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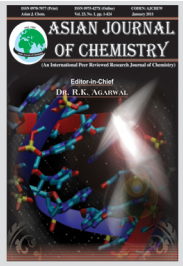

Synthesis of Polypyrrole Nanocomposites Using Sodium Dodecylbenzenesulfonate and Poly(vinyl alcohol)

MOJTABA MOKHTARIFAR[1], MOHAMMAD SADEGH NABIZADEH[1] and HOSSEIN EISAZADEH[2,*]

[1]Islamic Azad University, Shahrood Branch, Shahrood, Iran
[2]Faculty of Chemical Engineering, Babol University of Technology, P.O. Box 484, Babol, Iran

*Corresponding author: Fax: +98 1113234201; E-mail: eisazadeh@hotmail.com

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In this study, polypyrrole nanocomposites were prepared in the aqueous and aqueous\non-aqueous media by using ferric chloride as an oxidant in presence of various surfactants such as sodium dodecylbenzenesulfonate and poly(vinyl alcohol). Morphology, particle size, yield and chemical structure of the product were characterized by using scanning electron micrograph and fourier transform infrared. The results indicate that the morphology, yield and particle size of products are dependent on the type of surfactant. The results also show that the intensity of peaks is dependent on the type of surfactant.

Key Words: Nanocomposite, Surfactant, Chemical structure, Morphology.

INTRODUCTION

Conducting polymers possess good tunable electrical conductivity and are organic electrochromic materials with chemically active surface[1-3]. But they are chemically sensitive and have poor mechanical properties and processibility. The properties of nanocomposite are strongly dependent on concentration of polymer[4,5]. The importance of conducting polymers because of their applications, in the areas of rechargeable batteries[6-9], electrochromic displays[10,11] and as chemical sensors[12-15], is well known. Polypyrrole is a semiconducting polymer that has proven to be relatively highly conductive, easy to synthesize and environmentally stable[16,17]. Polypyrrole can be prepared by plasma and vapour phase polymerization techniques. In applications like coating dielectric materials, the most suitable process is the *in situ* chemical polymerization, because it provides relatively high conductivity as well as suitable thickness and uniformity of the film[17]. Moreover, polypyrrole have been paid more attention due to their potential application values in microelectronics, microsystems, optical sensors and photoelectronic chemistry[18-20]. Most of the optical, electrical and morphologic properties of the polypyrrole depend on the synthesis procedure as well as on the dopant nature[21].

In this study, polypyrrole nanocomposites were prepared in the aqueous and aqueous\non-aqueous media in presence of sodium dodecylbenzenesulfonate and poly(vinyl alcohol), by using ferric chloride as an oxidant.

EXPERIMENTAL

A magnetic mixer model MK20, digital scale model FR 200, scanning electron microscope (SEM) model XL30 and fourier transform infrared (FTIR) spectrometer model Shimadzu 4100 were employed.

Materials used in this work were pyrrole (d = 0.97 g/mL), ferric chloride and poly(vinyl alcohol) (PVA, M_w = 72000) from Merck, sodium dodecylbenzenesulfonate (DBSNa) from Loba chemie. 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.

Preparation of polypyrrole nanocomposite: The reaction was carried out in aqueous media at room temperature for 5 h. The conditions for nanocompoeite formation are summarized in Table-1.

In a typical experiment (1 mL) pyrrole monomer was added to stirred aqueous solution (100 mL) containing 5.4 g of $FeCl_3$. After 5 h, the polymer was filtered and in order to separate the oligomers and impurities, the product was washed several times with deionized water. It was then dried at temperature about 60 ºC in oven for 24 h.

RESULTS AND DISCUSSION

It is well established that the charge transport properties of conjugated polymers strongly depend on the processing parameters. The yield and particle size and electrical conduc-

TABLE-1
PREPARATION CONDITIONS AND TYPE OF SOLUTIONS ON THE PARTICLE SIZE AND YIELD OF PRODUCTS

Type of solution	Type of surfactant	Concentration of surfactant (g/L)	Yield of 1 g monomer to polymer (g)	Particle size (nm)
Water	–	–	88	117
Water	Dodecylbenzenesulfonate sodium	2	85	95
Water	Poly(vinyl alcohol)	2	82	97
Water + Toluene (50/50 % v/v)	–	–	77	98
Water + Toluene (50/50 % v/v)	Dodecylbenzenesulfonate sodium	2	75	85
Water + Toluene (50/50 % v/v)	Poly(vinyl alcohol)	2	73	87

tivity of nanocomposites using various surfactants are listed in Table-1.

The morphology of nanocomposites was studied, using scanning electron microscope. As shown in Figs. 1-6, the size and homogeneity of particles are dependent on the type of surfactant. Polypyrrole particles synthesized without surfactant is shown in Fig. 1. As can be seen in micrographs, the composite obtained using surfactants (DBSNa and PVA) exhibits spherical particles. It is apparent that using surfactant decreases the tendency to form agglomerates which leads to more homogeneous distribution, because surfactant prevent from gross aggregation of particles. As can see been in table, particle size decreases using various surfactants. Also the size of particles related to the type of surfactant.

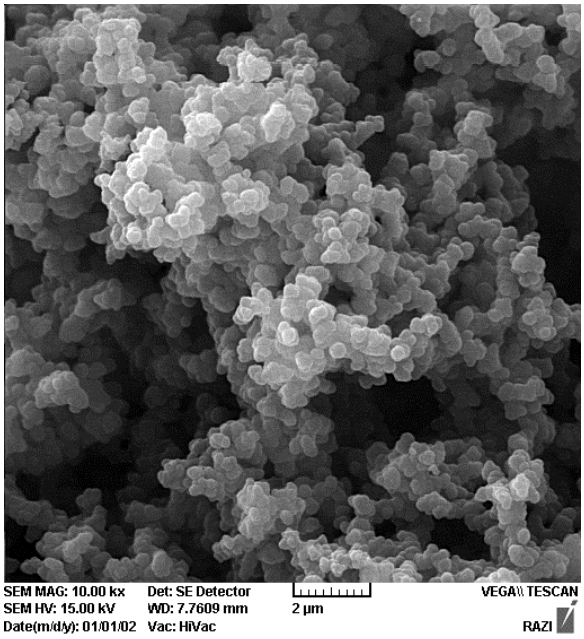

Fig. 1. Scanning electron micrograph of polypyrrole in aqueous media. Reaction conditions: (ferric chloride = 54 g/L, pyrrole monomer 14.45×10^{-2} mol/L, volume of solution 100 mL, reaction time 5 h at room temperature)

The FTIR spectrum changes when the composite is obtained by using various surfactants. The characteristic peak of the pyrrole unit is obtained at 1540 cm^{-1}. The peaks are at 1308 cm^{-1} (C-N stretching vibration), 1164 cm^{-1} (C-H in-plane deformation), 902 cm^{-1} (C-H out-of-plane deformation) and 790 cm^{-1} (C-H out-of-plane ring deformation).

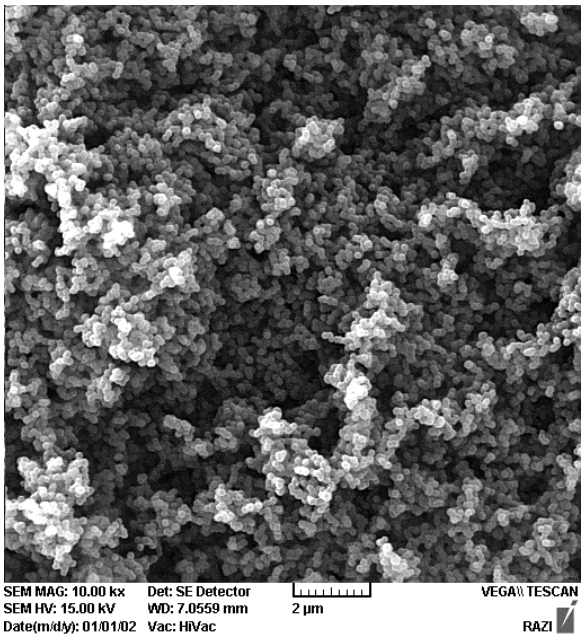

Fig. 2. Scanning electron micrograph of polypyrrole in aqueous media. Reaction conditions: (ferric chloride = 54 g/L, pyrrole monomer 14.45×10^{-2} mol/L, sodium dodecylbenzenesulfonate = 2 g/L, volume of solution 100 mL, reaction time 5 h at room temperature)

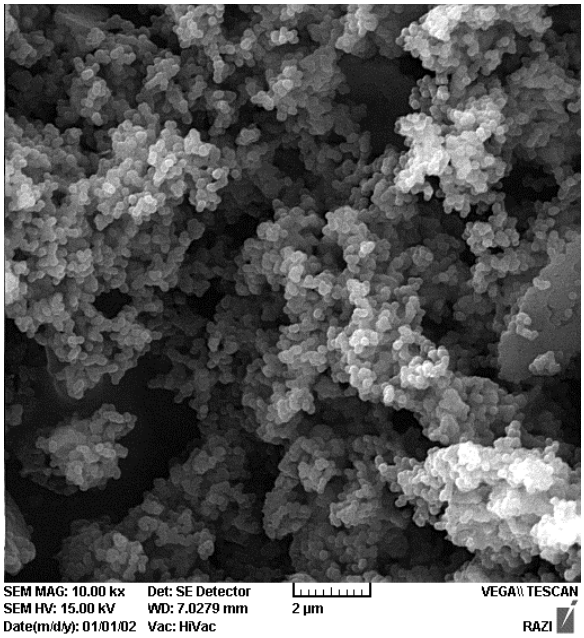

Fig. 3. Scanning electron micrograph of polypyrrole in aqueous media. Reaction conditions: (ferric chloride = 54 g/L, pyrrole monomer 14.45×10^{-2} mol/L, poly(vinyl alcohol) = 2 g/L, volume of solution 100 mL, reaction time 5 h at room temperature)

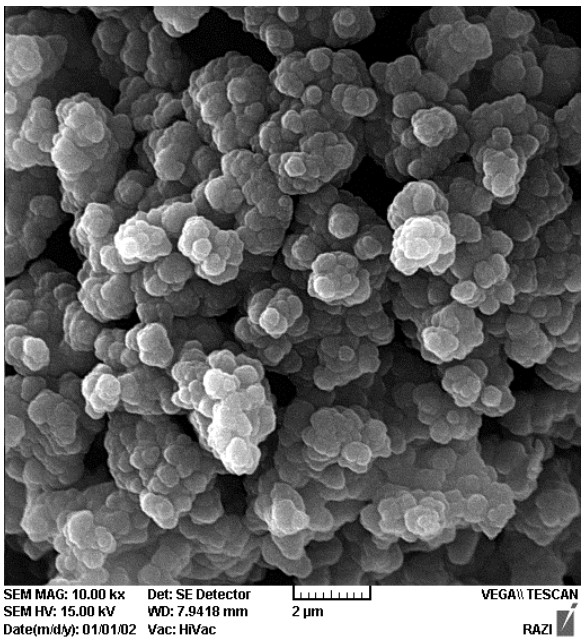

Fig. 4. Scanning electron micrograph of polypyrrole in aqueous/non-aqueous (water/toluene) media. Reaction conditions: (ferric chloride = 54 g/L, pyrrole monomer 14.45 × 10^{-2} mol/L, volume of solution 100 mL (50/50 % v/v), reaction time 5 h at room temperature)

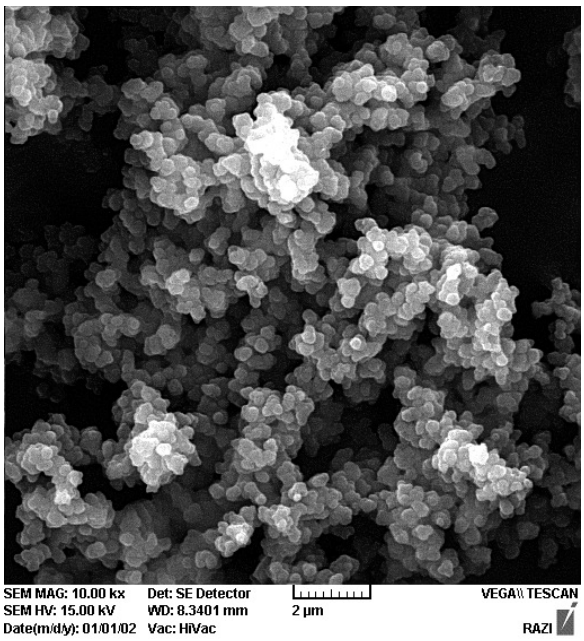

Fig. 5. Scanning electron micrograph of polypyrrole in aqueous/non-aqueous (water/toluene) media. Reaction conditions: (ferric chloride = 54 g/L, pyrrole monomer 14.45 × 10^{-2} mol/L, sodium dodecylbenzenesulfonate = 2 g/L, volume of solution 100 mL (50/50 % v/v), reaction time 5 h at room temperature)

Conclusion

In this work, the characteristics of polypyrrole nanocomposites such as morphology, chemical structure and particle size were investigated using various surfactants. It was found that, the type of surfactant has considerable effect on the conductivity, size, homogeneity, size distribution and morphology of resultant product which is probably due to additive

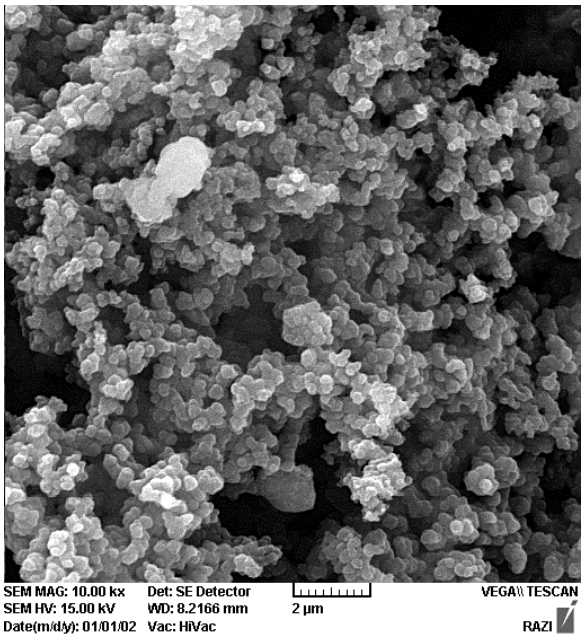

Fig. 6. Scanning electron micrograph of polypyrrole in aqueous/non-aqueous (water/toluene) media. Reaction conditions: (ferric chloride = 54 g/L, pyrrole monomer 14.45 × 10^{-2} mol/L, poly(vinyl alcohol) = 2 g/L, volume of solution 100 mL (50/50 % v/v), reaction time 5 h at room temperature)

absorption. Spherical nanoparticles were obtained using DBSNa and PVA as surfactant. The structure of products was determined by FTIR spectrum. The results indicate that the intensity of peaks related to the type of surfactant.

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