Green Synthesis of Silver Nano-Particles at Room Temperature

Ranjit Bankar, Lakhan Aade and Pratibha Rao*

Department of Physics, Modern College of Arts, Science and Commerce, Ganeshkhind, Pune-16

Abstract

Nano-particles can be prepared easily by different chemical, physical and biological approaches. But the biological approach is the most emerging approach of preparation, because, this method is easier than the other methods, eco-friendly and less time consuming. In this work green synthesis was done by using the aqueous solution of Azadirachta indica (Neem) and Murraya koenigii (Curry) leaf extract and $AgNO_3$. Silver was of a particular interest for this process due to its evocative physical and chemical properties. A fixed ratio of plant extract to metal ion was prepared and the colour change was observed which proved the formation of nano-particles. The nano-particles were characterized by UV-Vis spectroscopy and X-ray diffraction technique. The UV-VIS spectroscopy shows sharp absorbance around 440 nm, it also reveals the band gap to be around 2.5 eV and 3.2 eV for Ag nano-particles synthesized using Neem leaves and curry leaves respectively. The particle size was found to be 35 nm and 21 nm for Ag nano-particles synthesized using Neem leaves and curry leaves respectively.

Keywords:

Nano-particles, Green Synthesis, UV-Vis spectroscopy X-ray diffraction technique.

1. Introduction

Nano-technology is one of the most rapidly progressing fields of technology and it has opened up numerous new frontiers of research for us. Its advent into the field targeted drug delivery, therapeutic drug delivery, therapeutic actions and as bio sensors has captured the imagination of the scientific community and various methods are being devised to from new nano-particles with more specifications, scientists are striving to come up with methods which let us control the shape, size, specificity and other characteristics of the particles more closely [1].

One of the most and revolutionary technique coming up presently is synthesis of nano-particles using plant extracts has a major edge over methods in terms of its interaction and effect on the environment; it is completely environmentally friendly and does not pose any threats even from its waste. The time required for the formation of particles is also within acceptable limits and with the ease of getting the requisite plants make it one of the best options available in this field to develop the particles [2].

Silver nano-particles are of interest of the unique properties (e. g size and shape depending optical, electrical, and magnetic properties) which can be incorporated into antimicrobial applications, biosensor material, composite fibers, cryogenic, superconducting material, cosmetic products and electronic components. Several physical and chemical methods have been used for synthesizing and stabilizing silver nano-particles[3]. The most popular chemical approaches, including chemical reduction using a variety of organic and inorganic reducing agent, electrochemical techniques, physicochemical reduction and radiolysis are widely used for the synthesis of silver nano-particles. Recently, nano-particles synthesis is among the most interesting scientific areas of inquiry, and there is growing attention to produce nano-particles using environmentally friendly method (green synthesis) [3-5].

Green synthesis approaches include mixed-valence polyoxometalates, tollens, polysaacharides, biological, and irradiation method which have advantages over conventional method involving chemical agents associated with environment toxicity. Green synthesis is economical, energy efficient low cost and pollution free method.

In this work we have synthesized silver nano-particles using green synthesis. The nano-particles were characterized by UV-Vis spectroscopy and X-ray diffraction technique. The UV-VIS spectroscopy shows sharp absorbance around 440 nm, it also reveals the band gap to be around 2.5 eV and 3.2 eV for Ag nano-particles synthesized using Neem leaves and curry leaves respectively. The particle size was found to be 35 nm and 21 nm for Ag nano-particles synthesized using Neem leaves and curry leaves respectively.

2. Experimental

2.1. Green synthesis of silver nano-particles

Preparation of plant extract:

Fresh leaves of Azadirachtaindica (Neem) and morrayakoenigii (curry) leaves were collected, and washed several times with water to remove the dust particles and then sun dried to remove the residual moisture and grinded to form powder. Then plant extract was prepared by mixing 25g filtrate of plant extract with 100 ml of distilled water in conical flask. Then the solution was incubated for 30 min. and then subjected to centrifuge for 30 min at room temperature with 5000 rpm. The supernatant was separated and filtered with (mm filter paper pore size) filter paper. Then the solution was used for the reduction of silver ions to silver nano-particles.

The prepared leaves extract (1ml) was added to 0.001M and 0.0008M aqueous solution of silver nitrate ($AgNo_3$) and allowed to react at ambient conditions. The observed colour change from transparent to yellow and yellow to dark brown indicates the formation of silver nano-particles. Two different samples of using Neem leaves extract and two using Curry leaves extract were synthesized. The four different samples are explained in table below (Table1).

Table1 Different synthesized samples

Sample	Leaves extract	$AgNo_3$ Solution
N1	Neem =1ml	0.001M
N2	Neem= 3ml	0.001M
C1	Curry =1ml	0.001M
C2	Curry = 3ml	0.001M

This process is schematically shown in Fig.1. Further the reduction of Ag^+ ions is observed over time by UV-Vis spectroscopy for about 1hour and 30min.The formation of Silver nano-particles was also confirmed using X-ray diffraction technique.

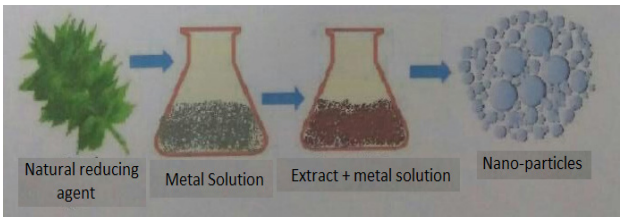

Fig.1: Schematic of synthesis of Ag- nano-particles

The water soluble ingredients present in the extract are responsible for reduction of metal ions and stabilisation of nano-particles and also act as capping agent. Possible chemical reaction is shown in Fig.2 and flowchart of process is shown in Fig.3.

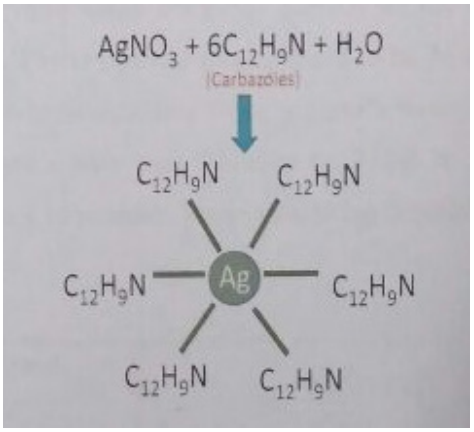

Fig.2: Chemical reaction

3. Results and discussion

3.1 UV-VIS spectroscopy

UV-Vis absorption spectra were obtained for all the samples at different time intervals up to 80 min. The absorption peak was observed at 440 nm for all the samples which confirms the formation of silver nano-particles. From the graph it is observed that with time absorption increases. This reveals increase in amount of silver nano-particles as the time passes.

To investigate the effect of different extract viz. Neem and Curry leaves of various concentrations (1 ml and 3 ml) on the synthesis

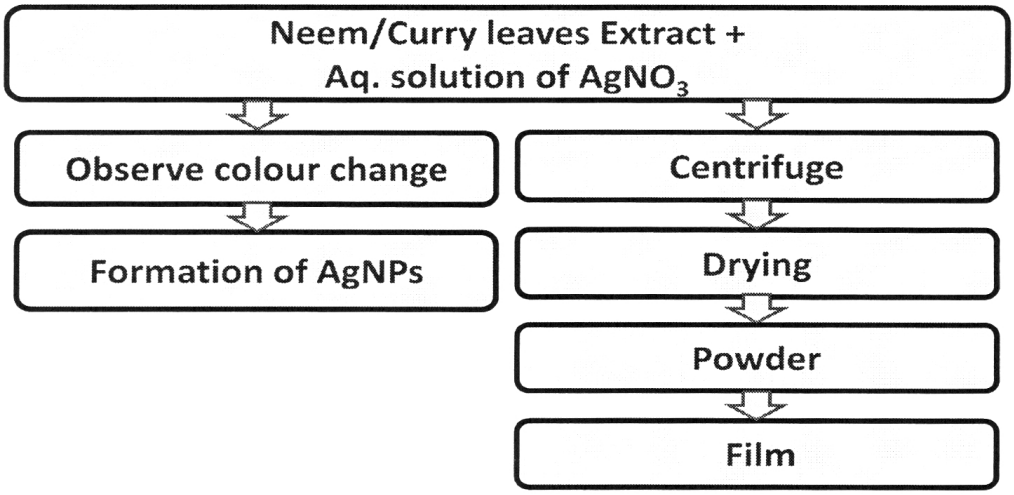

Fig.3: Flow chart for Green Synthesis of Ag- nano-particles

of silver nano-particles, the readings were recorded on spectrophotometer [6].

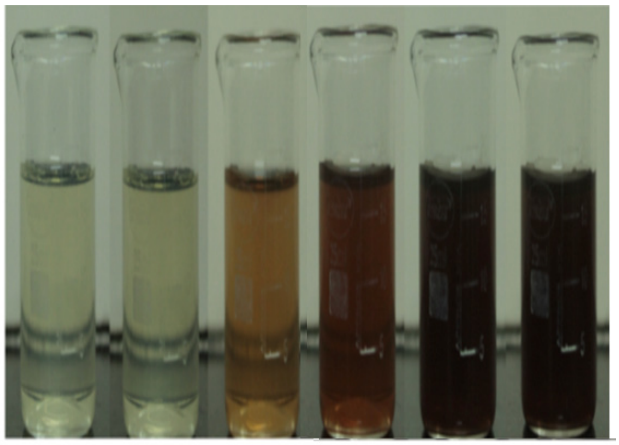

Fig.4(a) Change in colour with time for Ag nano-particles synthesized using Neem leaves

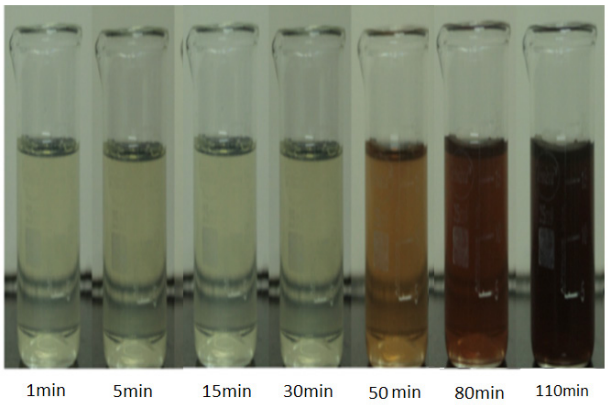

Fig. 4(b) Change in colour with time for Ag nano-particles synthesized using Curry leaves

Fig. 4(a) and (b) shows initially there is no formation of silver nano-particles. When colour changes from transparent to yellow, silver nano-particles form. The colour changes to brown means concentration of silver nano-particles increases.

Fig.5 (a), (b), (c), (d) shows the result of UV-Vis spectroscopy scan at various time intervals. Peak is observed at 440 nm. With increase in time, absorbance increases due to increase in concentration of silver nano-particles. Also with increase in time peak slightly shifts towards higher wavelength which indicates the increase in particles size. It reveals that with increasing the amount of leaves extract, particle concentration and particle size increases. Also it is observed that, for neem extract formation of silver nano-particles take place fast compare to curry leaves extract. Band gap silver nano-particles was calculated from absorption spectra using the following formula [7],

$$Eg = \frac{1240}{\lambda \text{ in nm}}$$

It is found to be 2.7 eV and 2.83 eV for silver nano-particles synthesized using Neem leaves and Curry leaves respectively. Therefore, band gap is more for Curry leaves sample.

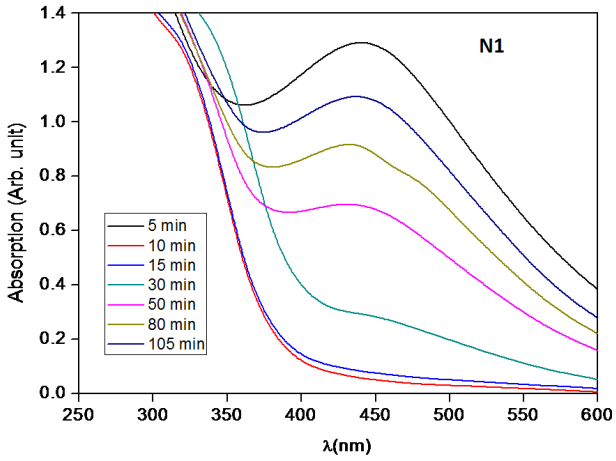

Fig. 5 (a) Absorption spectra for N1(Neem =1ml)

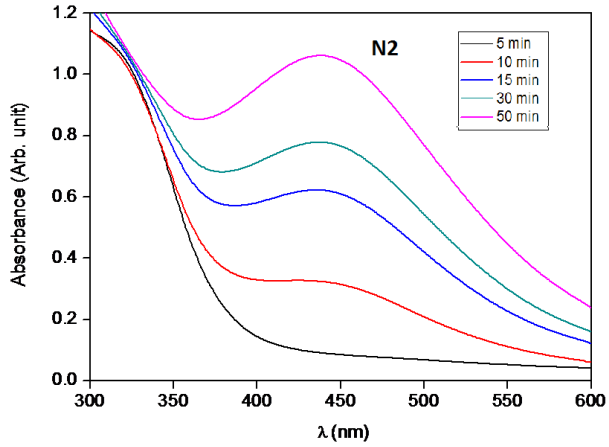

Fig. 5 (b) Absorption spectra for N2 (Neem = 3ml)

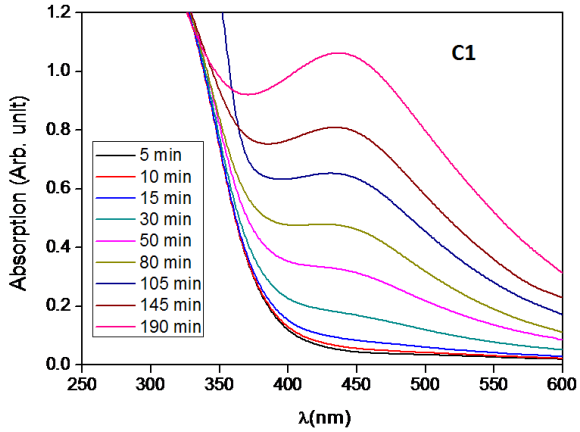

Fig. 5 (c) Absorption spectra for C1 (Curry Leaves =1ml)

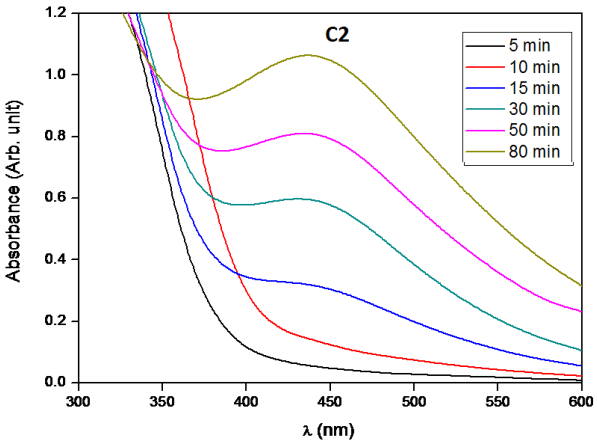

Fig. 5 (d) Absorption spectra for C2 (Curry Leaves =3ml)

3.2 X-ray diffraction technique

The structure of prepared silver nanoparticles has been investigated by X-ray diffraction (XRD) technique. Typical XRD patterns of the sample, prepared by the present method are shown in the Fig.6.

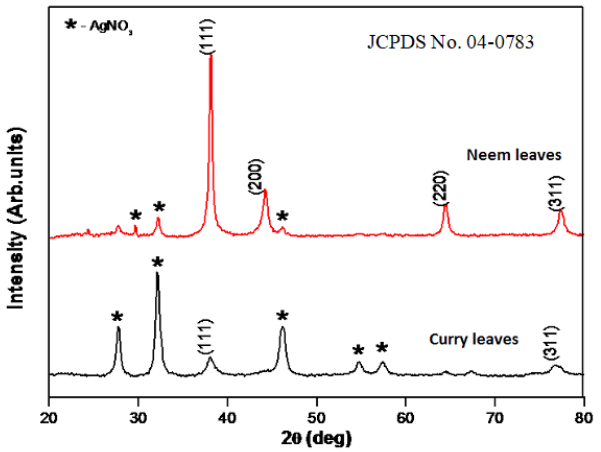

Fig.6. XRD of Ag-nano-particles

The XRD study indicates the formation of silver (Ag) nano-particles. The experimentally obtained X-ray diffraction angle matches with the standard diffraction angle of JCPDS No. 04-0783. In addition to these peaks, some peaks of $AgNo_3$were also observed. This is due to the incomplete reduction of $AgNo_3$. Particle size was calculated using Debye-Scherrer formula. It is found to be 35 nm and 21nm for silver nano-particles synthesized using Neem leaves and Curry leaves respectively [8].

Hence the particle size of silver nano-particles

synthesized using Neem leaves is greater compare to that of Curry leaves. This result also matches with UV-Vis spectroscopy analysis i.e. as particle size decreases band gap increases.

3.3 Conclusions

- The UV-VIS spectroscopy shows sharp absorbance around 440nm.
- With increase in time, absorbance increases due to increase in concentration of silver nano-particles.
- It also reveals the band gap is 2.7 eV and 2.83 eV for silver nano-particles synthesized using Neem leaves and Curry leaves respectively.
- Band gap is more for Curry leaves sample.
- XRD study shows contribution of $AgNo_3$ along with Ag which is in Curry leaves sample compare to Neem sample.
- The particle size of silver nano-particles synthesized using Neem leaves is greater compare to that of Curry leaves.
- XRD result also matches with UV-Vis spectroscopy analysis i.e. as particle size decreases band gap increases.

References

1. M. Lhadi, Hybrid Nanocomposites for Nanotechnology, Springer, New York, 2009.
2. S.K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Co., Delhi, 2007.
3. Afreen, B. and Vandana, A. (2011) Synthesis and characterization of silver nanoparticles by rhizopus stolonier. Int. Biomed. Adv. Res., 2: 148–158.
4. Ahlawat, J. and Sehrawat, A.R. (2015) Biological synthesis of silver nanoparticles using aqueous leaf extract of Capparis decidua (forsk.) edgew: a better alternative. J. Pharm. Res., 9: 244–249.
5. Ahmad, N., Sharma, S., Singh, V.N., Shamsi, S.F., Fatma, A. and Mehta, B.R. (2011) Biosynthesis of silver nanoparticles from Desmodium triflorum: a novel approach towards weed utilization. Biotechnol. Res. Int., 8.
6. E.C. Subbarao, L.K. Singhal, D. Chakravorty, M.F. Merriam and V. Raghavan, Experiments in Materials Science, Tata Magraw Hill Publishing Co. Ltd., New York, 1972.
7. C. Kittel, Introduction to Solid State Physics, John Wiley and Sons, New York, 1996.
8. B.D. Cullity and S.R. Stock, Elements of X-Ray Diffraction, Prentice-Hall, New Jersey, 2001.