JOURNAL OF KUFA–PHYSICS
www.uokufa.edu.iq/journals/index.php/jkp | ISSN: 2077–5830

The Effect of Addition Silver Nanoparticles (AgNPs) onThe Rheological and Optical Properties of Polymer Solution of Poly (Vinylpyrrolidone) (PVP) Prepared in Different Solvents

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KEYWORDS:

- poly(vinylpyrrolidone)
- silver nanoparticles
- rheological and optical Properties

ABSTRACT

In this research foursamples of polymer solution of (PVP)dissolved in distilled Water (DW) and ethanol with concentrations (0.004 PVP and 0.008PVP)(mol/L) were prepared .Rheological and optical properties were studied, whereobservedin rheologicalproperties the viscosity of polymer solution of PVP increased with increasing the concentrations of polymer solution of PVP. Also the density of PVP/DW was large than the density of PVP/ethanol.In optical properties the absorbance spectra increased with the increasing the concentrations of PVP polymer solution.Fourier Transform Infrared spectroscopy (FTIR)showed the bondswhich represents the formula structural of PVP. Silver nanoparticles(AgNPs) of polymer solution of PVPwere added with concentrations (0.1,0.2 and 0.3) wt%,in rheological properties observed the viscosity in PVP/DWwas less than in case of PVP/ethanol, where this difference in viscosity value because the viscosity was depending on the attraction between the particles and on the shape and their size. In optical propertiesit was notedthe appearance peak of absorption spectra at 419nm. Fourier Transform Infrared spectroscopy (FTIR) showed that adding AgNPs of polymer solution of PVP shifted the peaks of bonds in PVP polymer.

DOI: http://dx.doi.org/10.31257/2018/JKP/100211

تأثير إضافة جسيمات الفضة النانوية على الصفات البصرية والريولوجية لمحلول البوليمر PVP المحضر في مذيبات مختلفة

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الكلمات المفتاحية:

- بوليفينيلبيروليدون
- جسيمات الفضة النانوية
- الصفات الريولوجية والبصرية

الـــخُـــلاصـــة

في هذا البحث تم تحضير اربع نماذج من محلول البوليمر PVP المذاب في الماء المقطر والايثانول وبتراكيز (0.004PVP and 0.008PVP) مول/لتر . تم دراسة خواص الريولوجية والبصرية وتم ملاحظة زيادة في تركيز المحلول البوليمر تؤدي الى زيادة في الخواص الريولوجية لمحلول PVP وكذلك لوحظ ان كثافة محلول PVP المذاب في الماء المقطر هي اكبر من كثافة محلول PVP المذاب في الايثانول . لوحظ في الخواص البصرية زيادة في قيمة الامتصاصية مع زيادة التركيز محلول البوليمر PVP . أظهرت خواص FTIR وجود حزم طاقية تابعة لمركب PVP . تم اضافة دقائق الفضة النانوية الى محلول البوليمر PVP بتراكيز w_t%(0.1,0.2and 0.3) ، حيث أظهرت الخواص الريولوجية نقصان في قيمة اللزوجة لمحلول PVP/DW وزيادة لمحلول PVP/ethanol ويعود السبب في ذلك الى التفاعل الحاصل ما بين دقائق النانوية والمحلول البوليمر وتأثير الشكل والحجم على تلك الخواص . أظهر طيف FTIR ازاحة في الحزم لمركب PVP البوليمر.

1. INTRODUCTION

Silver in its dissimilar chemical shapes has been discovered for long time. Silver has large applications such as good antimicrobial agent ,biosensor materials and composite fibers [1-3].Silver nanoparticles (AgNPs),in the recent years are extensively studied because of their application as bactericidal substance and other uses of silver nanoparticles (AgNPs) in biomedical field [2]. Also their noticeable antibacterial effectiveness can be credited to the good advanced surface as well as big surface area to size ratio given well contact with the bacteria and microbes [4].Also bacterial cells have strong cytotoxicity as consequence of their contact with the useful collections on the bacterial cell surface [5].Silver nanoparticles can be used in to biosensor materials, antimicrobial applications ,electronic components ,cosmetic and composite fibres [6].The best common technique for creation of stable silver nanoparticles(Ag NPs) is the chemical reduction of Ag ions in dissimilar stabilizers for example polymers.AS in poly(vinylpyrrolidone) where it attracts large care because of its good physical and chemical of its properties creation and its excellent substance as a layer or as an additive to dissimilar materials poly (vinylpyrrolidone) (PVP) performances not just as a steadying agent but too has an influence on the control of the reduction rate of the silver(Ag) ions and aggregation method of Ag[7]

2. Experimental work

2.1 Materials

Poly(vinylpyrrolidone) (PVPK-30), is a hygroscopic powder, which has a weak characteristic order , Molecular weight equals to 40000(g/mole), glass temperature(T_g) equals to 163(C°) [8]. Ethanol is a colourless solvent its purity is equal to 99.9% and is made in Spain ,Distilled water (DW) used as solvent and silver nanoparticles (AgNPs) With The particles diameter in the range from (50 to 80)nm where made in USA.

2.2 Preparation of PVP polymer solution and addition of silver nanoparticles

Four samples of polymer solution of PVP were prepared by dissolving 8g (C1) PVP and16g(C2) PVP powder in 50 ml ethanol alcohol, also dissolving the same quantity in50ml distilled water then mixing solutions via stirrer device for 30 minutes at room temperature, according to the following equations [9].

$$C_x=\frac{n_x}{v} \quad (1)$$

$$n_x=\frac{m}{Mw} \quad (2)$$

Where $C_x$is the concentration (mol/L)

n_x is the number of mole

v is the volume of solvent (litter)

m is the mass of PVP(g)

Mw is the molecular weight(g/L)

C1is concentration at 0.004PVP (mol/L) C2 is concentration at 0.008PVP (mol/L)

Then adding (0.1,0.2,and0.3) wt% Ag NPs with incessant stirring for 1h at room temperature as shown in Table (1).

3. Results and Discussion

3.1 The viscosity

Figure(1) show the relationship between the viscosity and the concentration of AgNPs in PVP polymer. It can be seen that the viscosity value of pure PVP which dissolved in ethanol and distilled water increase with increasing the concentrations of polymer solution of PVP was due to the increasing in the crosslinking amid polymerchains [10]. As observed after addition silver nanoparticles (AgNPs) the viscosity in PVP/DW less than in case pure PVP/DW and in PVP/ethanol large than in case pure PVP/ethanol, where this different in viscosity value because of the viscosity is depending on the attraction between the particles and on the shape and size of its particles.[10-11]. As shown in Table (1).

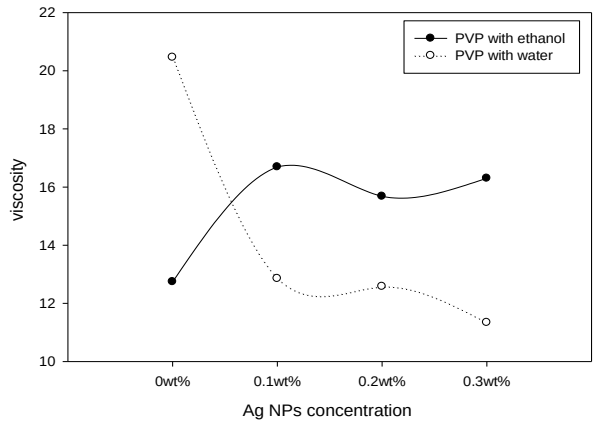


Figure (1): shows the relationship between the viscosity and the concentration of AgNPs

Table (1): shown viscosity of polymer solution of PVP after addition various concentrations of Ag NPs.

Concentration of AgNPs	PVP/ ethanol	viscosity (Cp)	PVP/ distilled water	viscosity (Cp)
0wt%	C1	12.74	C1	20.46
0wt%	C2	56.41	C2	32.55
0.1wt%	C1	16.69	C1	12.85
0.2wt%	C1	15.68	C1	12.58
0.3wt%	C1	16.30	C1	11.34

3.2 Density measurement of pure PVP in Distilled water (DW) and ethanol solutions

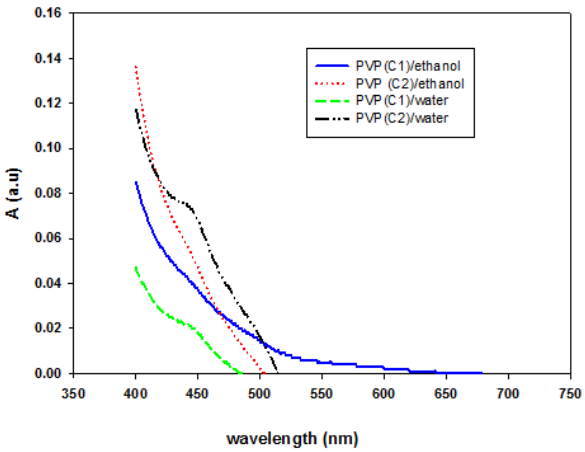
The density value of the PVP/ethanol was less than the density value of the pure PVP/DW .As shown in Table (2) .In addition, adding Ag NPs to polymer solution of PVP lead to decrease in the density because ofthe vacancies between the polymer chains were filled by AgNPs which lead themtobe expanded [12].

Table (2): explain the density of polymer solution of PVP which melted in ethanol and distilled water.

PVP/ethanol	Density (g/cm^3)	PVP/distilled water	Density (g/cm^3)
C1	0.8276	C1	1.0248
C2	0.8736	C2	1.0327

3.3.a Optical properties of polymer solution of PVP

Figure (2) shows that the increasing in PVP concentrations (C1 to C2) lead to increases the absorbance values form (0.04 to 0.12) in DW and from (0.08 to 0.14)in ethanol at a wavelength value of 400 nm to700nm. This result is an agreement with the result of researcher Panagiotis T. et al. [13].



Figure(2): Absorbance spectra of pure PVP prepared in ethanol and DW.

3.3.b Optical properties of Addition Ag NPs to polymer solution of PVP

The peak of polymer solution of PVP/ethanol doped with Ag NPs show at the wavelength419nm because of surface Plasmon resonance. And the result is an agreement with results of the researchers Kaminskiene,et al. [14]. As shown in figure (3).

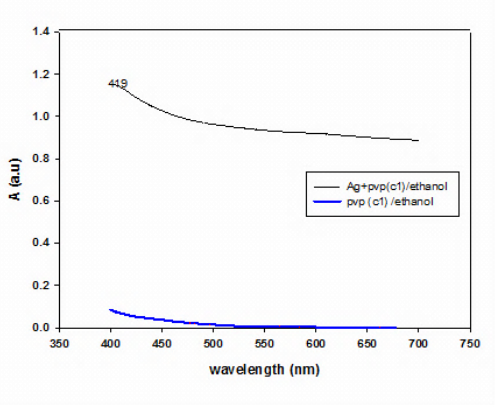


Figure (3): Absorbance spectra of pure PVP and PVP/AgNPs prepared in ethanol.

3.4 Fourier Trans form Infrared spectroscopy (FTIR) of pure PVP powder

The FTIR spectrum of PVP is shown in figure (4) at 1676.14 cm^{-1} appeared the

vibration bond which represents C=O group signifying several H-bonding carbonyl collections exist in PVP. An intense and wide bond in the array 3464~1676.14 cm^{-1} which is attributed extending vibration of linked hydroxyl collection .The bonds at 1676.14$cm^{-1}$and 2956.87$cm^{-1}$where are ascribed to features widening vibrations which represents C-H bond, also note wide bond at 2956.87 cm^{-1} as well as the peakat1020.34cm^{-1} represents the bond C-N or C-C [15].

In case adding AgNPs of polymer solution of PVP which dissolved in ethanol and DW were noticed the peak at 1676.14cm^{-1} which represents C=O collection in polymer PVP powder ,shift from1676.14cm^{-1}to1650.07cm^{-1}as well as C=O bond is decreased in wave number because of the bond weakening ,as a result of creation with the surface silver atoms the partial bond which finally passivation the surface of silver nanoparticles .Also at 1020.34$cm^{-1}$and 1074.35cm^{-1}which representspeakC-N movingfrom1020.34cm^{-1}to1057.51cm^{-1}in case the solvent ethanoland shift to1046.54cm^{-1} incase the solvent distilled water. Thepeak1074cm^{-1}shift to1285.92cm^{-1} in the solvent ethanol as shown in figure (5-a) and1216.22cm^{-1} in case the solvent distilled water as shown in figure (5-b) of PVP-embedded Ag , where the peak moving corresponding to group which represents C-N bonds to higher wave number because of chemical, the system of silver nanoparticles with C-N bond. Changing in optical behaviour of polymer PVP confirmed the system of silver nanoparticles with O atom and N atom of C=O bonds also C-N bonds of PVP [7]

Figure (5)(a and b) shows the FTIR spectra of PVP doped Ag nanoparticles prepared in ethanol and DW

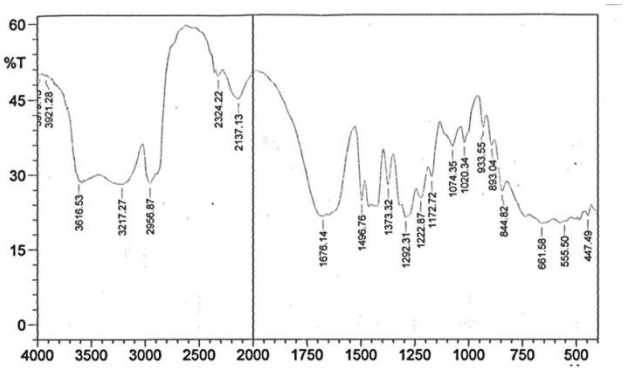


Figure (4) :Shows the FTIR of pure PVP powder.

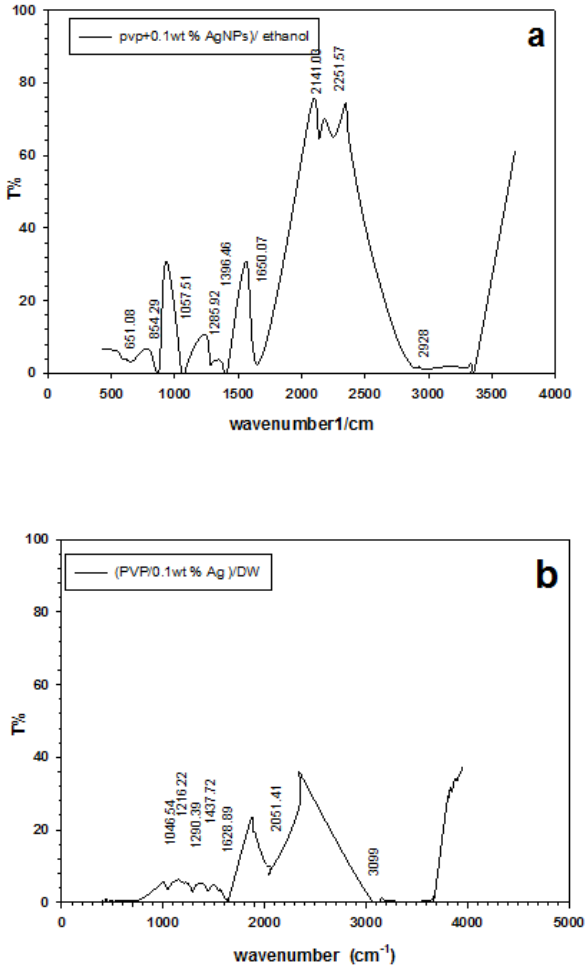


Figure (5): shows the FTIR of PVP/AgNPs in (a) ethanol (b) DW.

4. Conclusion

This study of the properties of polymer solution of PVP showed the influence ofaddition ofAgNPson rheological and optical properties of PVP . The viscosity values of PVP polymer solution increased with increase of the concentrations of polymer solution of

PVP. Where the high viscosity of PVP/ethanol doped with AgNPs was suitable for creating composite fibers. As observed that the density value of PVP/ethanol was less than the density value of PVP/DW. Therefore the increasing of absorbance values with increasing the concentration of polymer solution of PVP was noticed. The FTIR result of addition AgNPs on polymer solution of PVP shifted the peaks of bonds in PVP polymer.

Acknowledgement

We would like to thank Department of Physics, Faculty of Education for Girls in the University of Kufa.

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