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Fabrication of Metal Nanoparticles by Microemulsion Process

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Introduction

Metal nanoparticles have been attracting much interest due to their unique properties and potential application in the fields of electronic, catalytic and biomedical engineering. In particular, the noble metal nanopowders such as gold, silver are the most interesting materials because of their wide application to the drug delivery and bio-information technologies.

Many techniques have been developed for fabrication the novel metal nanoparticles such as CVC process, polyol process and sonochemical method. In many techniques, microemulsion process is the one of powerful process to make nanoparticles because the process can effectively control the particle size, shape and its distribution by controlling water droplets in oil phase. In this study, we develop a microemulsion process for fabrication silver nanopowder having spherical and uniform particle size. The study includes design of microemulsion system, chemical reaction between salt and reducing agent, and powder characterization.

Experimental Procedure

The two microemulsion systems used in this study were consisted of CTAB+1-butanol/octane/aqueous solution and AOT/octane/aqueous solution. CTAB (cetyltrimethylammonium bromide, $C_{19}H_{42}BrN$) and AOT(Sodium 1, 2 bis(2-ethyl hexyl) sulphosuccinate, $C_{20}H_{37}NaO_7S$) are used as the surfactant, 1-butanol as the cosurfactant, octane as the matrix phase, aqueous solution as the water droplets. Silver nitrate solutions of 0.2-0.5 mole were used as aqueous solution for source of silver ion. $NaBH_4$ solution of 0.2- 3M and N_2H_4 solution of 1.5M were used for reducing agent. During Mixing of $AgNO_3$ solution with reducing solution, The color of microemulsion was changed from yellow to dark red by the reaction of the two aqueous solution. After mixing for 1hr, the solution was centrifuged at 3,000rpm for 1hr to separate the reactant and washed several times with a mixture of chloroform and methanol. The washed particles then dried in vacuum at 70°C for 2hr. The particle morphology, size and phase were analyzed by using TEM and XRD.

Results and Discussion

Silver nanoparticles were successfully fabricated from microemulsion process by mixing the microemulsions containing the $AgNO_3$ solution and the reducing agent solution such as $NaBH_4$ and N_2H_4 . When using low concentration of the $NaBH_4$ reducing agent, two nanoparticles of Ag and AgBr were formed due to reaction between $AgNO_3$, $NaBH_4$ and Br in CTAB surfactant. With increasing the concentration of the $NaBH_4$ reducing agent, however, only Ag nanoparticle was formed by the reaction.

The Ag nanoparticles fabricated by this process became more spherical and their sizes also became more smaller with increasing the concentration of reducing agent. The high concentration of the reducing agent needed to get spherical and small nanoparticles in the microemulsion system.

The mean diameters of the silver particles were varied from 60nm to 10 nm with the concentration of reducing agent. This indicates that the mean particle size were significantly influenced by the concentration of reducing agent.

The particle diameters also varied with water/oil ratio in microemulsion. The size of the Ag nanoparticles were increased with increasing the ratio because the size of water droplets in microemulsion were increased with increasing the ratios.