



Preparation and Characterization of Polyacrylamide – Silver Nanocomposite

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Abstract

The preparation of polyacrylamide (PAAM)/silver (Ag) nanocomposites, transmission electron microscopy (TEM), X-ray powder diffraction (XRD), and vibrational structure were studied in this work. TEM results showed that the Ag particles were in sphere shape with 12 nm and 13 nm diameter. The X-ray diffraction results showed that, silver nanoparticles are present in the prepared nanocomposites 10 nm and 11 nm. The vibrational modes were analyzed by FTIR spectroscopy.

Keywords: PAAM; Ag; nanocomposites, TEM; XRD and FTIR

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1. Introduction

The inorganic–organic nanocomposites, mixed at molecular level or near molecular level, have attracted much attention due to their large potential applications in the field of optics, electrics, mechanics, and Photoconductors [1-4]. In view of the increasing importance, the structure and conformation of polyacrylamide (PAAM) have received considerable attention in the recent literature. Vibrational spectroscopy is potentially useful tool for structural analysis and deriving conformational variations. There are several discrepancies in the assignments proposed for polyacrylamide. In this article, PAAM/Ag nanocomposite was Prepared. The particle and crystal size were studied from X-ray diffraction (XRD) and transmission electron microscope (TEM). The Fourier transform infrared (FTIR) spectra were discussed.

2. Experimental

Polyacrylamide (PAAm) and silver nitrate (AgNO_3) were supplied by Sigma-Aldrich. Deionized water was used in all experimental procedures through the experiment. Polymer solution was prepared by adding 4 g PAAm into 40ml deionized water and stirring at room temperature until a viscous transparent solution was obtained. PAAM/Ag nanocomposite was prepared as follows. 20 ml PAAm solution was placed into flask and (0.8 -1.2) g of AgNO_3 solution was slowly added under stirring to PAAm solution. The mixture was stirred for 2 h to obtain a transparent solution. The resulting PAAM/ AgNO_3 mixture solution was cast onto clean glass plates. After the solvent evaporation, a thin film containing PAAm-Ag nanocrystals was obtained and the excess of soluble salts were removable from the surfaces of the films by washing the films using deionized water before characterization. Then the film heated in an oven at 100°C for 7 h. Finally, the film held in a vacuum dryer. The microstructures and the particle distribution were investigated by TEM (Zeiss EM 10) operating at 100 kV. The PAAM/Ag was prepared by making a suspension from the film in deionized water. Then a drop of the suspension was put into the carbon grid and left to dry at 100°C . XRD pattern was measured using (A Philips PW 1370) X-ray diffractometer operating at 35 kV and 15 mA, using a monochromatic Ni-filter, Co radiation ($\lambda = 0.1789$ nm), a scanning rate of ($2\theta^\circ/\text{min}$), and a range of $4 \leq \theta^\circ \leq 90$. FTIR-FT Raman Spectrometer (Nicolet USA) laser source 0–2 W, exposure power 0.6W were used for measuring the absorption spectra in the region; ($4000\text{--}200\text{ cm}^{-1}$) for the PAAM/Ag film.

3. Results and discussion

The XRD spectra of PAAM/Ag nanoparticles are shown in Fig (1). From this figure , it can be seen that the diffraction peaks at 2θ values of 38.14 , 43.66 , 64.15 and 77.5 corresponding to (111) , (200) , (220) and (310) crystal planes , for the two concentrations 0.8 and 1.2 (w/w) . This peaks agree with crystalline silver NPS (JCDPS , card no 04 – 0783) [5]. The particle size was calculated from scherer equation [6].

$$D = k\lambda / \beta \cos\theta$$

where β full width at half maximum of the peak k is the so-called shape factor which usually takes a value of about 0.9 , and θ is the angle obtained from 2θ value corresponding to maximum intensity peak in XRD pattern. From the equation, the calculated values of particle size 10 nm and 11 nm. The average nanocrystal diameter is significantly increased. This is due to growth of the Ag nanoparticles.

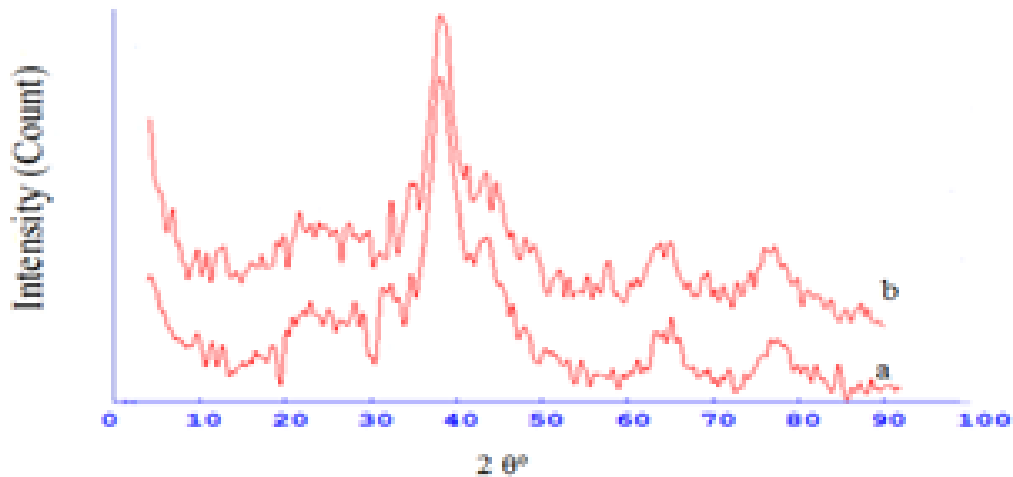


Fig. 1: X-Ray Diffraction Pattern of PAAM/Ag Nanocomposite at different amount of AgNO_3 (a) 0.8 Wt% (b) 1.2 Wt%

The size and morphology of silver nanoparticles formed on PAAM were determined through TEM imaging. Figure (2) represents images of micrographs for PAAM- Ag nanoparticles using 0.8 (w/w). Generally, from this figure it is clear that, a homogeneous distribution of the particles over a wide range of the sample was observed and it made up of small spheres or faceted particles. The value of particle size from TEM is equal to 12 nm which comparable to XRD calculations. The difference between the crystal size which calculated from XRD and particle size from TEM may be due to the change of aggregation of the crystal and smaller particles such that, the data of XRD were reflected the size of the crystal while the data of TEM was obtained the aggregation of the particle.

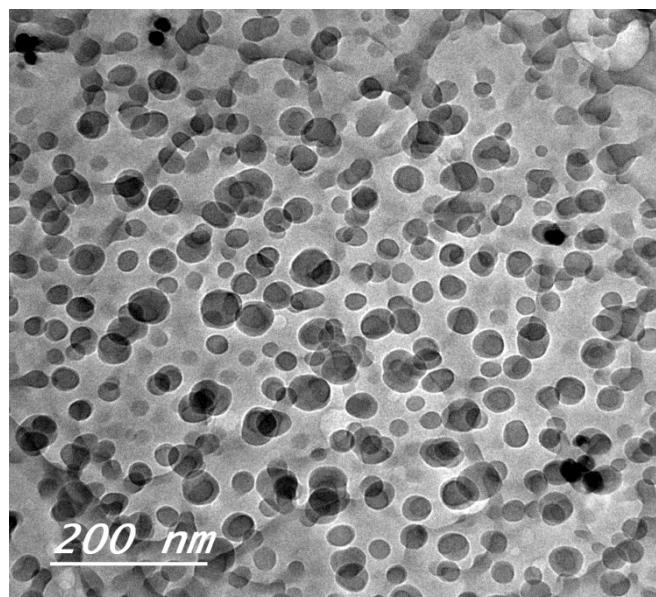


Figure 2. TEM image of Ag particle size distribution of PAAM/Ag nanocomposite

Figure (3) shows the infrared spectra of PAAM and PAAM with Ag nanoparticles. The concentration of Ag in the PAAM is 0.8 and 1.2 (w/w). The IR spectra of these samples have been studied as thin films. By correlating, the IR spectra of PAAM-Ag films with that of the pure (PAAM), its clear to observe that, a pair of fairly intense N-H stretching bands appeared at about 3200 cm^{-1} in the (PAAM) spectrum. This band due to the asymmetrical stretching vibration is broader. These bands were appeared at 3197 cm^{-1} in sample PAAM+0.8 Ag, also appeared at 3195 cm^{-1} in sample PAAM+1.2 It can be also noted that C=O stretching vibration shifted to lower wavenumber in the PAAM+Ag spectra than that of the pure PAAM spectrum. The C=O stretching (amide I) vibrations occurs at 1692 cm^{-1} in the infrared spectrum of pure PAAM, the corresponding band in



PAAM + 0.8 Ag is at 1608 cm^{-1} and in PAAM+1.2 Ag it is observed at 1604 cm^{-1} . These mentioned observations confirm presence of silver nanoparticles in the PAAM film (7).

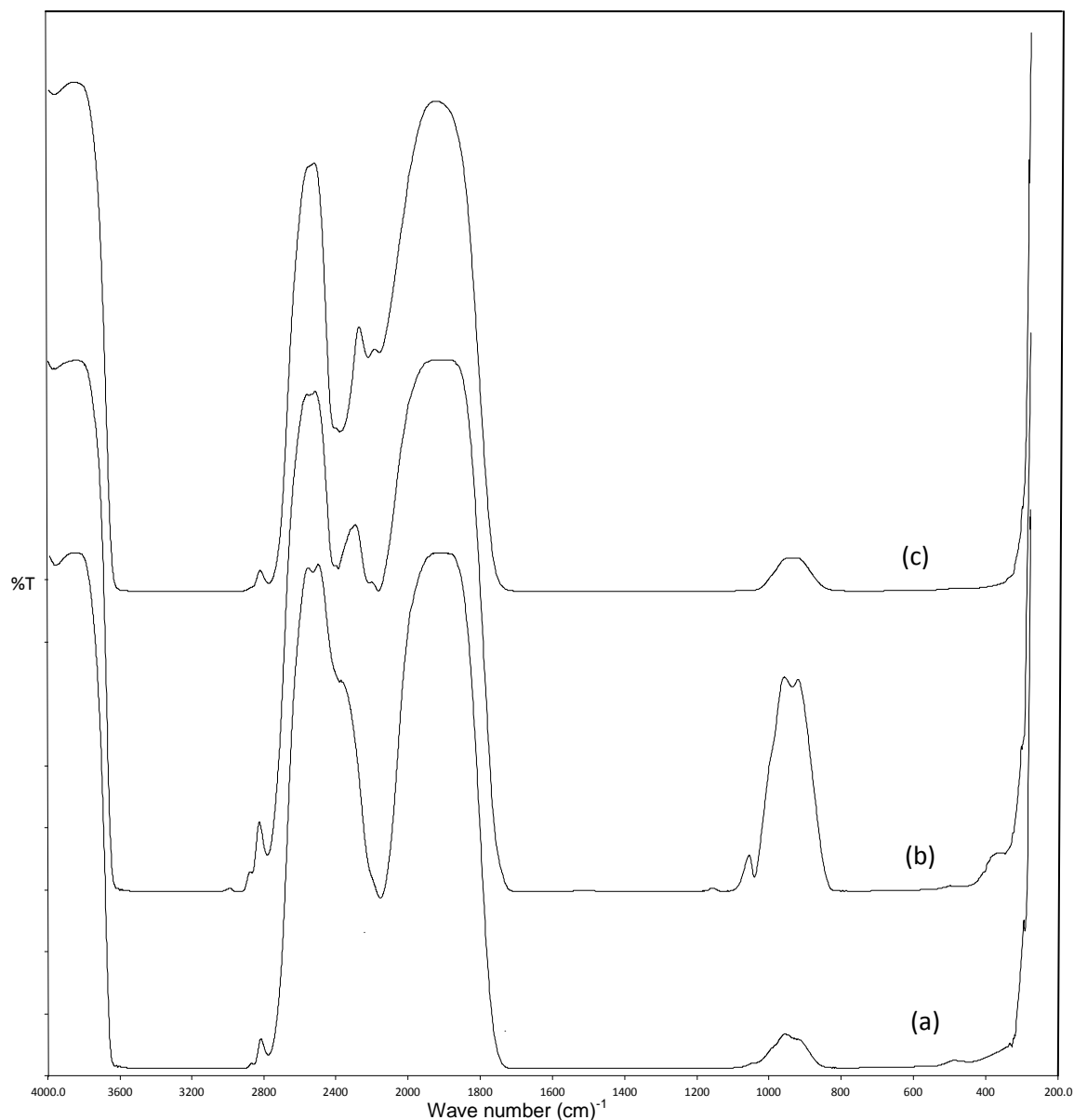


Fig. (3) Infrared spectra of polyacrylamide (a) and polyacrylamide with Ag nanoparticles (b) 0.8 Ag (c) 1.2 Ag

Conclusions

PAAM/Ag nanocomposites has been prepared by heat method. X-ray powder diffraction indicates the formation of PAAM/Ag nanocomposites. The particle size increases by increasing the concentration of Ag. The shift to lower wavenumber of C=O absorption bands indicated to the chemical coordination between Ag with PAAM.

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