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Research Article

Preparation and characterization of PEG-assisted growth of colloidal Ag nanoparticles

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Abstract

Colloidal Silver nanoparticles were prepared under mild conditions using poly (ethylene glycol) (PEG) in the presence of PVA as surfactant. Ethylene glycol was used as a reducing agent for the preparation of metal particles at room temperature. Ag^{+1} can be smoothly reduced to silver nanoparticles at ambient condition in PEG 400. UV-visible studies demonstrated that the reducing rate of Ag^{+1} to nano-Ag was remarkably enhanced with the increased amount of the PEG. The transmission microscope images prove that the reduced Ag nanoparticles were spherical in shape. The pathway described here was considered as a green route for preparation of silver nanoparticles.

Keywords: Silver, Ag, poly (ethylene glycol), Nanosilver.

1. Introduction

Silver nanoparticles have attracted a lot of attention through years. Due to their unique physical and chemical properties, they are widely used in many applications in different fields like electronics [1], anti-microbial applications [2], sensing applications [3], energy conversion [4], solar cells [5], and water purification [6,7]. As the rate of using silver nanoparticles in many application is increasing the need for cheap easy and more safe synthesis methods is increasing. Different methods for synthesis of silver nanoparticles have been investigated through the last years like reduction in solutions [8,9], chemical and photo-chemical reactions in reverse micelles [10], electrochemical [11], and microwave assisted processes [12]. Due to the environmental problems accompanied with metal nanoparticles synthesis [13], we have to give more attention to the green chemistry. Green chemistry is the design, development and implementation of chemical products and processes to reduce or eliminate the use and generation of substances hazardous to human health and the environment [14]. Synthesis methods without accumulating toxic and redundant chemicals in solid, liquid and gaseous form in the environment will be better, safer and cause less harm to the environment. A number of researches recently concentrated on the green synthesis or environmentally friendly methods for synthesis of metal nanopar- ticles have been studied to reduce the toxic and undesirable materials accompanied with the process of synthesis [15,16]. In this work we are affording a new green method that can be used in the synthesis of monodispersed silver nanoparticles. All the chemicals we used is environmental friendly. This method is low cost, fast and efficient. We report here synthesis of monodispersied silver nanoparticles by reduction of silver in a solution.

2. Material and methods

2.1. Chemicals

Poly vinyl alcohol was purchased from Roth GmbH, Germany. Silver Nitrate was purchased from Bio Basic Canada. Polyethylene alcohol was purchased from All the aqueous solutions were prepared using triply distilled de-ionized water.

2.2. Synthesis

100 g of polyvinyl alcohol was dissolved in 100 ml deionized water. This solution was acidified with 200 µl of HNO_3 (0.1 M). Then we added 5ml $AgNO_3$ (0.1 M) aqueous solution and left on stirrer for 15 minutes. We took then 20ml and added different concentrations of polyethylene glycol(200, 300, 400, 500)µl to each 5ml. After that we added a constant amount of ascorbic acid 70µl (0.1M) to each mix, and all the mixtures were left under stirring for 45 minutes. To study the effect of ascorbic acid at constant polyethylene glycol concentration, we made 3 solutions with different ascorbic acid. We took 15 ml of the acidified polymer with the $AgNO_3$ solution and we added 600 µl and left on magnetic stirring for 30 minutes. Then we took each 5ml and we added 3 different concentrations of ascorbic acid (50, 70, and 100) µl and all the mixtures were left under stirring for 45 minutes. All six samples were left for 12 hours at the ambient condition to make sure that the reaction was complete.

2.3 Characterization of the nanocomposite films

UV-vis absorption spectra of the specimens were recorded on Jasco V-630UV-vis spectrophotometer in the range of 800 to 300 nm. The morphologies and the distributions of the nanoparticle particles were studied by transmission electron microscopy (TEM), using Jeol JeM-2100.

3. Results and discussion

3.1. UV-Vis spectroscopic analysis

After leaving the solutions for 12 hours we observed the change in color from colorless to yellowish brown which indicates the presence of silver nanoparticles. Figure 1 Shows the UV-Vis absorption spectra of the solutions with different concentrations of polyethylene glycol (200, 300, 400, and 500) µl. The UV-Vis absorption spectrum shows a weak and broad absorption peak at 420 to 440 nm. This peak is ascribed to the characteristic surface plasmon resonance (SPR) absorption of Ag nanoparticles [17].

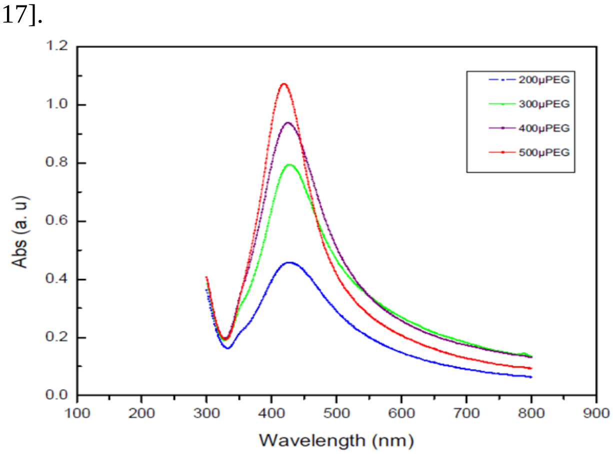

Figure 1: UV-vis absorption spectra of different concentrations of polyethylene glycol

From figure 1 we can see that as we increase the concentration of polyethylene glycol the intensity of the peak increases. This means that the concentration of the silver nanoparticles increases. Also the increasing in polyethylene glycolcausesthe peak to be narrower and shifts to the red region. Polyethylene glycol works as a green reducing agent [18]. We can see in figure 2 the absorption spectra of the solution at constant polyethylene glycol 200µl and different concentrations of ascorbic acid (50, 70, and 100) µl.

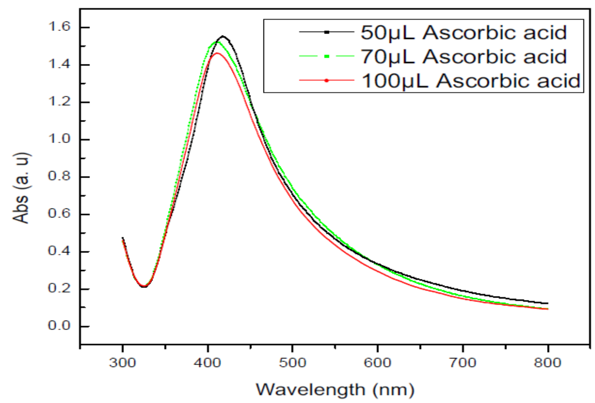

Figure 2: UV-vis absorption spectra of different concentrations of ascorbic acid

Figure 2 shows a narrow sharp beaks around 400 This peak is ascribed to the characteristic surface plasmon resonance (SPR) absorption of Ag nanoparticles [17]. We can see no big difference in the width ofthe beak but as we increase the amount of ascorbic acid the intensity of the peak increases. The increase in the intensity indicates the increasing of the silver nanoparticles inside the solution. From figure 3 we can see the difference on the peak after adding the ascorbic acid. We observe that the peak became narrower and shifted toward the blue region.

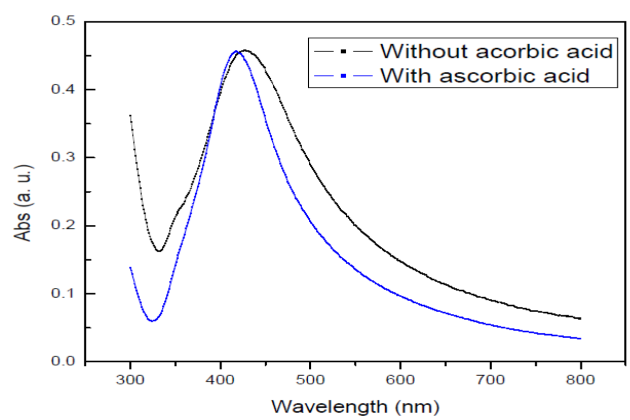

Figure 3: UV-vis absorption spectra of the effect of adding ascorbic acid

3.2 Tunneling Electron Microscope

TEM image of the Ag/PVA nanocomposite solution shows scattered and good concentration of spherical silver particles figure 4. These nanoparticles of silver have an average particle size of 20-25 nm.

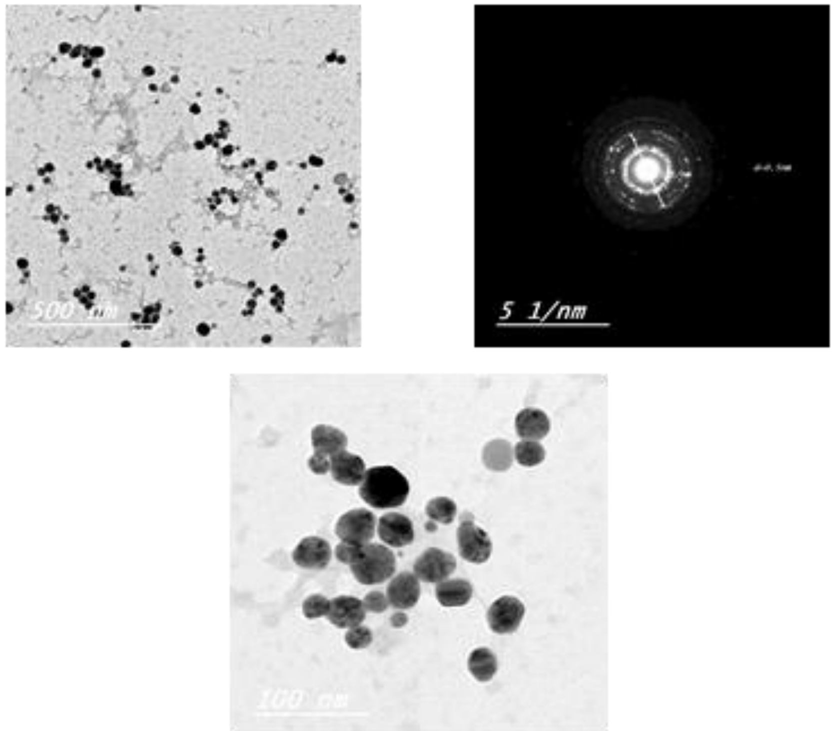

Figure 4: TEM micrographs of Ag nanoparticles in the solution

4. Conclusion

We have reported a green easy way to produce silver nanoparticles. Well dispersed silver nanoparticles with size 20-25 nm were produced. UV-vis spectroscopy showed the presence of silver nanoparticles. We found that as we increase polyethylene glycol concentration the intensity of the produced silver nanoparticle increases.

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