.

Reagents and Standard Solutions: Materials used in this work were pyrrole and hydroxypropylcellulose (HPC, $M_w=10^6$) from Aldrich, sodium dodecylbenzenesulfonate (DBSNa) from Loba chemie, styrene, ferric chloride and ammonium peroxodisulfate from Merck. All reagents were used as received without further purification, unless stated otherwise. Distilled deionized water was used throughout this work. Pyrrole was purified by simple distillation.

Ppy/PS Copolymer Preparation: The reaction was carried out in an aqueous media at room temperature for 4 h. The optimal conditions for copolymer formation are summarized in Table 1.

In a typical experiment, 1 mL pyrrole monomer was added to a stirred aqueous solution of 100 mL containing 4.8 g of $FeCl_3$, 5 g of $(NH_4)_2S_2O_8$ and 0.1 g one of the surfactants respectively. After few minutes, 1 mL styrene monomer was added to stirred aqueous solution. After

Corresponding Author: Dr. Hossein Eisazadeh, Faculty of Chemical Engineering, University of Mazandaran, P.O. Box 484, Babol, Iran

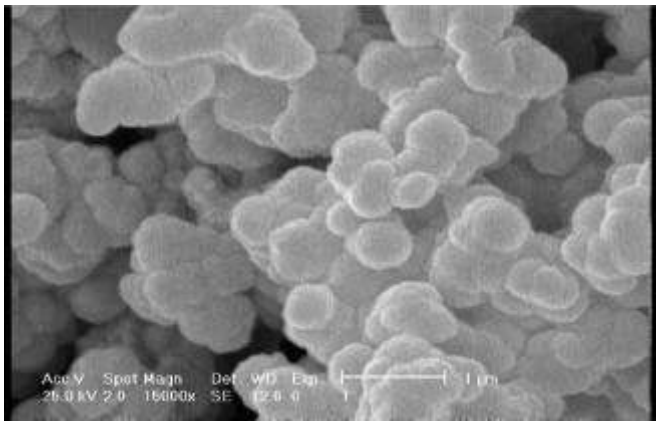

Fig. 1: Scanning electron micrograph of pure PPy. Reaction conditions: ($FeCl_3$=48 g L^{-1}, pyrrole monomer 14.4×10^{-2} mol L^{-1}, volume of solution 100 mL, reaction time 4 hours at room temperature)

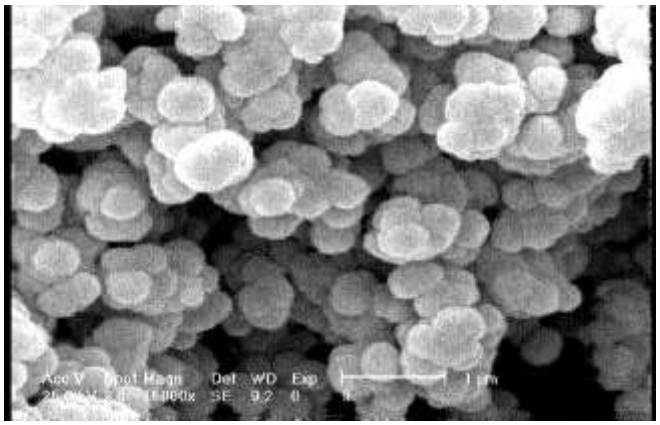

Fig. 2: Scanning electron micrograph of PPy/PS copolymer. Reaction conditions: ($FeCl_3$=48 g L^{-1}, $(NH_4)_2S_2O_8$=50 g L^{-1}, pyrrole monomer 14.4×10^{-2} mol L^{-1}, styrene monomer 8.7×10^{-2} mol L^{-1}, volume of solution 100 mL, reaction time 4 hours at room temperature)

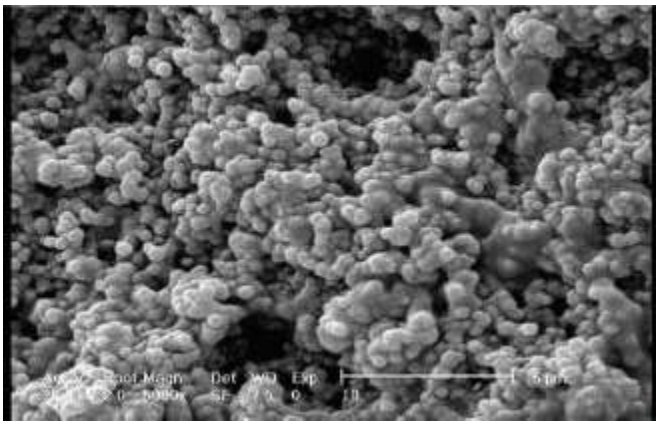

Fig. 3: Scanning electron micrograph of PPy/PS copolymer. Reaction conditions: ($FeCl_3$=48 g L^{-1}, $(NH_4)_2S_2O_8$=50 g L^{-1}, pyrrole monomer 14.4×10^{-2} mol L^{-1}, styrene monomer 8.7×10^{-2} mol L^{-1}, hydroxypropylcellulose=1 g L^{-1}, volume of solution 100 mL, reaction time 4 hours at room temperature)

Table 1: Effect of surfactant types on the conductivity and yield of PPy/PS copolymer

Type of surfactant	Type of oxidant	Concentration of surfactant (g L^{-1})	Ppy/PS yield (%)	Electrical conductivity (S cm^{-1})
Sodium dodecylbenzenesulfonate	$FeCl_3$+$(NH_4)_2S_2O_8$	1	83	0.053
hydroxypropylcellulose	$FeCl_3$+$(NH_4)_2S_2O_8$	1	80	0.042
-	$FeCl_3$+$(NH_4)_2S_2O_8$	-	76	0.074

4 h, Polymer was filtered, and to separate the oligomers and impurities, product was washed several times with deionized water and dried in room temperature.

RESULTS AND DISCUSSION

The electrical conductivities of various copolymers produced under different reaction conditions were measured on pressed pellets of the composite powders. The average thickness of the compressed pellets was 250 μm.

The yield and electrical conductivity of copolymers using various surfactants are listed in Table 1. As can be seen the yield and electrical conductivity are dependent on the type of surfactant, because the surfactants are adsorbed physically by the growing polymer [13]. HPC is polymeric surfactant and influences the viscosity and physical properties of solution, but DBSNa is ionic surfactant, acts as dopant and emulsifier.

The morphology of copolymers was studied, using scanning electron microscope. As shown in Figs. 1-3, the size and homogeneity of particles are dependent on the type of surfactant and resultant products. The interaction between surfactant and polymer or copolymer affects the electrical conductivity and morphology [14, 15]. The micrographs of PPy/PS copolymer are shown in Figs. 2 & 3. As can be seen in figures the copolymer obtained using HPC exhibit homogeneous spherical nanoparticles.

CONCLUSIONS

In this work the characteristics of PPy/PS copolymers such as conductivity, yield, and morphology were investigated using various surfactants. It was found that, the type of surfactant has a considerable effect on the conductivity and morphology of resultant product which is probably due to the physical adsorption of surfactant to the polymers or copolymers. The SEM micrographs show that the type of surface active agent plays a major role on the surface morphology, homogeneity and particle size of products.

REFERENCES

1. Yin, W., J. Li, Y. Li, J. Wu and T. Gu, 2001. Conducting composite film based on polypyrrole and crossliked cellulose. J. Appl. Polym. Sci., 80(9): 1368-1373.
2. Machado, J.M., F.E. Karasz and R.W. Lenz, 1988. Electrically conducting polymer blends. Polymer, 29(8): 1412-1417.
3. Paoli, M.A.D., R.J. Waltman, A.F. Diaz and J. Bargon, 1984. Conductive composites from poly(vinyl chloride) and polypyrrole. J. chem .Soc. Chem. Commun., 15: 1015-1016.
4. Lindsey, S.E. and G.B. Street, 1984/85. Conductive composites from poly(vinyl alcohol) and polypyrrole. Synth. Met., 10(1): 67-69.
5. Cassignol, C., M. Cavarero, A. Boudet and A. Ricard, 1999. Microstructure conductivity relationship in conducting polypyrrole/epoxy composites. Polymer, 40(5): 1139-1151.
6. Bhat, N.V., A.P. Gadre and V.A. Bambole, 2001. Structural and electrical properties of electropolymerized polypyrrole composite film. J. Appl. Polym. Sci., 80(13): 2511-2517.
7. Scrosati, B., 1998. Conducting polymers: advanced materials for new design: rechargeable lithium batteries. Polym. Inter., 47: 50-55.
8. Eisazadeh, H., G. Spinks and G.G. Wallace, 1993. Conductive electroactive paint containing polypyrrole colloids. Mater. Forum, 17: 241-245.
9. Eisazadeh, H., 2007. Removal of chromium from waste water using polyaniline. Journal of Applied Polymers, 104(3): 1964-1967.
10. Eisazadeh, H., 2007. Removal of mercury from water using polypyrrole and its composites. Chinese Journal of Polymer Science, 25(4): 393-397.
11. Dhawan, S.K., N. Singh and S. Venkatachalam, 2002. Shielding effectiveness of conducting polyaniline coated fabrics at 101 GHz. Synth. Met., 125: 389-393.
12. Benabderrahmane, S., S. Bousalem, C. Mangeney, A. Azioune, M.J. Vaulay and M.M. Chehimi, 2005. Interfacial physicochemical properties of functionalized conducting polypyrrole particles. Polymer, 46: 1339-1346.

13. Aldissi, M. and S.P. Armes, 1991. Colloidal dispersion of conducting polymers. Prog. Org. Coat., 19(1): 21-58.
14. Ruckenstein, E. and Y. Yuan, 1998. Colloidal scale blends of poly(p-benzamide) with sulfonated polystyrene and poly(vinyl acetate. Polymer, 39(5): 1043-1049.
15. Goh, S.H., H.S.O. Chan and C.H. Ong, 1996. Miscibility of polyaniline/poly(vinyl acetate) blends. Polymer, 37(13): 2675-2679.