International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 06, June 2017
www.ijates.com
ijates
ISSN 2348 - 7550

Synthesis of Self-Organized Silver Nanoparticles Via Thermal Decomposition of $AgNO_3$ on Glass Substrate

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ABSTRACT

In this study, silver nanoparticles were synthesized via thermal decomposition of aqueous solution of silver nitrate coated on glass slides at very low temperature condition. The particles were spherical in shape with average sizes between 70 to 90 nm, and are due to thermal reduction of $AgNO_3$ at low temperature of sintering. These free standing silver nanoparticles prepared by this method are free from contamination and are suitable for use in semiconductor industry.

Keywords: Silver nanoparticles, thermal decomposition.

I. INTRODUCTION

Materials at nano form exhibited extraordinary properties; usually differ from those of the bulk material. Metals nanoparticles have recently been an important focus of research due to their unusual electrical, optical and thermal properties. In addition to this there has been a special interest in the study of metal nanoparticles with the increasing developments in the field of nano-engineering, nano-electronics and nano-bioelectronics. Novel metal nanoparticles (silver and gold) have electrons moving freely in close lying conduction and valance bands, which results in highest electrical and thermal conductivity among all metals. Moreover, the free electrons give rise to a surface plasmon absorption band, which depends on both the particle size and chemical surroundings.

Synthesis of well defined one-dimensional silver nanostructures is a major goal now a day. A large number of reports are available on the synthesis of metal and semiconducting nanoparticles in solution by various ways such as photochemical reduction, electrochemical techniques and chemical reduction. Synthesis of silver nanoparticles is a significant area of research, because Ag nanoparticles have potential applications in various fields such as biochemistry, environment, medicine, catalysis, electronics and optics [1–4].

In the present work, we have synthesized silver nanoparticles on glass substrate via thermal decomposition of AgNO3 at two different temperatures. The synthesized silver nanoparticles have been characterized by X-ray diffraction (XRD), UV-Vis absorption spectrscopy, Scanning electron microscope (SEM) and Energy dispersive X-ray (EDX) analysis techniques.

II. EXPERIMENTAL

For synthesis of Ag nanoparticles, solution was prepared by mixing 0.001 M $AgNO_3$ in distilled water. A thin film of this solution was formed on clean glass slide of size 2.5 x 2.5 x 0.2 mm. This thin film was kept for drying at room temperature in dark room to avoid photo-degradation of $AgNO_3$. This film was them kept for

sintering in muffle furnace at atmospheric condition at 100 and 150 ^{o}C for 1 hour. The obtained film sample was then analysed by XRD, UV-Vis absorption, SEM and EDX techniques.

III. RESULTS AND DISCUSSION

The recorded XRD spectra of the Ag nanoparticles thin film obtained via thermal decomposition of $AgNO_3$ on glass substrate at 150 ^{o}C are shown in Figure 1.

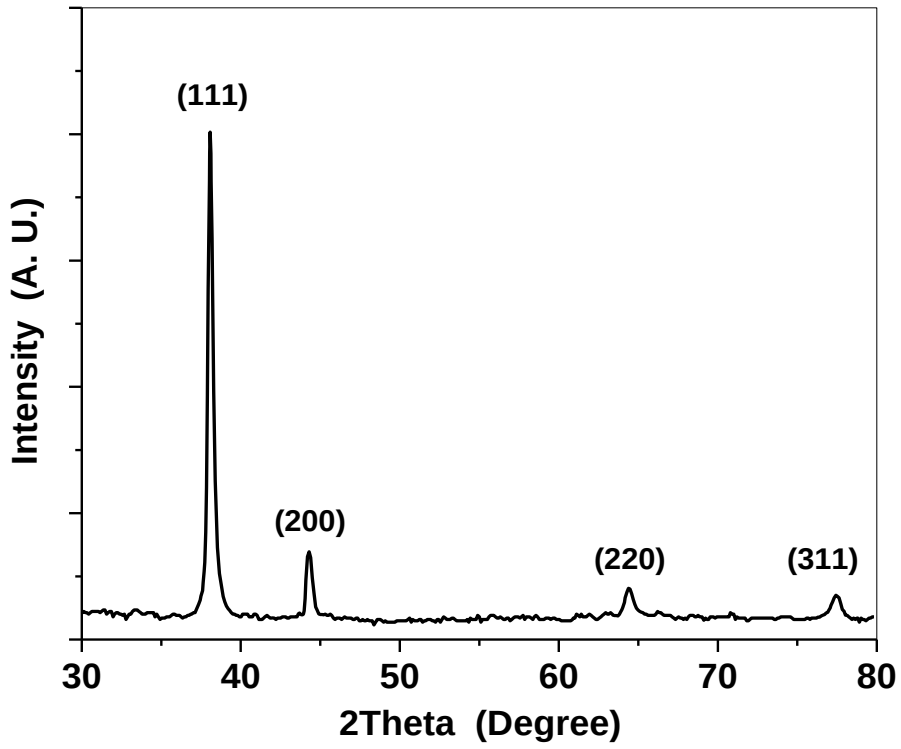


Figure 1: The recorded XRD spectra of the Ag nanoparticles thin film obtained via thermal decomposition of $AgNO_3$ on glass substrate at 150 ^{o}C.

The XRD peaks appeared at the same positions of the bulk Ag are known to appear. The four distinct XRD peaks as shown Figure 1 at 2θ values of 38.40, 44.30, 64.40 and 77.40 represent the (111), (200), (220) and (311) crystalline planes of the face centred cubic Ag crystal structure [2,5,6]. The sizes of the particles were estimated by analyzing the XRD spectra using Scherrer's formula [7]. The average Ag particle size distribution estimated from the XRD spectra are 70 to 90 nm for the samples sintered at 100 and 150 ^{o}C, respectively.

The optical absorption spectrum for the Ag nanoparticles thin film obtained via thermal decomposition of $AgNO_3$ on glass substrate at 100 and 150 ^{o}C are shown in Figure 2. Sample sintered at 100 ^{o}C is dominated by a single absorption peak at ~ 455 nm, which corresponds to the surface plasmon absorption peak of the spherical Ag nanoparticles [8]. It can be seen in Figure 2 that, the plasmon absorption peak appeared at ~ 455 nm for 100 ^{o}C sintered sample shifts to higher wavelength ~ 479 nm for the sample sintered at 150 ^{o}C. This shift of ~ 24 nm in the plasmon absorption peak reveals that the size of the Ag nanoparticles increases with increase in the sintering temperature.

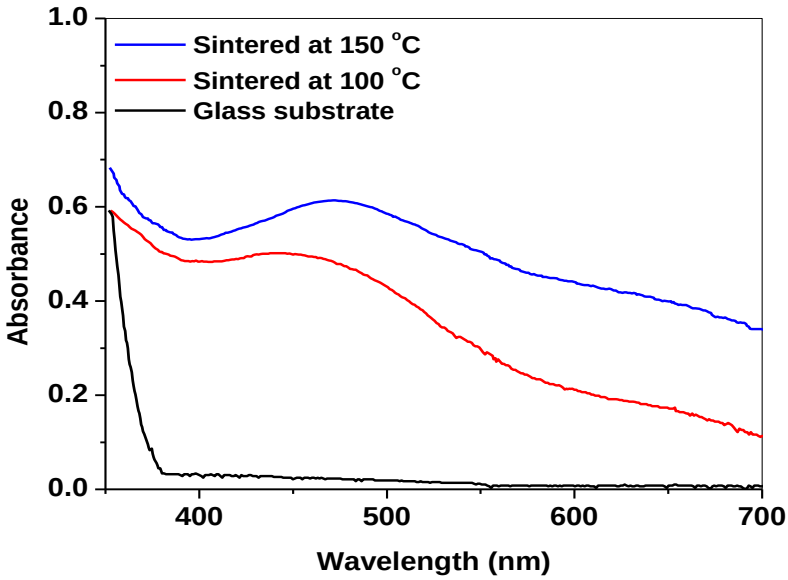
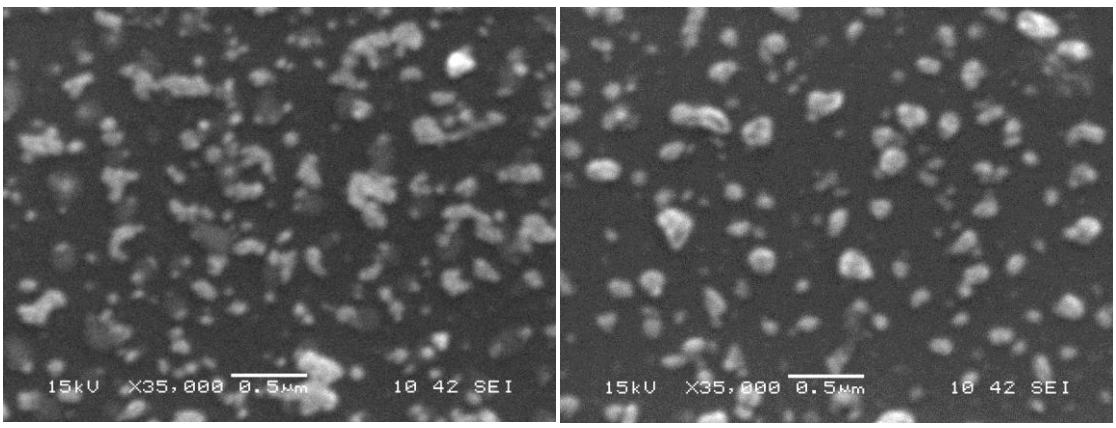


Figure 2: The optical absorption spectra of Ag nanoparticles thin film obtained via thermal decomposition of AgNO3 on glass substrate at 100 and 150 °C.

The SEM images of the Ag nanoparticles thin film coatings on glass sintered at 100 and 150 °C are shown respectively in Figure 3. A comparison reveals that in the sample sintered at 100 °C, the number of the Ag particles of sizes in the range of ~ 70 to 90 nm is greater than those of sizes in the range ~ 150 to 250 nm. However, in the sample sintered at 150 °C, the number of Ag particles of sizes in the range ~ 150 to 250 nm is greater than that of sizes in the range ~ 70 to 90 nm. These SEM results clearly reveal that, the rate of agglomeration of the Ag particles on glass substrate increases with increasing sintering temperature.



(a) **(b)**

Figure 3: SEM images of the Ag nanoparticles thin film coatings on glass sintered at (a) 100 and (b) 150 °C.

The presence of Ag nanoparticles in the thin film coatings made via thermal decomposition ofAgNO3 on glass substrate was confirmed using an elemental analysis technique such as Energy dispersive spectroscopy (EDS). The recorded EDS spectrum for the Ag nanoparticles synthesized at sintering temperature of 150 °C is shown in

Figure 4. The presence of Ag in the thin film coating can be identified by the presence of Ag line at E = 2.983 keV and from the substrate of Si a strong Si line at E = 1.739 keV. The observed core level x-ray line indicates that the thin coatings contain Ag nanoparticles.

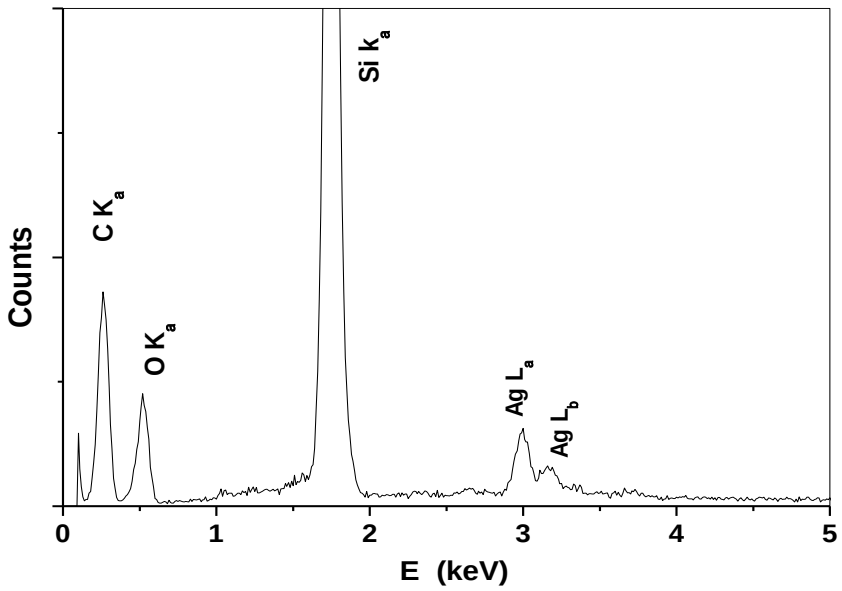


Figure 4: EDS spectra for the thin film coatings made via thermal decomposition of AgNO3 on glass substrate at 150 ^{o}C.

The results shown in above study clearly indicate that the sintering temperature plays an important role in decomposing $AgNO_3$ and controlling the size of Ag nanoparticles. The literature survey show that the surface plasmon peak is strongly depends on the particle size under identical conditions of the precursor. The increase in the nanoparticles size with increasing sintering temperature shift in the surface plasmon absorption peak position towards right side of spectra.

IV. CONCLUSION

Silver nanoparticles were prepared by decomposing thin film of AgNO3 coated on glass substrate on sintering. The optical study reveals that the surface plasmon peak of silver nanoparticles is affected by the sintering temperature. The XRD result reveals polycrystalline silver nanoparticles can be synthesizes on glass substrate via above method. SEM measurements shows that the silver nanoparticles synthesized in solution have spherical shape with size distribution in the range 70 to 90 nm.

REFERENCES

[1] P. S. Alegaonkar, A. B. Mandle, S. R. Sainkar and V. N. Bhoraskar, Nucl. Instr. and Meth. B 194 (2002) 281.

[2] M. K. Temgire and S. S. Joshi, Radiat. Phys. Chem. 71 (2004) 1039.

[3] Wei-Tai Wu, Yusong Wang, Lei Shi, Qingren Zhu, Wenmin Pang, Guoyong Xu and Fei Lu, Nanotechnology 16 (2005) 3017.

[4] Y. Sun and Y. Xia, Science 298 (2002) 2176.

[5] M. Kumar, L. Varshney and S. Francis, Rad. Phys. Chem. 73 (2005) 21

[6] I. Hussain, B. Mathias, A. J. Papworht and A. I. Cooper, Langmuir 19 (2003) 4831.

[7] B. D. Cullity, Elements of X-ray Diffraction (Addision-Wesley, New York, 1959).

[8] R. He, X. Qian, J. Yin and Z. Zhu, J. Mater. Chem. 12 (2002) 3783.