The Soft-template Technique to Synthesize Metal Ag Nanoparticle

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ABSTRACT

Metal Ag nanoparticle is successfully synthesized in a novel Brij56/H2O/AgNO3 solution by taking advantage of the simple natural light reduction method. The metal Ag nanoparticle was investigated by TEM, XRD. A soft template mechanism is put forward to try to interpret the formation of Ag nanoparticle. It is expected to utilize the simple synthesis technique to prepare many other nanoparticles.

INTRODUCTION

Nanostructured materials are one of the most active areas of materials science research. This interest is due to their unique properties (e.g., magnetic, optical, electronic, mechanical) and potential applications[1-2]. Well-defined silver nanoparticle have been extensively exploited in catalysis, electronics, photonics, and photography[3-4]. Much attention has been paid to the synthesis of inorganic, organic, and composite nanofibrillar structures [5-6]. Template synthesis method has been one of the popular methods. Various nanoparticle have been prepared by using hard templates such as porous Al, carbon-nanotube [7-8]. The soft templates employs such as polymers [9], surfactants [10], and solvents. Surfactants have been extensively used as protective agents in the preparation of nanoparticles. High surfactant concentration can led to formation of normal hexagonal liquid crystal or a reverse hexagonal liquid crystal that supplies 1D aqueous channels as micoreactors for controlling material growth on the nanometer scale. At present, mesoporous silica and porous metal and semiconductor have been obtained by using normal liquid crystal as templates. Otherwise, it is obvious that Ag nanoparticles were obtained by the normal hexagonal liquid crystal.

In this paper, Ag nanoparticles are successfully synthesized in the solution system by taking advantage of the simple photochemical reduction method. Due to various metals [11], alloys [12], oxides, and sulfides obtained by the simple photochemical reduction method, the synthesis technique in the novel solution is expected to expand to prepare a variety of nanoparticles.

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EXPERIMENTAL

Analytically pure AgNO₃, Brij56 (C₁₆[EO]₁₀), Ultra pure water were used in a typical experimental procedure. Brij56 % were dissolved in H₂O solutions containing 0.05 mol/L AgNO₃. The solutions were placed on the natural light at room temperature for a specified time in sealed transparent containers. The obtained products were collected and washed with ultra water and absolute alcohol. Finally, the products were dried in a vacuum at 40°C.

The TEM images of the products were taken with a Hitachimodel H-800 transmission electron microscope, using an accelerating voltage of 200 kV.

RESULTS AND DISCUSSION

According to the phase diagram (Fig.1), the hexagonal phase consisted of 50% wt Brij56, 0.05 mol/L AgNO₃ aqueous solution at the 40°C.

![Phase Diagram](image)

**Figure 1.** The phase diagram of the mixture of the Brij56 and H₂O.

The X-ray diffraction (XRD) pattern of the as synthesized silver nanoparticle is shown in Fig. 2. All the reflection peaks can be indexed to the corresponding (100), (200), (220), (311) planes for the cubic phase Ag. The cell parameter is Å=4.083, which is close to the reported data (JCPDS 4-783). The product has high crystallinity.

![XRD Pattern](image)

**Figure 2.** The XRD pattern of the silver nanoparticle.

TEM is usually used to investigate the morphology of nanoparticles. The sample was dispersed in ethyl alcohol by sonication for 10 min before TEM test. It is obviously shown that the shape of Ag nanoparticle is spheroid. The size
The Ag nanoparticle is discussed. The possible reactions are given by eqns.(1) and (2).

\[
\text{Ag}^+ + C_{16}H_{33}(OCH_2CH_2)_{10}O\text{OH} \rightarrow C_{16}H_{33}(OCH_2CH_2)_{10}O\text{Ag} + H^+ 
\]

(1)

\[
C_{16}H_{33}(OCH_2CH_2)_{10}O\text{Ag} + e_{\text{aq}}^{-} \rightarrow \text{Ag} + C_{16}H_{33}(OCH_2CH_2)_{10}O^{-} 
\]

(2)

From eqns. (1) and (2), Ag\textsuperscript{+} ions can be reduced by hydrated electrons generated by natural light. The color of the mixture is light brown after a month at room temperature. The spherical Ag nanoparticles were obtained [16]. This result indicates that natural light promotes the reduction of Ag\textsuperscript{+} and formation of Ag nanoparticle (Fig.4).

**CONCLUSION**

Silver nanoparticle were deposited from fabricating in a novel AgNO\textsubscript{3}, 50%Brij56/ 50%H\textsubscript{2}O/ 0.05mol/L AgNO\textsubscript{3} solution using chemical reduction method of the natural light. TEM observations proved that the Ag nanoparticles have the uniform size.
It is possible to conclude that the soft template mechanism as a result of the cooperation of solvent and surfactant can be used to study the formation of Ag nanoparticle. As the various metals, alloys, and oxides can be obtained by the simple natural light reduction method, the synthesis technique of nanoparticle in the novel solution is expected to expand to prepare a variety of nanoparticle.

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REFERENCES