



Silver nanoplates and nanowires by a simple chemical reduction method

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ABSTRACT

This paper describes a simple preparation of single-crystalline Ag-nanoparticles including plates, and wires in water by truncated triangular particles for the first time during the reduction of $[\text{Ag}(\text{NH}_3)_2]^+$ complex with glucose at room temperature. Silver particles were characterized by means of the conventional transmission electron microscopy (TEM) and UV–VIS spectroscopy. Cetyltrimethylammonium bromide, CTAB, plays a number of roles during the redox process by solubilizing the reactants, controlling the nucleation and/or growth of nanoparticles, stabilizing the thus-prepared Ag-nanoparticles and minimizing the formation of Ag_2O , AgCl , and AgBr precipitates. It was found that the rate constant and absorbance of silver nanoparticles were sigmoidal to the concentration of silver nitrate.

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1. Introduction

Synthesis, characterization, and physicochemical properties of advanced small structured materials of noble metals have been the subject of various investigators in many laboratories during the past two decades for many purposes and it has been also established that size, shape, stability, color, and properties strongly depend on the method of preparation (radiation, chemical, photochemical, and electrochemical) as well as experimental conditions. A research study on the oxidation of saccharides (biomolecule) by ammoniacal solution of silver nitrate revealed that the smallest particles were formed at the lowest ammonia concentration [1]. Specifically, glucose and the lowest ammonia concentration resulted in the smallest average particle size of 57 nm with an intense maximum of the surface plasmon absorbance at 420 nm. Moreover, this synthesis route is environment friendly because of using of non-toxic chemicals [2–7]. Selection of solvent medium, environmentally benign reducing agent and nontoxic substances for the nanoparticle stability are the main steps based on green chemistry perspectives [6]. Chen et al. [7] have demonstrated a simple and controlled method of preparing uniform Ag nanoparticles with tunable packing densities on the surface of Tollens-soaked silica spheres. Without adding any stabilizers or capping reagents

as-prepared aqueous dispersions of nanosilver particles could be very stable for a long time [8]. The particle size (20–70 nm in diameter), size distribution, and stability of the nanoparticles dispersion depend on the temperature of the process, ammonia concentration, the pH of the medium and type of reducing saccharide during the reduction process [9,10]. A modified Ag mirror reaction was used to synthesize Ag nanoparticles of various morphologies with 10 nm diameters in water by adjusting the concentrations of *n*-hexadecyltrimethylammonium bromide, and the Tollens reagent, $\text{Ag}(\text{NH}_3)_2^+$, at 120 °C [11,12]. Role of different surfactants as growth modifiers in the synthesis of silver nanoparticles and their effect on the on fundamental characteristics of silver nanoparticles prepared by modified Tollens process was studied by Soukupova et al. [13].

The special properties of surfactants are important in a wide variety of applications in chemistry, biology, engineering, material science, photochemical, photo-biological solar energy conversions and other areas [14]. The effects of surfactant and its micelle on chemical reactions are always an interesting field of research for chemists and biologists [15]. There is extensive evidence on the ability of aqueous micelles and other associated colloids to influence the reaction rates, equilibriums, concentration or depletion of reactants in the interfacial region [16–18]. The rates, size and shapes of advanced silver nanomaterials can be either accelerated or changed, depending on the chemical system, nature of stabilizers, the types of reducing sugars and the surfactant [19–24]. It was, therefore, thought to be of interest to investigate the silver nanoparticles formation based on the Tollens process with a view to having an insight into the role of cationic CTAB surfactant and silver ions concentrations in the mechanism of silver sol. In the present

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