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Synthesis and Characterization of Silver Nano Particles using Tecoma Stans Flower Extract

Kavitha K.R, Vijayalakshmi.S, Murali Babu B

Abstract ***Metallic nanoparticles are mostly used in every phase of science and technology including medical fields and are still attracting the scientists to explore new dimensions for their respective worth which is generally attributed to their corresponding small sizes. The silver nano particles have attained a special focus among various noble metal nanoparticles due to their anti microbial significance. In the proposed method, to avoid the usage of harmful chemicals colloidal silver nano particles are obtained using green synthesis method which is eco friendly and cost effective. In this reaction, Tecoma stans flower extract is affianced to serve reducing and capping agents. During synthesis of nanoparticles , the parameters silver ion concentration, plant extract volume and reaction time have been studied. To reveal the nature of the nanoparticles, the synthesized nano particles are characterized using ultraviolet–visible (UV–vis) spectroscopy, x-ray diffractometry (XRD), transmission electron microscope (TEM), and particle size analysis (PSA). The size of the nanoparticles are ranging from 20-50nm. The high-density uniform nanoparticles can be obtained by optimizing the experimental conditions. The uniform and stable silver nanoparticles are prepared in this method.***

Key Words: Tecoma stans flower, silver nano particles, synthesis, characterization, transmission electron microscope

I. INTRODUCTION

In modern research, Nanotechnology is an important to dealing with synthesis, strategy and manipulation of particle's structure ranging from approximately 1 to 100 nm in size.All the chemical, physical and biological properties differs significantly in fundamental ways within this size [1].

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* Correspondence Author
Kavitha K.R*, Department of ECE, Sona College of Technology, Salem 636005, Tamil nadu, India.
kavithakrece@gmail.com,
Vijayalakshmi.S, Department of ECE, Sona College of Technology, Salem 636005, Tamil nadu, India.
vijisaumiya@gmail.com ,
Murali Babu B, Department of EEE, Paavai Engineering College, Namakkal , Tamil nadu, India. muraliknk2003@gmail.com,

The synthesis of nanomaterials which is having coveted quality plays a major role in modern nanoscience and nano technology [2]. Nanoparticles that is ultrafine metal is showing greater interest towards their singular physical, chemical and thermodynamic properties [3]. Silver nanoparticles(Ag NPs) are mainly used because of their singular properties like catalytic, optical, electrical and antimicrobial properties [4].Lot many approaches are available inorder to synthesize silver nanoparticles such as thermal decomposition, electrochemical , microwave assisted process and green chemistry. Nanoparticle synthesis and/or production methods of nanoparticles will make use of potential loss chemicals , low material conversions and high energy requirements. This problem to be sorted out so, a growing is need to develop an process for the synthesis of nano particles without using envenomed chemicals is a additional advantage [5]. In order to conquer the role of chemicals, the synthesis of nanoparticles is implemented using materials such as plants, fungi, seaweed, bacteria and enzymes. It is just a simple step which offers numerous advantages such as less time , less cost and innoxious. Nanocrystalline silver is a well known metal and they have numerous applications in the field of detection, diagnostics, therapeutics and antimicrobial activity. Biological approaches which uses micro organisms and plants or plant extract for metal nano particles synthesis is suggested as valuable alternative valuable alternatives to hazardous chemicals[6]. For large scale production of nano particles synthesis of nanoparticles using plant is very cost effective which is very economic [7]. For the biosynthesis of silver nano particles Camellia sinensis extract is used as a reducing and stabilizing agent [8].

Silver nanoparticles(Ag NPs) are mainly used because of their properties. In all the methods available for the synthesis of silver nano particles reactants and starting materials which has been made used is very toxic and hazardous. In Chemical synthesis process there occurs some adverse effects in medical applications and it leads to some toxic chemical species absorption [9]. For over centuries, silver based compounds were used as nontoxic inorganic antibacterial agents owing to their biocide properties in many applications such as wood preservatives, water purification in hospitals, in wound or burn dressing, and so on . Silver nanoparticles is mainly used in antimicrobial activity. Silver and silver nano particles are used in the medical industry such as tropical ointments which helps us to prevent the infection against burning and open wounds. Because of the attractive physiochemical properties silver nanoparticles plays a vital role in the field of biology and medicine. [10].

Jafer Telabi et al have presented synthesis of silver nano particles in Y-zeolite substrate. Silver ions were condensed by using ultrasonic waves in ion-exchanged Ag^{+}–Y zeolite. A huge density of energy is provided due to the collision of bubbles which is formed by ultrasonic waves in sonochemical process.

Shinde V.V et al have synthesized truncated triangular silver nanoparticles using a simple one step chemical reduction method. The reduction of silver ions by sodium borohydride was performed in the presence of poly(vinyl pyrrolidone) as a stabilizing agent. The synthesized particles were characterized by UV, TEM, dynamic light scattering, FT-Raman spectrometer and X-ray diffraction in order to study optical, morphological, compositional, and structural properties. The UV–Vis spectrum showed three plasmon peaks located at 340, 412, and 700 nm confirmed the anisotropic Ag-NPs.

The average edge length of 22 ± 5 nm was observed from TEM images for truncated triangular Ag-NPs. From XRD pattern it was confirmed that the Ag-NPs were polycrystalline in nature, with preferential orientation along (111) lattice plane.

Zainal Abidin Ali et al (2016) have synthesized silver nano particle using apple extract as a reducing agent aqueous silver nitrate as the precursor. The dynamic light scattering estimates the average sizes of the silver nano particles to be 30.25 ± 5.26 nm. Synthesis of silver nanoparticles has been demonstrated using Ananas comosus extract by Naheed Ahmad & Seema Sharma (2012). Khodashenas.B and Ghorbani.H.R (2015) have presented the synthesis of silver nano particles using biological methods and the anti-bacterial properties were investigated. Swarup Roy and Tapan kumar Das (2015) have analysed the green synthesis of nano particles using various plant sources. Nanoparticles are more stable and rate of synthesis is very fast in the case of microorganisms.

The current study is to develop a protocol for eco friendly synthesis of silver nanoparticles using flower extract of tecoma stans and their characterization using UV-Visible spectroscopy, XRD (X- ray Diffraction), SEM (Scanning Electron Microscopy), TEM (Transmission Electron Microscopy), FTIR(Fourier transform infrared spectroscopy) and Particle size analysis are studied.

Fig 1 Tecoma stans flower

Fig 1 shows the Tecoma stans flower. This flower origins at desert shrublands and dry forest in the region from texas and Arizona southward to argentina. It has become established in many parts of the pacific and is naturalizing in south florida. Tecoma stans is a species of flowering perennial shrub in the trumpet vine family. It has sharply toothed, lance-shaped green leaves and bears large, showy, bright golden yellow trumpet-shaped flowers.

II. EXPERIMENTAL PROCEDURE

It includes preparation of plant extract and synthesis of silver nanoparticles

Fig 2 300 ml of aqueous $AgNO_3$ solution (0.05M) with 30 ml of Tecoma stans flower extract at (a) 0 min (b) 10 min (c) 30 min (d) 60 min (e) 360 min and (f) 1440 min

Fig 2 shows color of the 300 ml of aqueous $AgNO_3$ solution in 0.05M with 30 ml of Tecoma stans flower extract for various timings. A naked color change has been observed, as the colorless aqueous $AgNO_3$ which changes to yellowish-brown and to dark brown thereby indicating the formation of silver nanoparticles.

Fig 3 (a) 5ml (b) 20 ml (c) 40 ml

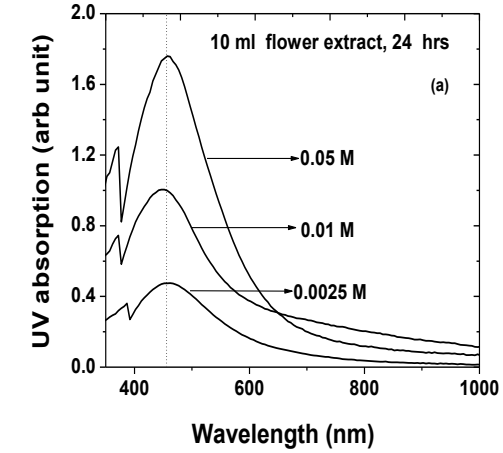
Fig 3 shows color of the 0.05M $AgNO_3$ with various flower extract after 24 hrs. A visible color difference has been observed when the volume of the flower extract changes from 5 ml, 20 ml and 40 ml. The color changes indicates the formation of more number of silver nanoparticles when the volume of the flower extract increased.

III. RESULTS AND DISCUSSION

Silver nanoparticles are synthesized from the tecoma stans flower extract into an aqueous solution of $AgNO_3$. As shown in Fig. 2 for 0.05M $AgNO_3$ concentration as the time increases the color concentration increased, indicates the reduction of nanoparticles up to 1440 mins. To increase the volume of the flower extract, changes the intensity of the color (5ml, 20ml and 40ml) for 100 ml of 0.05M $AgNO_3$ concentration [Fig 3].

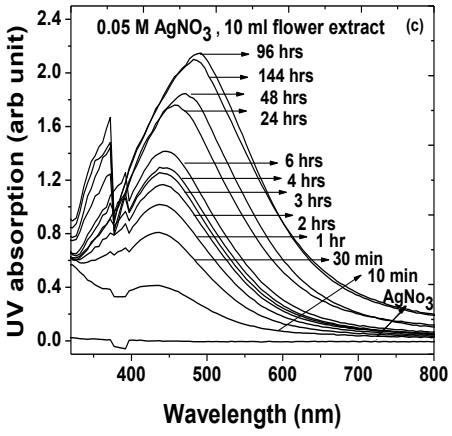
UV-visible spectroscopy

For structural characterization of silver nanoparticles, UV–vis spectroscopy is used for preliminary characterization and examining the reduction of silver ions from aqueous $AgNO_3$ solution to silver nanoparticles. The resonance of the synthesized silver nanoparticles is analyzed with the UV–vis double-beam bio-spectrophotometer using the software in the range of 350 to 1000 nm with periodic time intervals.



(a) after 24 hrs

(b) after 96 hrs



(c) different time intervals

Fig 4 UV–vis spectra for different $AgNO_3$ concentration (a) after 24 hrs, (b) after 96 hrs and (c) different time intervals.

Fig 4(a) shows the UV spectra for different concentration of $AgNO_3$ solution with 10 ml tecoma stans flower extract in 100 ml of $AgNO_3$ precursor at different mole ratio after 24 hrs. For higher $AgNO_3$ concentration, the intensity and UV absorbance are high and the peak is obtained at the wavelength of around 450 nm. Figure 4(b) shows the UV absorption spectra for different concentration of $AgNO_3$ solution with 10 ml flower extract in 100 ml of precursor after 96 hrs. As shown in the fig 4 (b) the UV peak red shifted up to 40 nm when the concentration is increased to 0.05M. This indicates the formation of aggregation of nanoparticles when the precursor concentration is increased to 0.05M, Whereas there is no red shift found for lower concentration (0.0025M and 0.01M) of $AgNO_3$ indicates the particles are well dispersed and stabilized even after 96 hrs.

Fig 4(c) shows the UV absorption spectra for 0.05 M $AgNO_3$ concentration with 10 ml flower extract at different timings ranging from 0 minutes to 144 hrs. During the time duration up to 96 hrs, the UV–vis absorbance intensity increased which denotes the higher acquiesce of silver nanoparticles, because of more reducing bio molecules. After that the intensity gets saturated. The peak position is red shifted nearly 50 nm (from 450 nm to 500 nm). This red shift indicates the availability of the aggregation of nanoparticles due to the presence of higher number of nanoparticles.

Fig 5 shows the UV absorption spectra for 0.05M $AgNO_3$ concentration with 5ml, 20ml and 40ml volume of flower extract in 0.05M of 100ml $AgNO_3$ precursor after (a) 1 hr and (b) 24 hrs. Also, as the time increases to 24 hrs the intensity of UV absorption increased indicates the formation of more nanoparticles.

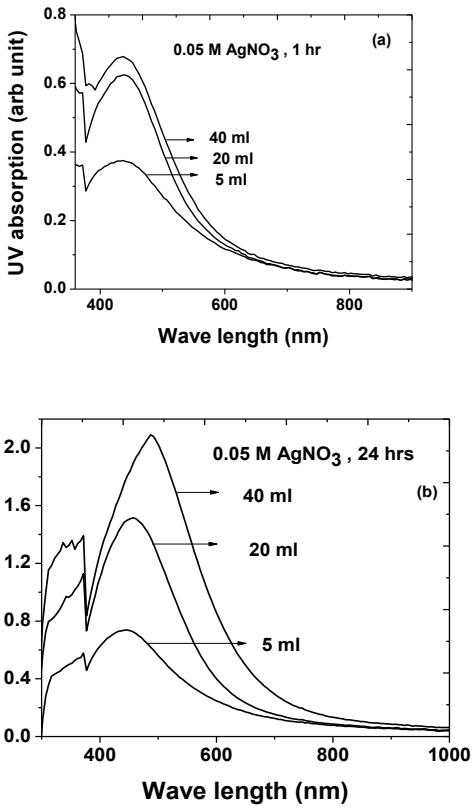
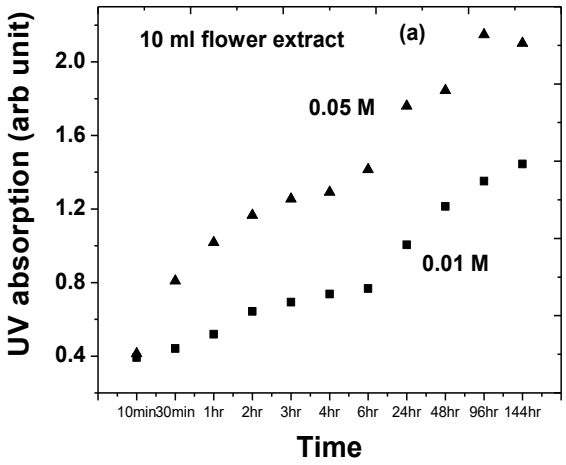


Fig 5 UV–vis. spectra for different volume of extract after (a) 1 hr and (b) 24 hrs

Fig 6(a) shows the UV absorption spectra for various time interval for 0.05M and 0.01M $AgNO_3$ with 10 ml flower extract in 100ml of precursor. At time T=10 min, both 0.05M and 0.01M $AgNO_3$ solution produces the same absorption intensity.

At T=30 min onwards, the intensity level increases for 0.05M compared to 0.01M.The intensity saturated around 96 hrs indicates the completion of reduction process.

Fig 6(b) shows the peak position for UV spectra with different time intervals. The peak positions are same for both 0.05M and 0.01M $AgNO_3$ solution up to 1 hr.



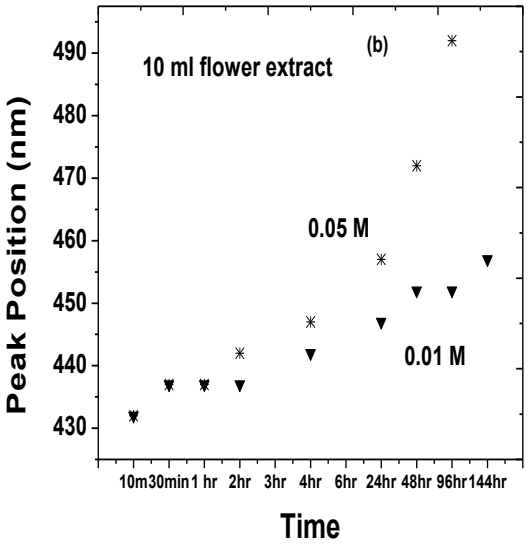


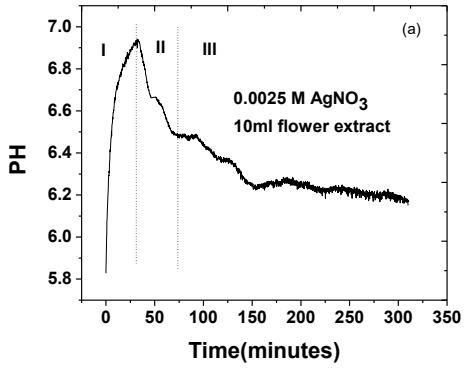
Fig 6 (a) UV absorption with time

(b) Peak position with time

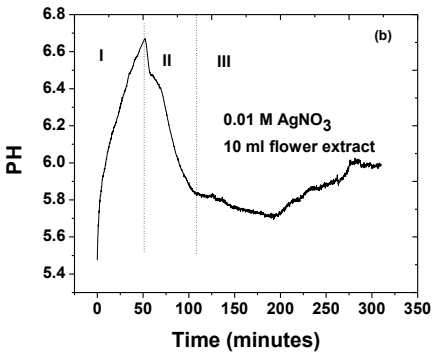
After that the red shift of the peak position is increased for 0.05M compared to 0.01 M. For 0.01 M and 0.05 M the red shift is around 25nm and 60nm respectively. When the precursor mole fraction is higher, the red shift also higher indicates more aggregation of nanoparticles.

pH Calculation

Fig 7(a) and (b) show the pH level for various time interval before, during and after mixing of flower extract with $AgNO_3$ pre cursor. Initially when the $AgNO_3$ is mixed with DI water the pH of the solution (region I) is increased and reached to 6.9 and 6.7 for 0.0025M and 0.01M.



(a) 0.0025 M $AgNO_3$



(b) 0.01 M $AgNO_3$

Fig 7 Variation of pH with time for (a) 0.0025 M and (b) 0.01 M $AgNO_3$ concentration

I-Before mixing II- During mixing

III-After mixing

The increase in pH after adding the $AgNO_3$ in DI water indicates the increase in H+ ions during the dissociation of $AgNO_3$ in to Ag^+ and $NO3^-$. The pH of the flower extract is 4.01. So, during mixing of 10 ml tecoma stans flower extract to 0.0025 M and 0.01 M $AgNO_3$ solution, the pH level starts to decrease up to 6.5 and 5.8 respectively. During mixing (region II) the pH level is reduced due to the reduction of silver ions. After mixing (region III), the pH level is reduced up to 150 min and then it is saturated in the case of 0.0025 M whereas for 0.01M the pH increased from 5.7 to 6.1.

X-ray Diffraction

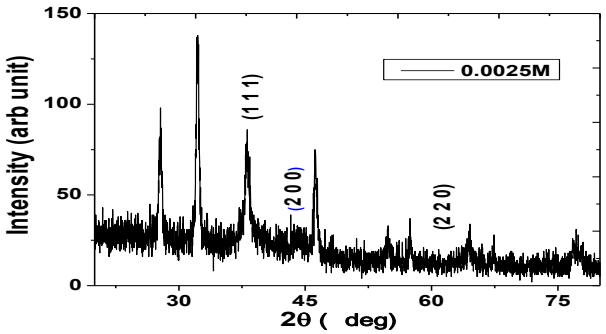
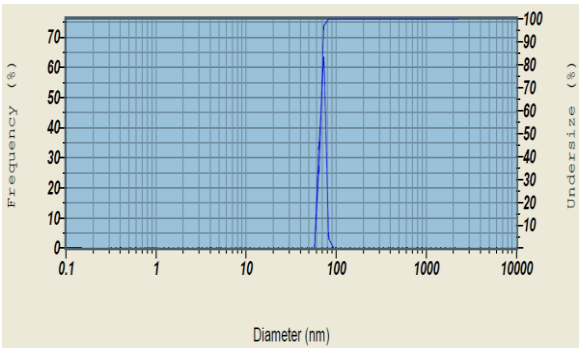


Fig 8 XRD pattern of silver nano particles

Fig 8 shows 0.0025M $AgNO_3$ with 5ml of tecoma stans flower extract XRD pattern of silver nanoparticles.

The peaks at 2θ angles are approximately 38, 43, and 62 corresponds to the (111), (200), and (220) fcc crystal plane.

Particle size analysis



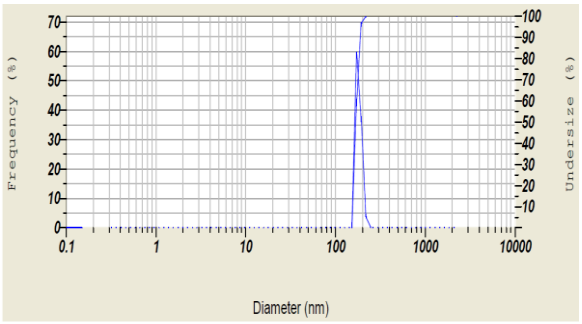
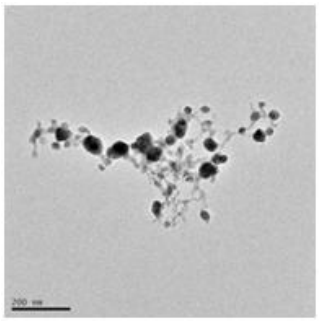


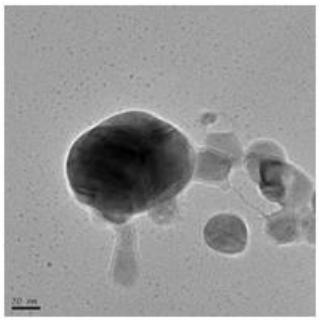
Fig 9 Particle size analysis of silver nano particle for (a) 0.01M and (b) 0.05M $AgNO_3$ with 10 ml tecoma stans flower extract

Fig 9 shows the particle size analysis of silver nano particles for two different mole ratio (0.01M and 0.05M) of $AgNO_3$ with 10ml tecoma stans flower extract in 100 ml of precursor. The particle size can vary from 70 nm to 110 nm when the $AgNO_3$ concentration is increased from 0.01M to 0.05M.

High Resolution –Transmission Electron Microscopy



(a)



(b)

Fig 10 (a) and (b) HR-TEM images of silver nanoparticles prepared for 0.0025M of $AgNO_3$ with 10mL of flower extract at room temperature

The prepared samples are analyzed used TEM in order to determine the sizes and also morphology of the particles. The High Resolution-TEM images of silver nanoparticles is shown in figure 10. By using TEM image clear morphology of silver nano particles with a good distributions are obtained. The coating is assigned to plant organic compounds present in the lower broth. On the surface of the prepared silver nanoparticles, organic compounds of the plant extract are adsorbed and no bond formation will be there because this is simply a physical absorption. The size of the prepared nanoparticles ranges from 20-50nm.

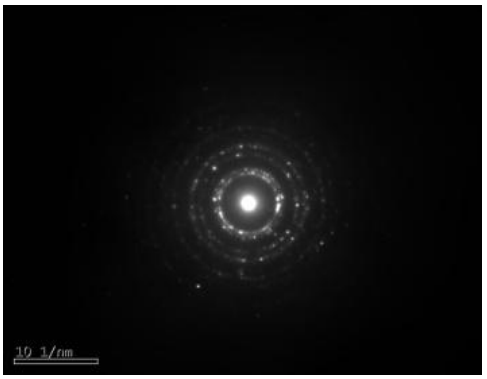
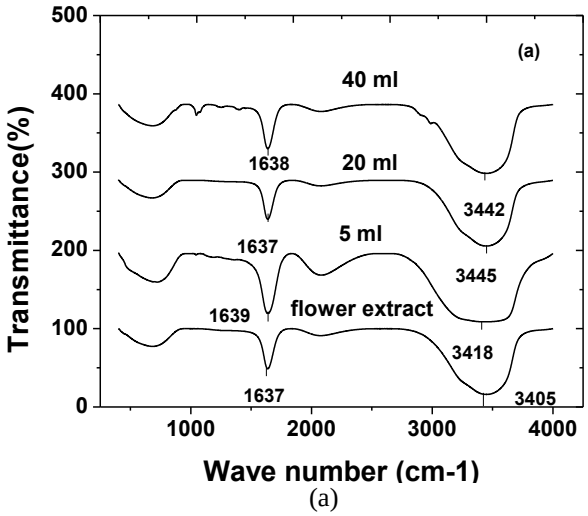


Fig 11 Selected area electron diffraction

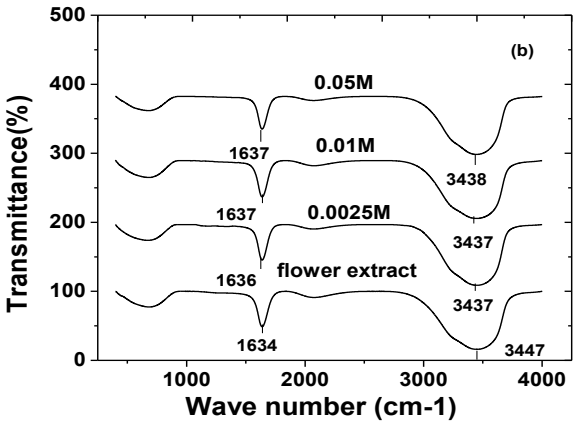
The selected area electron diffraction is shown in figure 11. The selected area electron diffraction (SAED) pattern is obtained by applying the electron beam perpendicular sphere and the sharp spots indicates that the silver nanoparticles are polycrystalline in nature.

Fourier Transform Infrared Spectroscopy

Fourier transform infrared (FTIR) provides the information of changes in functional groups of chemicals, basically found in TS flower extract which was further utilized to bio reduction of silver nanoparticles.



(a)



(b)

Fig 12 shows the Fourier transform infrared spectroscopy images of silver nanoparticles for a) different volume of flower extract and b) different $AgNO_3$ mole concentration. The spectra indicates that,the molecules present in the tecoma stans flower extract perform formation and stabilization of silver nanoparticles. FTIR spectra of Tecoma Stans flower extract clearly show a large number of peaks from 3600 to 3200 cm^{-1}. Around 3400 cm^{-1}, there is a broad peak which attributes to stretching vibration of O−H.

IV. CONCLUSION

The synthesis of silver nanoparticles using the Tecoma stans flower extract is presented. The prepared silver nanoparticle size can be varied from 20nm to 50nm based on the parameters. The size of the particles can be controlled by varying the initial conditions. The reduction and stabilization of silver ions to silver nanoparticles are obtained due to the presence of water-soluble organic compounds in the tecoma stans flower extract. The results show that, the tecoma stans flower extract is one among the best agents for the synthesis of silver nanoparticles. This biological method is potentially attractive for the large scale synthesis and also very useful for environment remediation and also. Compare to conventional methods, it is more reasonable. The silver nanoparticles produced in the above proposed method can be used in solar cells and Optical communications etc.

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AUTHORS PROFILE

Dr.K.R.Kavitha, Professor/ECE, Sona College of Technology, Salem. Her area of interest is Nano Electronics. She has published more than 25 international and National Journals/Conferences.

Dr.S.Vijayalakshmi, AP/ECE, Sona College of Technology, Salem. Her area of interest is Digital Image Processing. She has published more than 20 international and National journals/Conferences.

Dr.B.MuraliBabu, Professor/EEE, Paavai Engineering College, Namakkal. His area of interest is Power Systems. He has published more than 25 international and National journals/Conferences.

K.Karthick, PG Student, Sona College of Technology, Salem. His area of interest is wireless communication and networks.