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OPTICAL PROPERTIES OF GREEN SYNTHEZISED SILVER NANO PARTICLES

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ABSTRACT

Here we report the synthesis of silver nanoparticles of using neem leaf extract. The synthesized nanoparticles are characterized using Scanning electron microscope (SEM), X-ray diffractometer (XRD) and UV-visible spectrophotometer. Also photoluminescence (PL) emissions from the synthesized silver nanoparticles have been recorded. Plant extract is very cost effective and eco friendly and thus can be economic and effective alternative for the large scale synthesis of silver nanoparticles.

KEYWORDS: Silver nano, SEM, SPR, UV-vis.

INTRODUCTION

Silver nanoparticles have unique optical, electrical, and thermal properties and are being incorporated into products that range from photovoltaics to biological and chemical sensors. Examples include conductive inks, pastes and fillers which utilize silver nanoparticles for their high electrical conductivity, stability, and low sintering temperatures. Additional applications include molecular diagnostics and photonic devices, which take advantage of the novel optical properties of these nanomaterials. An increasingly common application is the use of silver nanoparticles for antimicrobial coatings, and many textiles, keyboards, wound dressings, and biomedical devices now contain silver nanoparticles that continuously release a low level of silver ions to provide protection against bacteria. There is growing interest in utilizing the optical properties of silver nanoparticles as the functional component in various products and sensors. Silver nanoparticles are extraordinarily efficient at absorbing and scattering light and, unlike many dyes and pigments, have a color that depends upon the size and the shape of the particle. The strong interaction of the silver nanoparticles with light occurs because the conduction electrons on the metal surface undergo a collective oscillation when excited by light at specific wavelengths (**Figure 1**), known as a surface plasmon resonance (SPR), this oscillation results in unusually strong scattering and absorption properties. A unique property of spherical silver nanoparticles is that this SPR peak wavelength can be tuned from 400 nm (violet light) to 530 nm (green light) by changing the particle size and the local refractive index near the particle surface. Even larger shifts of the SPR peak wavelength out into the infrared region of the electromagnetic spectrum can be achieved by producing silver nanoparticles with rod or plate shapes.

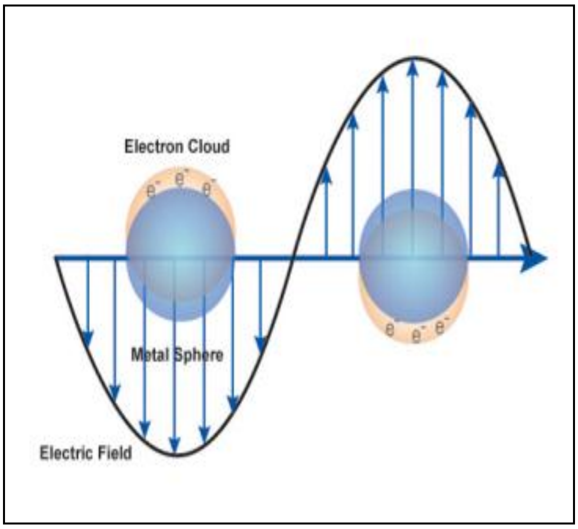

Figure 1: Surface plasmon resonance where the free electrons in the metal nanoparticle are driven into oscillation due to a strong coupling with a specific wavelength of incident light.

However, here we report the synthesis of silver nanoparticles using neem leaf extract in the aqueous solution by introducing solution of silver nitrate and the morphological characterizations are performed using scanning electron microscope (SEM) and X-ray diffractometer (XRD). The optical absorption properties are measured using UV-visible spectrophotometer and observed the absorption peaks in 429 nm region, which are close to the characteristics surface plasmon resonance (SPR) wavelength of metallic silver. In addition, the photoluminescence (PL) spectra from the synthesized silver nanoparticles have been recorded.

MATERIALS AND METHODS

Chemicals

AR grade silver nitrate ($AgNO_3$) purchased from Merck, India. All other chemicals and solvents used were of analytical grade available commercially.

Preparation of plant extract, 1mM $AgNO_3$ and AgNPs

The fresh *neem* leaves (10 g) were boiled with 100 ml distilled water and filtered. For the preparation of 1mM $AgNO_3$, 0.016 gm of AgNO3 weighed accurately and made upto 100 ml using sterile distilled water . For the preparation of AgNPs, 90ml of 1mM silver nitrate solution was added to 10 ml of plant extract to make up a final solution 100 ml and centrifuged at 3,000 rpm for 10 min.

UV-Vis Spectra analysis

The reduction of pure Ag^+ ions was monitored by measuring the UV-Vis spectrum of the reaction medium at 5 hours after diluting a small aliquot of the sample into distilled water. UV-Vis spectral analysis was done by using Sl-210 Double Beam UV Visible Spectrophotometer (Elico).

Photoluminescence (PL) spectra analysis

The photoluminescence (PL) emissions spectra of from the samples are recorded by a spectrofluorimeter (Perkin Elmer) at roomtemperature. For PL measurement also samples are dispersed in distilled water.

SEM analysis of silver nano particles

Scanning electron microscopic (SEM) analysis was done using VEGA3 TESCAN machine, Japan. Thin films of the sample were prepared on a carbon coated copper grid by just dropping a very small amount of the sample on the grid. Extra solution was removed using a blotting paper and then the films on the SEM grid were allowed to dry by putting it under a mercury lamp for 5 min.

RESULTS AND DISCUSSIONS

In this study, AgNPs were synthesized using a reduction of aqueous Ag^+ with plant extract. It was generally recognized that AgNPs produced brown solution in water, due to the surface plasmon resonances (SPR) effect and reduction of $AgNO_3$.[1] After the addition of $AgNO_3$ solution, the plant extract changed colour from light yellow to brown in a few minutes, while no colour change was observed without $AgNO_3$ **(Figure 2)**. Thus, colour change of the solution clearly indicated the formation of AgNPs. The colour intensity of plant extract with $AgNO_3$ was sustained even after 24 hour incubation, which indicated that the particles were well dispersed in the solution, and there was no obvious aggregation.

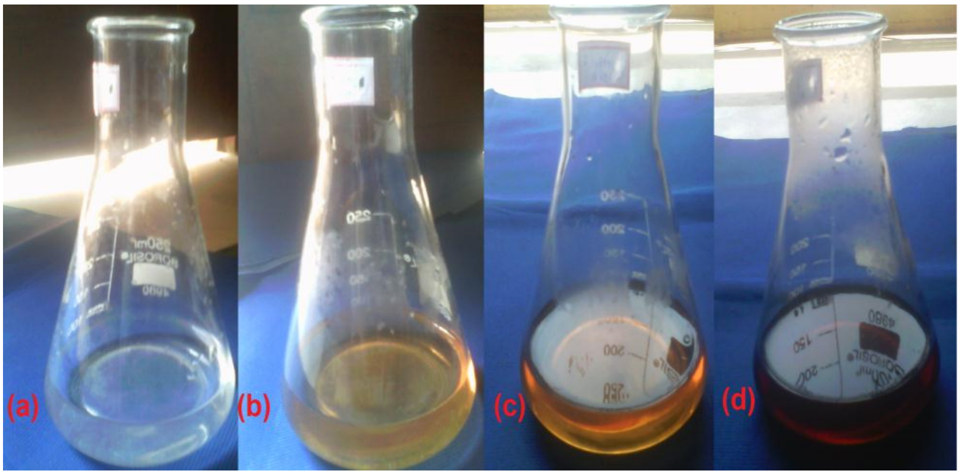

Figure 2: Visible observation of AgNPs biosynthesis. (a) Pure $AgNO_3$ solution (1 mM). (b-d) Gradual colour change appeared after the addition plant extract into $AgNO_3$ solution.

UV-VIS absorption spectra have been proved to be quite sensitive to the formation of silver colloids because silver nanoparticles exhibit an intense absorption peak due to the surface plasmon (it describes the collective excitation of conduction electrons in a metal excitation. Silver nanoparticles were readily synthesized with the plant extract without the use of any additional stabilizing agents. UV-Vis absorption spectra have been proved to be quite sensitive to the formation of silver colloids because silver nanoparticles exhibit an intense absorption peak due to the surface plasmon (it describes the collective excitation of conduction electrons in a metal) excitation.[2] We observed the UV spectra of silver colloids in the range of 300 to 700 nm. Well defined plasmon band observed at 429 nm **(Figure 3)**. The increase in maximum absorbance is due to the particle density, which strongly depends on the amount of silver reduction at the surface of the medium [3-6]. Sols with a single visible extinction band near 400 nm are characteristic of silver particles substantially smaller than the wavelength of light.[7]

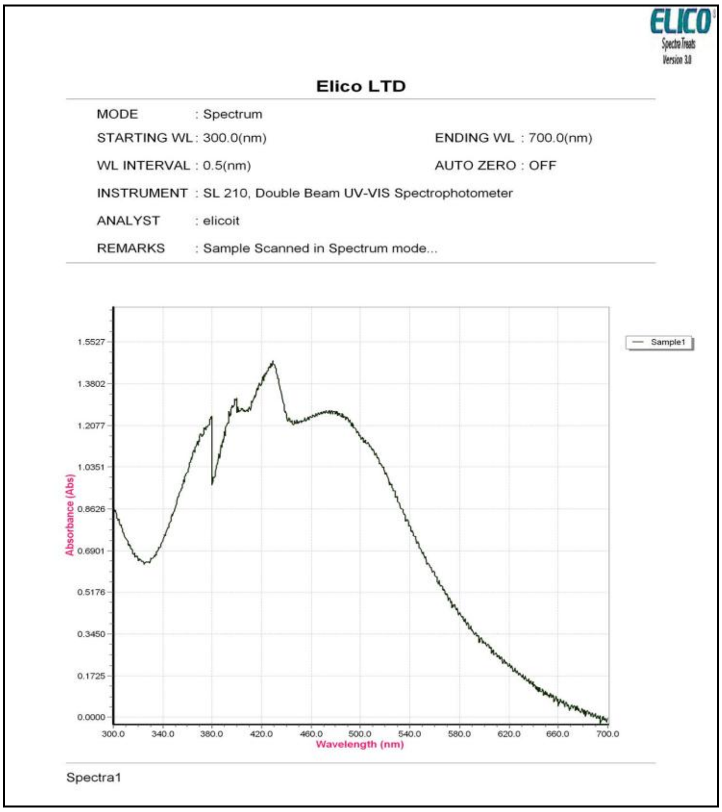

Figure: 3. UV-Vis absorption spectra of synthezied silver nanoparticle solutions at 0.1 mM $AgNO_3$ concentration.

The synthesized colloidal silver nanoparticles are found to be photoluminescent. Photoluminescence (PL) spectra obtained from the synthesized silver nanoparticles at room temperature are shown in **Figure 4**. From Figure 4 it is seen that PL peaks appeared 400 nm. The PL emission peak and UV-visible peak appeared nearly equal wavelength. The visible luminescence from silver nanoparticles attributed to the excitation of electrons from occupied d bands into states above the Fermi level.

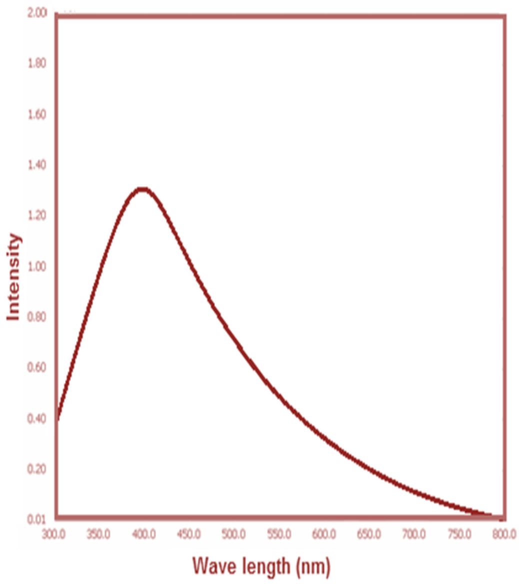

Figure: 4. Photoluminescence emission spectra of the aqueous solution of Silver nano particles

XRD studies

Figure 5 showed the XRD confirming the existence of silver colloids in the sample. The Braggs reflections were observed in the XRD pattern at 2 Ø = 38.08, 44.04 and 64.28 and 77.24°. These Braggs reflections clearly indicated the presence of (111), (200), (220) and (311) sets of lattice planes and further on the basis that they can be indexed as face-centered-cubic (FCC) structure of silver. Hence XRD pattern thus clearly illustrated that the silver nan oparticles formed in this present synthesis are crystalline in nature.

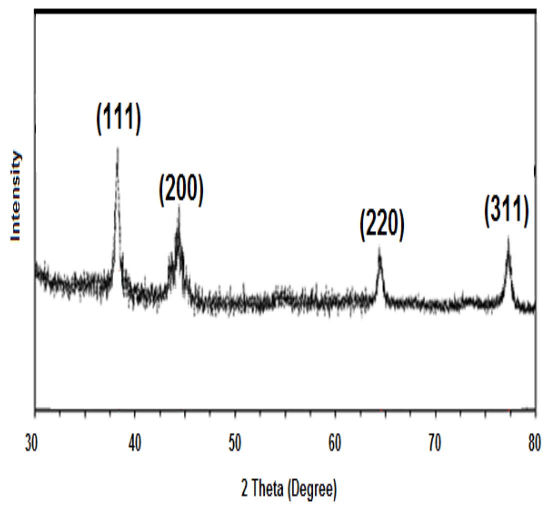

Figure: 5. X-Ray diffraction pattern of synthesized nano particles

Scanning Electron Microscopy (SEM) analysis

SEM measurements were carried out to determine the morphology and shape of AgNPs. SEM micrograph **(Figure 6)** revealed that, the AgNPs were spherical shaped and well dispersed without agglomeration. The particle sizes of AgNPs synthesized were within 100 nm.

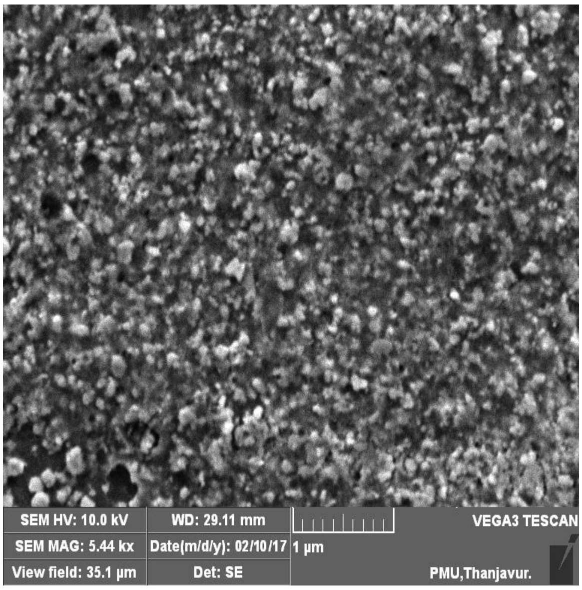

Figure 6: SEM image of synthezied silver nanoparticle

CONCLUSION

The surface plasmon resonance (SPR) of silver nanoparticles can be tuned throughout the visible and near-infrared region by their shape and size. Considering SPR applications, an easy and controllable method for preparing the silver nanocrystals with defined shape and size, is necessary. In this work, the silver nanoplates were synthesized by reducing Ag^{+} ions with plant extract. The method demonstrated in this work provided a simple, reproducible, controllable route to synthesize silver nano particles. The structural characterizations of the synthezied silver nano particles are performed using SEM and XRD analysis. The UV-visible optical absorption properties are measured and found the shift of SPR wavelengths. In addition visible photoluminescence emissions are observed from the synthesized silver nano particles.

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