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# Preparation of Ag nanoparticles with triethanolamine as reducing agent and their antibacterial property

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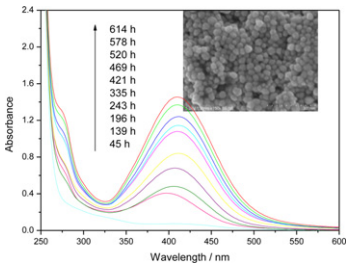
## HIGHLIGHTS

- Ag nanoparticles were prepared with triethanolamine as reducing and alkaline agent.
- Particles about 40 nm in size were obtained.
- Effects of stabilizer, temperature and concentration on particles were studied.

## GRAPHICAL ABSTRACT

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## ABSTRACT

Hydroxide ions play a crucial role in the reduction of $Ag^+$ ions with alcohol. In this paper, Ag nanoparticles were prepared with triethanolamine (TEA) serving as reducing agent and alkali for the first time. The effects of stabilizer, mole ratio of $AgNO_3$/TEA, temperature and $AgNO_3$ concentration on the particles, as well as the antibacterial performance of the particles, were studied. The results showed that, PEG and PVP are effective for inhibiting the growth of particles, and Ag particles about 40 nm in size were obtained. The effects of TEA amount on the particles are negligible. On rising temperature, the particles size increase and the particles become more regular. With the increased $AgNO_3$ concentration, the particles tend to large and poly-dispersed. The Ag nanoparticles show excellent antibacterial property.



## 1. Introduction

Silver nanoparticles (NPs) have attracted great interests due to their special property and wide-spread applications in photography, catalysis [1], surface-enhanced Raman scattering (SERS) detection [2,3], sensors [4], antibacterial materials [5], conductive pastes and inks, etc. Various methods, such as homogeneous chemical reduction, polyol process [6], two-phase method [7,8], microemulsions [9], have been developed for the preparation of Ag NPs. In polyol process, the polyol acts as solvent, reducing agent and complexing agent simultaneously. In homogeneous chemical reduction, formaldehyde, hydrazine [10], hydrogen, carbon monoxide, $NaBH_4$ [11], L-ascorbic acid [12], glucose [13], aniline [14], soluble starch [15], $\beta$-cyclodextrin grafted with poly(acrylic acid) [16], etc. have been employed as reducing agents.

The reduction of $Ag^+$ in solution is known to proceed according to the following steps:

$$Ag^+ + e^- \rightarrow Ag$$

$$Ag + Ag^+ \rightarrow Ag_2{}^+$$

$$Ag_2{}^+ + e^- \rightarrow Ag_2$$

$$\vdots$$

$$Ag_n{}^+ + e^- \rightarrow Ag_n$$

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