International Conference on Frontiers in Life and Earth Science
© 2018 IJSRST | Volume 5 | Issue 1 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X

Synthesis of Silver and Gold Nano-particles Using co-precipitation Method

Nitin Longadge[1], Anjali Rahatgaonkar[2], Swati Raut[3] , AmolNande*[4]
[1]Regional Forensic Science Laboratory, Amravati, Maharashtra, India
[2]Institute of Forensic Science, Nagpur, Maharashtra, India
[3]Department of Physics, RTM Nagpur University, Nagpur, Maharashtra, India
[4]Guru Nanak College of Science, Ballarpur, Maharashtra, India

ABSTRACT

In continuation of the efforts a chemical method for in situ synthesis of gold and silver nanoparticles using co-precipitation method under ambient conditions has been reported. $NaBH_4$ was used as a reducing reagent to perform the reaction. The obtained nanoparticles have been investigated by Transmission Electron Microscopy. The process is easy to make and size can be controlled using reduction reagent.

Keywords: Gold nanoparticle, Silver nanoparticle, transmission electron microscopy, nanoparticles, co-precipitation synthesis

I. INTRODUCTION

Over the past few decades, nanoparticles of noble metals such as gold and silver displayed noticeably varied physical, chemical and biological properties from their bulk counterparts. Nano-size particles of less than 100 nm in diameter are presently attracting increasing interest for the broad variety of new applications in diverse fields of industry.[1] Nanoparticles are of immense scientific significance as they viaduct the gap between bulk materials and atomic or molecular structures[2]

Metal nanoparticles particularly gold and silver have fascinated significant importance in biotechnology, bioengineering, textile engineering, water treatment, metal-based consumer products and other areas, electronic, magnetic, optoelectronics, and information storage, catalysis, optics, sensing, imaging and biomedical devices [3].

Metal nanoparticles can be prepared by two routes, the first one is a physical approach that utilizes several methods such as evaporation/condensation and laser ablation. The second one is a chemical approach in which the metal ions in solution are reduced in conditions favoring the subsequent formation of small metal clusters or aggregates [4-6]. Number of methods have been developed for the preparation of metal nanoparticles, such as photolytic reduction[7], radiolytic reduction [8],sonochemical method [9], solvent extraction reduction [10], microemulsion technique [11] polyol process [12] and alcohol reduction [13].

Recently, chemist, physicist and material scientists have shown great significance in the development of new methods for the synthesis of nanomaterials. Physical and chemical properties of these materials are highly size dependent therefore, it is important to develop novel techniques for the synthesis of smaller and monodispersed nanomaterials.

In this paper we have reported a one pot synthesis method to prepare pure gold and silver nanoparticle using co-precipitation method with uniform size at ambient condition (air atmosphere and at room temperature) by sodium borohydride as a reducing agent. The samples were characterized using transmission electron microscopy (TEM).

II. MATERIALS AND SAMPLE PREPARATION

In the presented work, we have used silver nitrate ($AgNO_3$), chloroauric acid ($HAuCl_4.H_2O$), triply distilled water (H_2O), 1 % tri-sodium citrate and $NaBH_4$. All used chemicals were of synthesis grade and all the solvents are distilled prior to use.

Silver nanoparticles were prepared by the reduction of silver nitrate using co-precipitation process. 1 % tri-sodium citrate and $NaBH_4$ are acts like reducing agents for this process.

Gold nanoparticles were also prepared by the reduction reaction using co-precipitation method. Gold chloride (4%) solution and sodium citrate solution were made in deionized H_2O. The addition of sodium citrate solution to the gold chloride initiated series of reduction reaction characterised by changes in the color of the initial gold chloride solution. The silver and gold nanoparticles were concentrated by centrifugation of the reaction mixture at 10,000 rpm for 10 min and then were collected. The obtained nanoparticles were stored at room temperature in dark bottles.

III. RESULTS AND DISCUSSION

Previous studies showed that [14-16] several of reduction reactions are characterized by changes in the color as the reaction progressed. The Ag nanoparticles reaction mentioned in this work also showed the change in color as our reaction progressed – the solution were transparent liquid and it changed to pale yellow followed by the formation of colloidal solution, as shown in Figure 1.

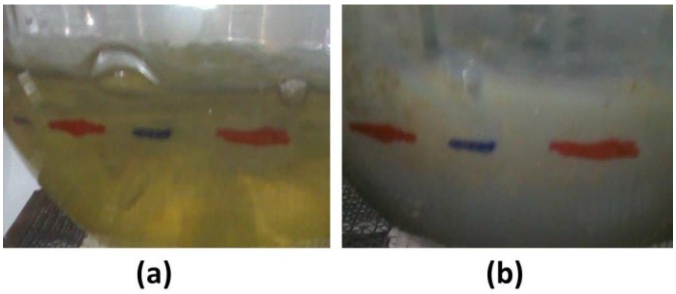

Figure 1. The change in sequence of the color of the reduction reaction during silver nanoparticle formation. (a) After some time during boiling the liquid changed to pale yellow color. (b) At the end of the reaction we have observed the colloidal solution.

A similar reduction reaction (change in color) was observed during gold nanoparticle reaction. However the color changes from pale yellow to blackish purple, as shown in Figure 2. These colloidal solutions were centrifuged for 10000 rpm and the nanoparticles were stored in dark bottles which were used for further characterizations.

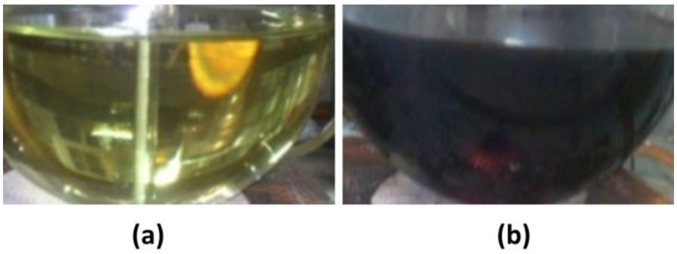

Figure 2. The change in sequence of the color of the reduction reaction during gold nanoparticle formation. (a) After some time during boiling the liquid changed to pale yellow color. (b) At the end of reaction the color was changed to blackish purple color.

The changed in color of the both reaction i.e. for silver nanoparticle and gold nanoparticle confirmed that the reactions were successfully carried out and on can expect that the silver and gold nanoparticles were formed.

Transmission Electron Microscopy Study

Transmission is used as a primary tool to determine physical characteristics and the size of the nanoparticles. The samples were scan at various scan sizes from 20 nm – 200 nm as shown in Figure 3.

From the figure it is clear that the nanoparticles of silver and gold are formed with a fairly even size. Hence the distribution is also fairly even size distribution. Many particles fell within in ~ 20 nm particle size for both silver and gold nanoparticles.

From the figure (especially 20 nm scaled figure – third from left in for silver and gold system) some nanoparticles aggregated and formed a comparative bigger size. It is observed that the normal size nanoparticles were coagulating around the large particle in a circular order. However, the average still these bigger particles are in nano-meter size.

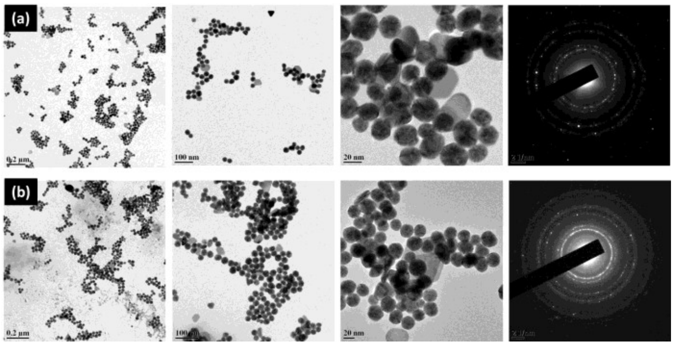

Figure 3. High-resolution TEM images of silver nanoparticle at various scan. (a) 0.2 μm scanned Ag-nanoparticles. (b) 20 nm scanned Ag-nanoparticles to show that the distribution is nearly uniform. (c) 20 nm scanned Ag-nanoparticles to show the formation of aggregated nanoparticle.

Thus from the above observation, it confirmed that silver and gold nanoparticles were successfully synthesized using co-precipitation method and $NaBH_4$ as a reduction agent.

IV. CONCLUSION

The study shows that the silver nanoparticles prepared using co-precipitation method using $NaBH_4$ as a reducing agent. The distribution of particles was uniformly distributed and the nanoparticles size was ~ 20 nm.

V. REFERENCES

[1] K.M.A. El-Nour, A.a. Eftaiha, A. Al-Warthan, R.A. Ammar, Arabian journal of chemistry 3 (2010) 135-140.

[2] K.N. Thakkar, S.S. Mhatre, R.Y. Parikh, Nanomedicine: Nanotechnology, Biology and Medicine 6 (2010) 257-262.

[3] Z. Zaheer, Colloids and Surfaces B: Biointerfaces 108 (2013) 90-94.

[4] G. Khomutov, S. Gubin, Materials Science and Engineering: C 22 (2002) 141-146.

[5] M.M. Oliveira, D. Ugarte, D. Zanchet, A.J. Zarbin, Journal of colloid and interface science 292 (2005) 429-435.

[6] E. Egorova, A. Revina, Colloids and Surfaces A: Physicochemical and Engineering Aspects 168 (2000) 87-96.

[7] S. Remita, M. Mostafavi, M. Delcourt, Radiation Physics and Chemistry 47 (1996) 275-279.

[8] J.H. Hodak, A. Henglein, G.V. Hartland, Photophysics of nanometer sized metal particles: Electron– Phonon coupling and coherent excitation of breathing vibrational modes, ACS Publications, 2000.

[9] Y. Mizukoshi, K. Okitsu, Y. Maeda, T.A. Yamamoto, R. Oshima, Y. Nagata, The Journal of Physical Chemistry B 101 (1997) 7033-7037.

[10] M. Brust, M. Walker, D. Bethell, D.J. Schiffrin, R. Whyman, Journal of the Chemical Society, Chemical Communications (1994) 801-802.

[11] K. Osseo-Asare, F. Arriagada, Ceramic Powder Science III (1990) 3-16.

[12] L. Kurihara, G. Chow, P. Schoen, Nanostructured Materials 5 (1995) 607-613.

[13] H. Huang, X. Ni, G. Loy, C. Chew, K. Tan, F. Loh, J. Deng, G. Xu, Langmuir 12 (1996) 909-912.

[14] R.S. Chorghade, M.K. Gaidhane, A.M. Rahatgaonkar, M.S. Chorghade, Facile polymer supported synthesis of N-PEGylated quinoline scaffolds, AMER CHEMICAL SOC 1155 16TH ST, NW, WASHINGTON, DC 20036 USA, 2014.
[15] S.T. Dubas, V. Pimpan, Talanta 76 (2008) 29-33.
[16] D. Philip, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 71 (2008) 80-85.