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## The Wet Chemical Synthesis of Silver Nanostructures with Controllable Aspect Ratio

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### Abstract:

Silver nanorods (AgNRs) are prepared by seed mediated growth method in aqueous medium. In this method, initially tiny metal particles are prepared which are used as a seeds for the preparation of NRs. Silver seeds were prepared by reduction of silver ions with sodium borohydride in the presence of sodium citrate dehydrate as a stabilizer. The seeds solution was added into a solution consisting more metal salts, a weak reducing agent (ascorbic acid) and a rod-like micellar template cetyltrimethylammonium bromide (CTAB). We have investigated the effect of all the parameters involved in the synthesis of NRs, such as, concentrations of CTAB, AgNO<sub>3</sub> and seed solution on the longitudinal plasmon band and its tunability. The synthesized AgNRs were characterized using UV-visible spectroscopy, X-ray diffraction and transmission electron microscopy (TEM). The result demonstrates the growth of stable and controlled shape and size of NRs in an aqueous medium.

### Introduction:

The controlled size of the plasmonic nanostructure has received considerable attention due to their optical, electrical, catalytic and thermal properties that are different from those of the bulk material [1-3]. All these properties are strongly depend on the aspect ratio. It has been demonstrated that the intrinsic properties of gold and silver nanostructure are closely related to their shape and size. These classes of material have obtained a wide verity of application, such as catalysis, electronic, medicine, biological sensor, and optoelectronics [4-6]. The shape controlled syntheses of different size of nanostructure are most important for achieving their different applications. So, far different methods are reported to synthesis of plasmonic nanostructures such as, electrochemical technique, solvothermal method, ultrasonic assistant method, colloidal method, seed mediated method and polyol method, etc. Among all these methods, seed mediated growth method is the most popular method to synthesis of nanorods in presence of surfactant, which was first developed by Murphy and El-Sayed [7]. In these methods, citrate capped 3-4 nm size NPs use as a seeds. These seeds are then added to the growth solution. The growth solution containing more metal salt, surfactant (CTAB) and weak reducing agent (ascorbic acid). These protocols were necessary for the formation of rod like particle.

Here we report, the effect of various concentration of surfactant, seed solution and reducing agent on the synthesis of AgNRs in aqueous medium.

### Experimental Section :

#### Materials :

Silver nitrate (AgNO<sub>3</sub>, 99.995%), sodium citrate dihydrate (99%), sodium borohydride (NaBH<sub>4</sub>, 99%), cetyltrimethylammonium bromide (CTAB, 99%) and l-ascorbic acid (AA, 99%) were obtained from Sigma-Aldrich. Sodium hydroxide (NaOH, 96%) was purchased from Merck. Double distilled water was used in all experiments.

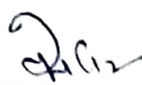
#### Preparation of Silver Seed Solution :

A 20 ml aqueous solution containing 0.25 mM AgNO<sub>3</sub> and 0.25 mM trisodium citrate was prepared. Next, 0.6 mL freshly prepared ice-cold 0.01 M NaBH<sub>4</sub> solution was injected into the solution and stirred vigorously for 30 s. The color of solution changed immediately to light yellow, indicating that silver nanoparticles are produced. The prepared solutions were used as seeds within 2-5 h after preparation.

#### Preparation of Silver Nanorods :

In order to synthesize silver nanorods, three sets of growth solution were prepared. In first set, different concentration of seed solution (i.e. 0.05 ml, 0.1ml, 0.2 ml, 0.5 ml and 1 ml) were added in a solution containing 10 mM AgNO<sub>3</sub>, 5 mM AA acid and 10 ml of 75 mM CTAB. Similarly second and third set were prepared. In second set, different concentrations of CTAB (i.e. 25 mM, 50 mM, 75 mM and 100 mM) were added in 10 mM AgNO<sub>3</sub>, 5 mM AA and 0.2 ml seed solution. In third set, different concentrations of AA (i.e. 4 mM, 5 MM, 6 mM and 7 mM) in 75 mM CTAB, 10 mM AgNO<sub>3</sub> and 0.2 ml seed solution were added.



  
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