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Fabrication of silver/ cross-linked polyvinyl alcohol nanoparticles by hydrothermal method

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Abstract In this article, we report the fabrication of nanometer sized silver particles by simple hydrothermal method Obtained nanoparticles are nearly spherical and have a narrow size distribution (20 30nm) as found in SEM pictures The very strong plasmon resonance peak at 423 441nm ranges in UV-Visible spectra is a consequence of the nano sized Ag particles XRD patterns show a characteristic peak for silver nanoparticles at $2\theta = 40^0$ FTIR spectra reveals the evidence of silver PVA cross-linking The I V curve exhibits non ohmic behaviour with maximum current 5 9 μ A at 20 V

Keywords Silver nanoparticles polymer composite hydrothermal plasmon resonance peak

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1. Introduction

The materials with nanometer grain sizes in one (nanowire), two (nanoflakes, nanoscales *etc*) or three dimensions (nanosphere, nanorod, *etc*) have the unique physical, chemical, and mechanical properties that are neither those of bulk materials nor those of molecular compounds. These have been exploited for the extensive potential applications in optics, electronics, magnetic, catalysis, chemical sensing, biomedicine, micro-reactor *etc* Noble metal nanoparticles/ organic polymer films are of particular interest because of their potential application for photonics and electro-optics [1-4] The polymers prevent oxidation and coalescence of the particles and provide them long time stability As a result, the optical and electrical properties of the nanoparticles can be brought into full play, while the typical advantages of organic polymers (*e g.* elasticity, transparency, relatively simple way of synthesis *etc*) are retained in the composite films Several methods have been developed for the fabrication of nanocomposite films containing noble metal nanoparticles dispersed in polymer matrix.

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We report in this work the hydrothermal synthesis of silver nanoparticles in aqueous solution using polyvinyl alcohol (PVA) (which is very commonly available inexpensive polymer) as both reducing and stabilizing agent (*i.e.* without the use of an additional reducing agent). The characterization of synthesized Ag/ PVA nanofilms is done by SEM, XRD, and UV-Vis spectrometry. Also the electrical property of the composite films is studied through I-V characteristics in order to explore more in the direction of applicability in electro- optic devices.

2. Experimental details

Silver nanoparticles are prepared by reducing silver nitrate ($AgNO_3$) of different concentrations in PVA solutions. In 3wt% PVA solution silver nitrate is added drop wise with a continuous stirring. The temperature of the solution is kept at 90^0 c. The change of colour of the resultant solution from colourless to yellow after about 2hrs. indicates the nano formation The resultant solution is spin cast on various substrates for further investigation.

3. Result and discussion

3.1. UV-Vis spectroscopy :

The presence of a very strong plasmon resonance peak at 423nm- 441nm range in the UV-visible spectra for different concentrations of $AgNO_3$ is a clear consequence of formation of nano sized silver particles. Figure 1 shows UV-Vis absorption spectra of spin cast films. This shows characteristics plasmon band of silver nano as has been found in silver nano fabricated in polysodium acrylate matrix [5] (which is much costlier and not so readily available).

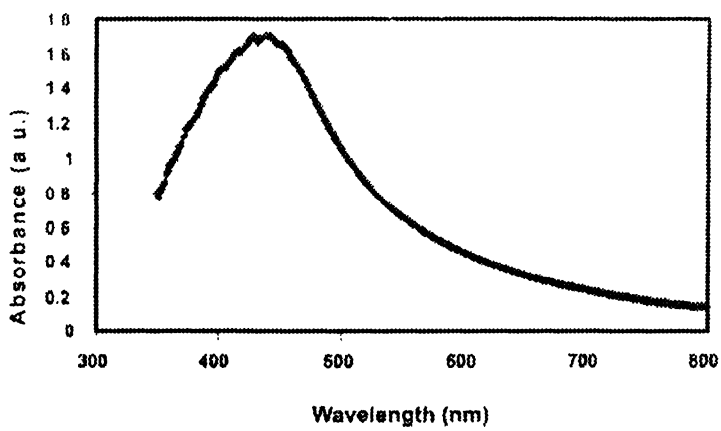

Figure 1. Absorbance for 1mM $AgNO_3$.

3.2. SEM Image :

Figure 2 shows SEM image of PVA/Ag nano film. SEM image shows the average size of the grains in the range 20-30nm.

3 3 XRD Pattern

The XRD pattern is taken by Seifert XRD 3000pd diffractometer with cu-kα (0 15418nm) Figure 3 shows XRD pattern of PVA/Ag nano films This shows characteristic peak of silver (fcc) nano at $2\theta = 40^0$ for (111) plane as have been seen in silver nano synthesized in polyvinyl pyrrolidone matrix by polyol process [6] (which involves many stages of chemical preparations)

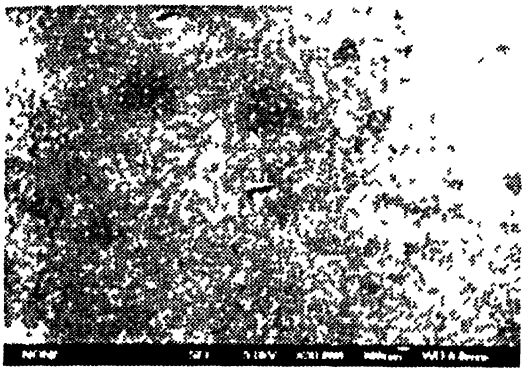

Figure 2. SEM image PVA/Ag nano film

Figure 3 XRD pattern of Ag nano

3 4 FTIR spectra

FTIR spectra of the spin cast films show a clear shift in band from that of pure PVA, which indicates the PVA-silver, cross-linking Figure 4 shows the FTIR spectra of PVA/ silver nano film.

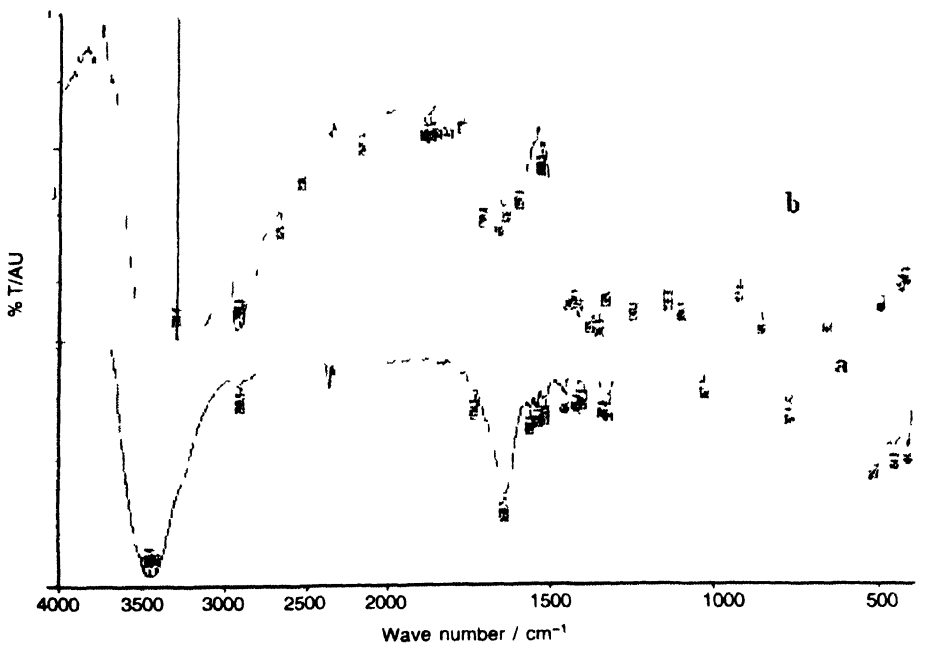

Figure 4. FTIR spectra of (a) PVA and (b) PVA/Ag nano

3.5. I-V characteristics :

The electrical properties of PVA/Ag nanoparticles are measured by I-V curves taken by Keithley CV meter (model 595). I-V curves show similar non-ohmic behaviour both in-plane as well as perpendicular electrode configurations. For in- plane configuration, on the top of the film two small areas are coated with silver paint and connections are taken by fine copper wires. For perpendicular configuration, the film is spin cast on ITO glass and top electrode is taken as earlier Figure 5 shows LOG I- LOGV curve with maximum current 5900 nA for 20 Volts.

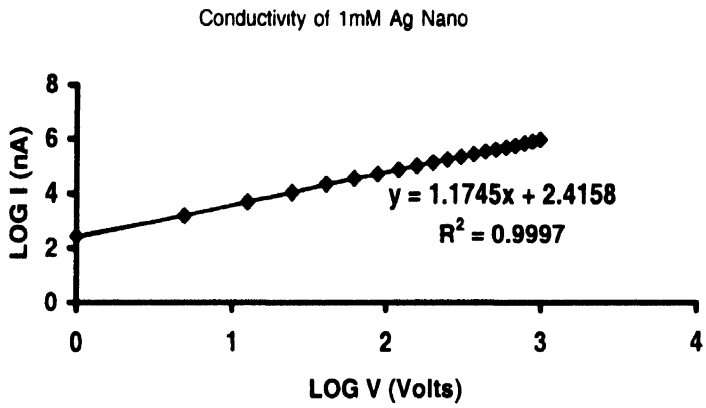

Figure 5. I-V characteristic of PVA/Ag nano

4. Conclusion

In summery, silver nano spheres are successfully synthesized by hydrothermal method in PVA polymer, which acts as both reducing and stabilizing (the polymer prevent oxidation and coalescence of the particles and provide them long time stability) agent. This method of nanocomposite preparation offer advantages of: (1) A cluster or atomic level control and (2) an efficient scale up for processing and production. We hope to have structure- property correlation and nano device application in future.

References

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