PREPARATION OF SILVER NANOPARTICLES IN SILVER NITRATE SOLUTION BY USING TANNIN

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Preparation of silver nanoparticles in silver nitrate solution using tannin as a reductant and sodium carbonate-as a solution stabilizer was performed. Spectrophotometric and electron-microscopic methods were used to investigate the process of synthesis of silver nanoparticles. The effect of microwave power on the formation of nanoparticles was analyzed.

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Introduction

Silver nanoparticles possess unique physical, chemical and bactericidal properties, which determine their widespread use in electronic, optical and sensor devices, in medicine, etc. Among chemical methods of preparation of silver nanoparticles, the most generally employed is the method of formation of silver nanoparticles in water solution by using various reductants and stabilizers.[1,2] Toxic substances such as sodium borhydride and hydrazine are often used as reductants. Hence, it is topical to develop the technology of preparation of silver nanoparticles by using nontoxic agents (reductants and solution stabilizers). The use of the exposure to high-energy physical fields, such as the microwave electromagnetic one, in combination with chemical methods is quite efficient. As is well known, the elevation of temperature is one of widespread methods for acceleration of chemical reactions. When a solution is heated up by traditional methods, heat transfer occurs gradually via heat conduction, convection or radiation mechanism, which is always associated with emergence of a temperature gradient. In case of the exposure to microwave radiation, the whole body of the solution is heated up immediately.[3,4]

Experimentals

We used tannin as a reductant and sodium carbonate, being the source of carbonate ions, as a stabilizer. Distilled water was user for dilution. The solution was prepared at room temperature. The solutions of tannin and sodium carbonate (10^{-5} M) were added to silver nitrate solutions of $5\cdot10^{-4}$ and $5\cdot10^{-3}$ M under continuous stirring. The pH value of the prepared solutions was equal to 5.77. The silver nitrate solution was placed in microwave oven Saturn equipped with a rotating table. The microwave power was 600 W and the exposure duration was 4 min.

The optical absorption spectra of the prepared solution were measured with an UV-vis spectrometer Sintra 10e. The spectra were detected at room temperature.

Electron microscope Jem100–SX was used for the electron-microscopic investigation.

Results and Discussion

The silver nanoparticles prepared in silver nitrate solutions using tannin as reducing agent and sodium carbonate as source of carbonate ion as stabilizer were performed at at pH=5.77. The exposure for microwave irradiation was 4 min. The UV-Vis spectra of the reaction mixtures formed with or without microwave irradiation contain well-defined plasmon bands with a peak at 420 nm, which is characteristic of silver nanoparticles (Figures 1 and 2).

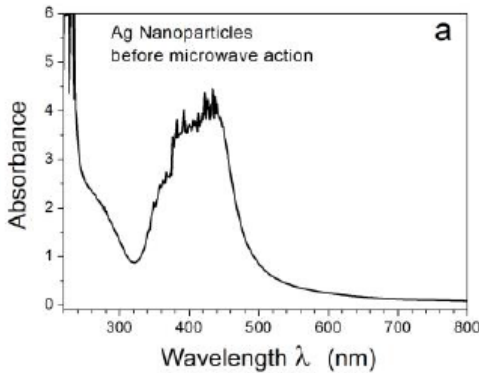

Figure 1. Absorption spectra of silver nanoparticles in silver nitrate solution $5\cdot10^{-3}$ M

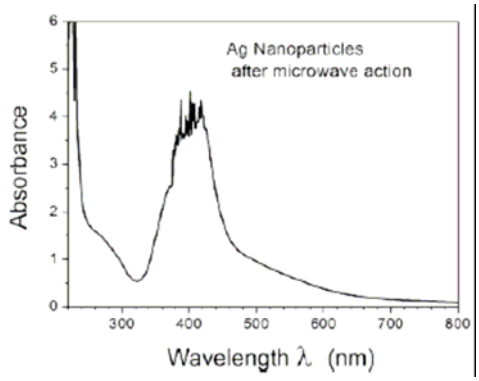

Figure 2. Absorption spectra of silver nanoparticles in silver nitrate solution (10^{-3} M) after the exposure to the microwave field.

The obtained nanoparticles proved to be crystalline (Fig. 3). The size distribution of nanoparticles before microwave action is shown in Figure 4. As it can be seen from the microphotographs, the solutions of nanoparticles generally contained spheroids 15 – 20 nm in size. A small amount of larger nanoparticles 30 – 40 nm in size was also observed.

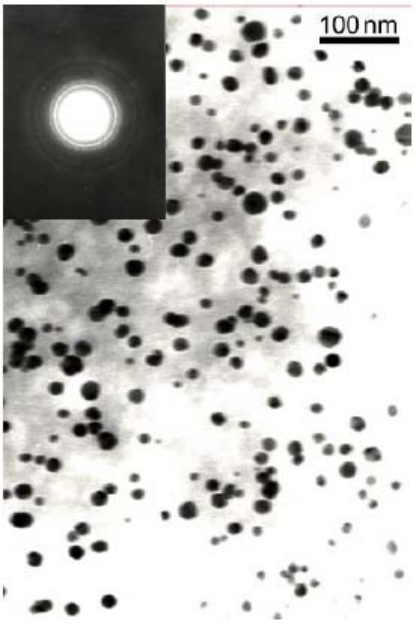

Figure 3. Electron-microscopic microphotograph of silver nanoparticles before the exposure to the microwave field.

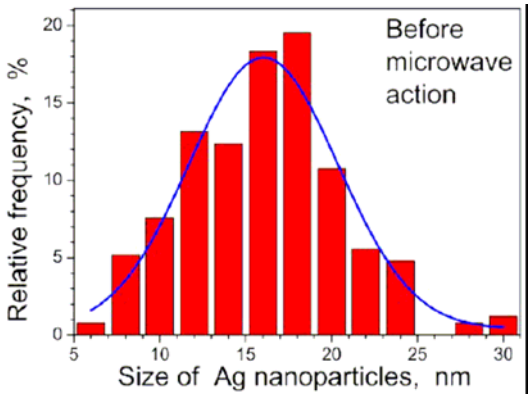

Figure 4. Size distribution of silver nanoparticles before the exposure to the microwave field.

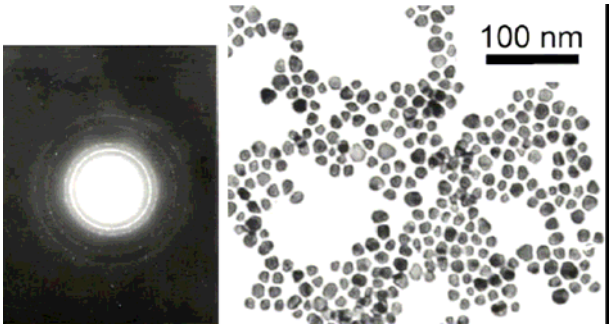

Figure 5. Electron-microscopic microphotograph of silver nanoparticles after the exposure to the microwave field.

The Electron-microscopic investigation performed after the exposure of the samples to the microwave field showed that there had taken place changes in the shape and size of the nanoparticles (Figure 5). The size of nanoparticles reduced and made up 10–15nm.To analyze the size distribution of nanoparticles, we constructed relevant histograms. IT is seen that, after the exposure to the microwave field, the nanoparticles were distributed within a much narrower size range than before it (Figure 6).

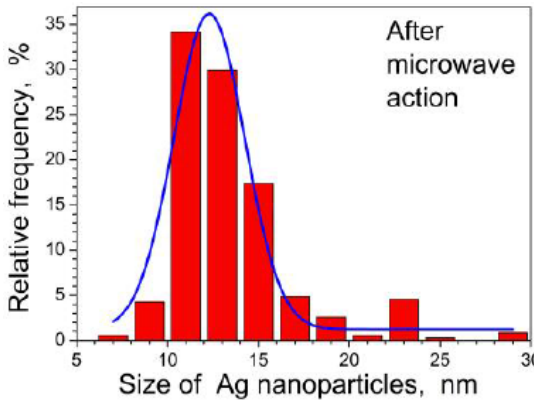

Figure 6. Size distribution of silver nanoparticles after the exposure to the microwave field.

The experiments showed that sodium carbonate possessed good stabilizing properties. The prepared solution of silver nitrate containing silver nanoparticles retained its properties during a month, and there was no aggregation.

Conclusions

Using tannin as a reductant and sodium carbonate as a solution stabilizer proved to be a promising method for the preparation of silver nanoparticles. The experiments showed that sodium carbonate possessed good stabilizing properties, and the prepared silver nanoparticle containing silver nitrate solution retained its properties during a month, and there was no aggregation. The method we propose is realized without using highly toxic substances, does not require expensive reagents.

References

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