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Biosynthesis of Silver Nanowires by Extract of *R.Capsulate*

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An environmentally friendly method using a cell-free extract (CFE) of *Rhodopseudomonas capsulata* is proposed to synthesize silver nanowires with a network structure. This procedure offers control over the shapes of silver nanoparticles with the change of AgNO3 concentration. The CFE solutions were added with different concentrations of AgNO3, resulting in the bioreduction of silver ions and biosynthesis of morphologies of silver nanostructures. It is probable that proteins acted as the major biomolecules involved in the bioreduction and synthesis of silver nanoparticles. At a lower concentration of silver ions, exclusively spherical silver nanoparticles with sizes ranging from 10 to 20 nm were produced, whereas silver nanowires with a network structure formed at the higher concentration of silver ions in the aqueous solution. This method is expected to be applicable to the synthesis of other metallic nanowires such as silver and platinum, and even other anisotropic metal nanostructures are expected using the biosynthetic methods.

Key words: Silver, Nanowires, *Rhodopseudomonas capsulata*.

Nanotechnology has been established as a new interdisciplinary science that refers to a field of science and engineering dedicated to materials of dimensions sizing from 1 – 100 nn[1]. Nanoscience and has the facility to make available explanations to the humanity in different parts like the environment challenges viz. water management, defensible chemical manufacture etc. as well as in fields like medicine, solar energy renovation etc. Commonly, the methods used for the preparation of metal nanoparticles can be clustered into two different types Top-down or Bottom-up.Breaking a wall down into its components–the bricks, characterizes the Top-down attitude[2]. Silver nanoparticles (Ag-NPs or nanosilver) have paying attention growing interest because of their exceptional chemical, physical and biological properties compared to their macro-scaled equals. Recently, numerous techniques have been described for the synthesis of Ag-NPs by using physical, chemical, biological paths and photochemical. Each one has advantages and disadvantages with usual difficulties being scalability, prices, particle sizes and size dispersal[3,4].

Bio-recovery of metals from solution, a process referred to as "biosorption", occurs by either active or passive mechanisms. Active metal transformation processes require viable microbes, enzymatically catalyzing the alteration of the metal, leading to sequestration or concentration[5]. One possible (passive) role of the microorganisms is in providing a multitude of nucleation centers; establishing conditions for obtaining highly disperse nanoparticle systems. In addition, they slow down aggregation, or entirely prevent it by immobilizing the particles, and providing viscous medium[6,7,8]. Thus produced nanoparticles have highly intricate architectures and are ordered during assembly. In some cases, the particles have a well-

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defined shape formed within a narrow size range and have orientational and geometrical symmetry[9,10]. Even though many biotechnological applications such as the remediation of toxic metals employ microorganisms such as bacteria and fungi, such microorganisms are recently found as possible eco-friendly nanofactories[11,12]. However, the biosynthesis of silver nanowires using microorganisms or plant extracts has been rarely reported. This study demonstrated the extracellular synthesis of stable silver nanowires.

EXPERIMENTAL

All chemical agent including $AgNO_3$, purvate, yeast extract, NaCl, NH_4Cl, and K_2HPO_4 were obtained from Sigma Company and used as received. The mixed culture of *R. capsulata* was cultured in a medium containing pyruvate, yeast extract, NaCl, NH_4Cl, and K_2HPO_4 at pH 7 and 30 °C. After 96 h of fermentation, the cells were separated from the culture broth by centrifugation (5000 rpm) at 15 °C for 20 min and washed five times with deionized water to obtain about 1 g wet weight of cells.The harvested cells were then resuspended in 10 mL of deionized water for 15 days. The cells were then removed by centrifugation, and the aqueous supernatant obtained was cell-free extract (CFE). The CFE solution thus prepared was a light yellow liquid and was used for the reduction of AgNO3. To test tubes containing 10 mL of CFE solution was added 50-100 *m*L of 0.05 M aqueous AgNO3 solution. All experiments were conducted at 30 °C and pH 6 for 48 h, during which time reduction of Ag+ in all of the reaction mixtures had occurred. The reduction of the Ag+ ions in the solutions was monitored by sampling the aqueous component and measuring the UV–Vis spectrum of solutions. Particle-size distributions of the samples were also obtained using dynamic light scattering (DLS). Furthermore, the silver nanoparticles were characterized by transmission electron microscopy (TEM).

RESULTS AND DISCUSSIONS

It is well known that silver can be reduced from Ag+ to Ag0 by a cell-free extract (CFE) of *Rhodopseudomonas capsulate*. The absorption band at about 420 nm is known to be due to surface

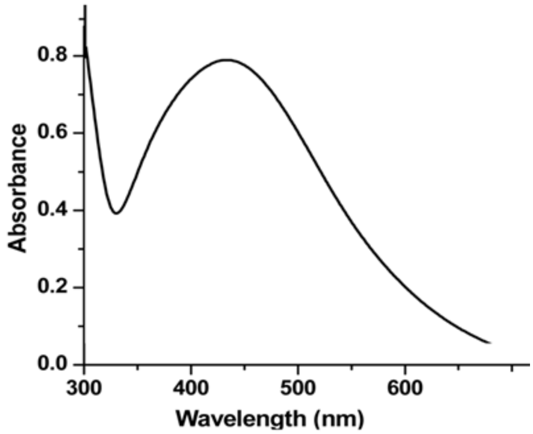

Fig. 1. UV–Visible spectrum of silver nanowires

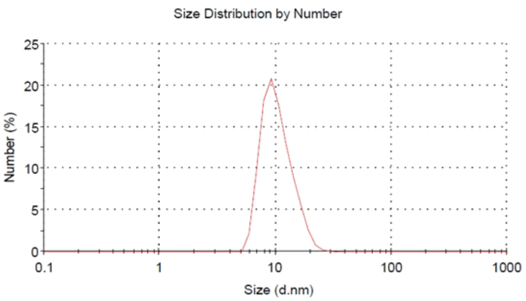

Fig. 2. A particle size distribution histogram of silver nanowires

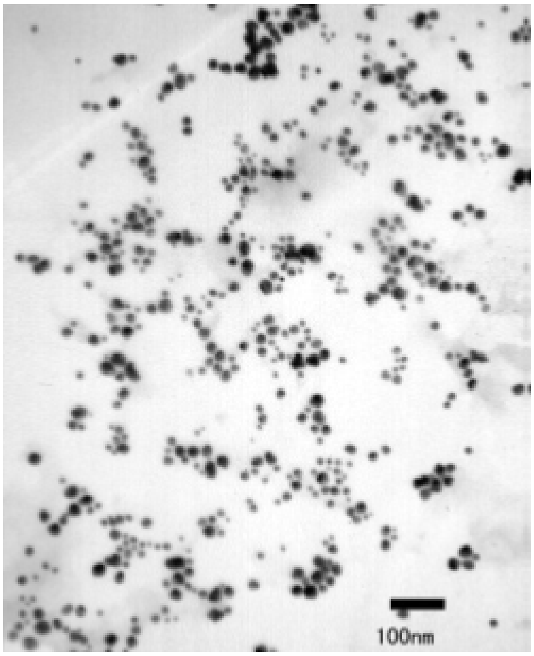

Fig. 3. TEM micrograph of silver nanowires

plasmon resonance in nano-silver solutions. In fact, the energy of absorption would depend on the degree of plasmon resonance i.e. it may shift either side of this value depending on the ratio of silver ions and zero-valent silver. The UV–Visible spectrum (Fig. 1) of the solution showed a well-defined surface plasmon resonance at <"420 nm. The technique outlined above has proven to be very useful for analyzing nanoparticles[9].

Dynamic light scattering is a used method for the determination of nanoparticle size. The silver particles' size histograms show that the nanoparticles size is 10-20 nm (Fig. 2). TEM micrograph of silver colloidal particles is shown in Fig. 3. It can be noticed that the graphs show that the particles are spherical in shape.

CONCLUSIONS

Silver nanowires were synthesized by *Rhodopseudomonas capsulata*. The size of silver nanowires was 10-20 nm. UV–Vis spectroscopy confirmed silver nanowires. Also, nanowires were characterized by DLS and TEM. From a technological point of view, these obtained silver nanowires have potential applications in the various fields and this simple procedure has several advantages such as cost effectiveness and scale commercial production.

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