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SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES (AgNPs)

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ABSTRACT

A curiosity has been created as we are progressing towards the deep study of species in nano-metric size. Their scale of size and metallic character makes them more and more interesting and useful in various applications like petroleum refining, automotive catalytic converters, etc. They are being used increasingly as catalyst to boost the chemical reactions. The area of silver (Ag) nanoparticles research has also been witnessed tremendous growth due to their unusual chemical and physical properties. Production of Ag nanoparticles can be achieved through different methods like biological method, ion implantation method, and wet chemical method or chemical reduction method. Chemical approaches are one of the most popular methods for the production of nanoparticles. In the present paper, silver nanoparticles have been prepared by reducing the silver nitrate in polyvinylpyrrolidone (PVP) aqueous solution. Glucose was used as reducer and sodium hydroxide to accelerate the reaction. Characterization has also been done and discussed using techniques like X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Transmission Electron Microscope (TEM)

Keywords-Silver nanoparticles, chemical reduction method, particle size, X-ray Diffraction (XRD), Transmission Electron Microscope (TEM) and scanning electron microscopy (SEM**)**

[1]INTRODUCTION

Silver nanoparticles (AgNPs) are used increasingly in various fields like medical, health care, food, industrial purpose and consumer due to some unique chemical, physical, optical and biological properties like high electrical and thermal conductivity [1-6]. AgNPs have also been used in various applications like optical sensors, household products, antibacterial products, industrial products, healthcare related products, medical device coating, cosmetics, food industry, drug delivery, anticancer agents, in diagnostic, optical sensors and pharmaceutical industry [7-9]. Surface to volume ratio of nanoparticles is an important parameter on which physical, biological and chemical properties depend and used for various applications.

Surface to volume ratio depends on shape and size of particles, which can be derived by synthesis method. Various physical and chemical methods are developed to synthesize silver nanoparticles. In this work, chemical reduction method is used to prepare AgNPs [10]. Further, the characterization has to be done and discussed by using techniques like X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) and Transmission electron microscope (TEM)

[2]EXPERIMENTAL DETAILS

Synthesis of Silver (Ag) nanoparticles:

All the chemicals used in this work were analytic reagent (AR) and provided by LobaChemie, India. Silver nanoparticles were prepared by reducing the silver nitrate in polyvinylpyrrolidone (PVP) aqueous solution. Glucose was used as reducer and sodium hydroxide to accelerate the reaction. Solution A was then prepared by adding 3.4g of $AgNO_3$ into 20ml distilled water. Solution B was prepared by dissolving PVP (2.6gm), glucose (11.88gm) and sodium hydroxide (1.92gm) in 60ml distilled water together. Solution B was heated to 60^0C and stirred hardly, and solution A was added to B drop by drop. At the end, all the silver nitrate solution was added and the mixed solution was stirred for 10 minutes. The particles were separated by centrifugation method and washed with distilled water several times. The particles were then dried by vacuum.

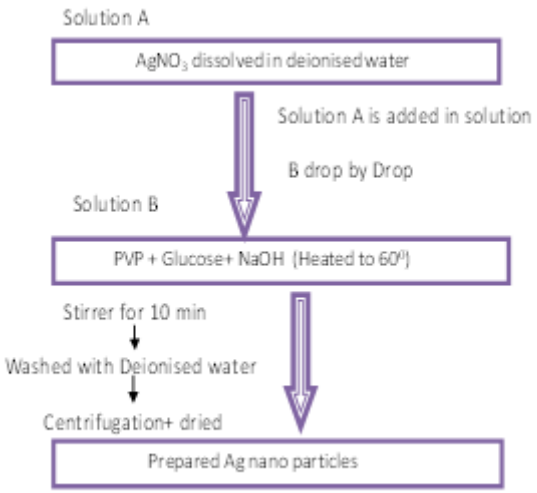


Fig.-1: Structural characterization of Ag nanoparticles

Structural characterization of silver nanoparticles:

The dried powder of silver nanoparticles was analysed under X'Pert Pro X-ray diffractometer operated at a voltage of 40 kV and a current of 40 mA with Cu K α radiation in θ-2θ configurations. Crystalline domain size was calculated from the width of the XRD peaks using the Scherrer's formula:

$$D=0.94\lambda/\beta\text{Cos}\theta \quad (1)$$

Where D is the average crystalline domain size perpendicular to the reflecting planes, λ is the X-ray wavelength i.e. 1.54Å, β is the full width at half maximum (FWHM) and θ is the diffraction angle

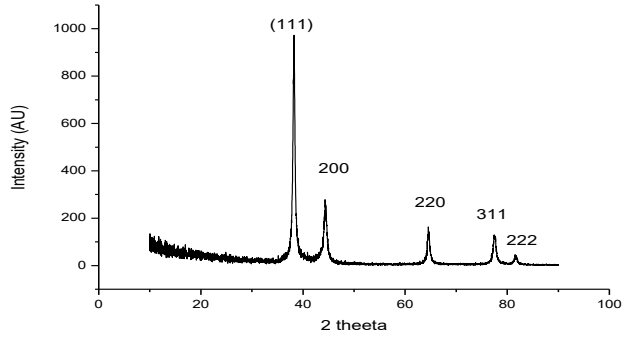
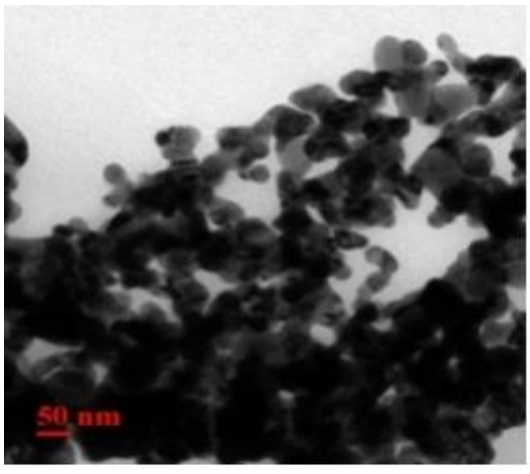


Fig.-2: X-Ray diffraction of Ag nanoparticles

[2]RESULT AND DISCUSSION

The XRD pattern of Figure 2 shows 2θ value ranging from 10 to 90 with five intense peaks specific for silver nanoparticles at 38.23°, 44.39°, 64.53°, 77.49°and 81.61°. These peaks correspond to 111, 200, 220, 311 and 222 planes for silver nanoparticles indicating that the particles were crystalline in nature. The sharp bands of Bragg's peak authenticates that the particles were nano-sized and were stabilized by the reducing agents present in the leaf broth. The XRD pattern also showed peaks for additional and yet unassigned bio-organic phase present on the surface of the silver nanoparticles. The calculated average particle size was 35nm with size ranging from 20nm to 50nm. TEM image Fig.3, and SEM image Fig.4 clearly indicates that the shape of the silver nanoparticles synthesized were spherical.



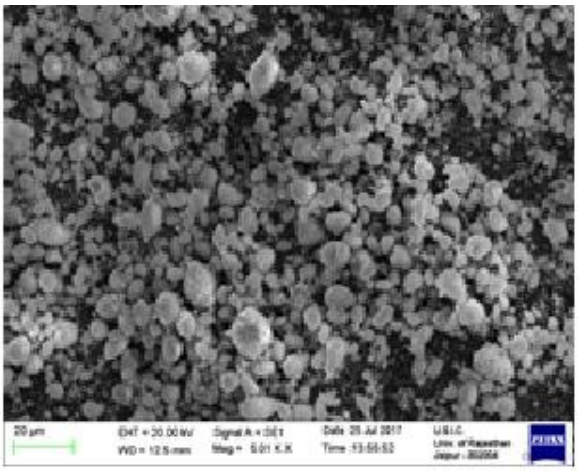


Fig.-3: TEM micrograph of Ag nanoparticles **Fig.-4:** SEM micrograph of Ag nanoparticle

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