PGA CAPPED SILVER NANOPARTICLES FOR BIOMEDICAL APPLICATION

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Metallic nanoparticles possess unique electrical, optical and biological performances that have attracted considerable attention due to their potential use in many applications, such as catalysis, drug delivery, nanodevice fabrication, etc. Capped silver nanoparticles (AgNPs) have many biomedical applications due to its excellent biocompatibility, antiviral and antibacterial properties. However, in the literature it has been reported that bare silver nanoparticles can be toxic. This supports the idea that the toxicity is associated to the presence of bare metallic nanoparticle surfaces, while particles protected by the organic layer are much more biocompatible and thereby less toxic. Poly (α, γ, L-glutamic acid) (PGA) is a hydrophilic, biodegradable, and naturally available biopolymer. Its biological properties such as nontoxicity, biocompatibility, and nonimmunogenicity qualify it as an important biomaterial in drug delivery applications. In this study we used PGA as organic layer for silver nanoparticles.

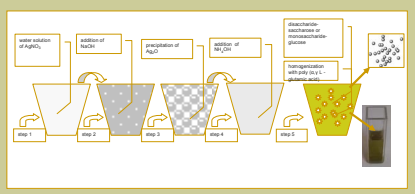
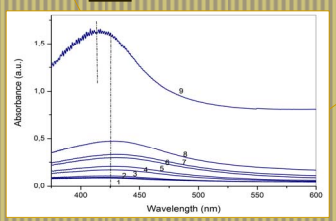


Figure 1. Schematics for obtaining of PGA capped silver nanoparticles

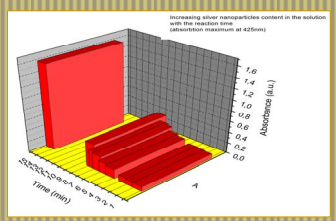
Poly (α, γ, L-glutamic acid) (PGA) capped silver nanoparticles were prepared by chemical reduction method with saccharide (saccharose or glucose) as reducing agent. PGA was obtained from Guilin Peptide Technology Limited. Molecular weight of the PGA was 20000-40000 g/mol.

The synthesis procedure was carried out as follows (Figure 1): When sodium hydroxide (NaOH) is added, the precursor solution-$AgNO_3$ turns into dark color of Ag_2O precipitate. The addition of a NH_4OH into the solution make solution clear. After that the disaccharide- saccharose or monosaccharide-glucose, as a reducing agent, was added into the mixture. The formation of silver nanoparticles can be observed by a change in color since small nanoparticles of silver are yellowish green. The addition of a small amount of poly(α, γ, L glutamic acid) will prevent aggregation of the nanoparticles. A layer of absorbed glutamic acid anions on the surface of the nanoparticles keep the nanoparticles separated.

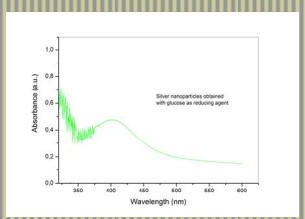
The samples were characterized by Ultraviolet Spectroscopy (UV) and Field Emision Scanning Electron Microscopy (FESEM)

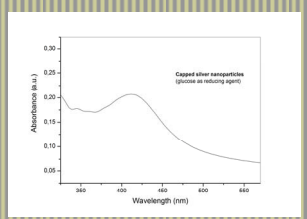


UV–Vis spectra of nine samples taken from the same reaction between 30 and 40 min

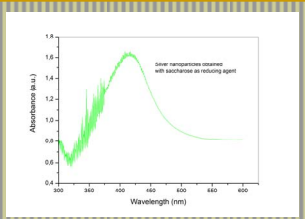


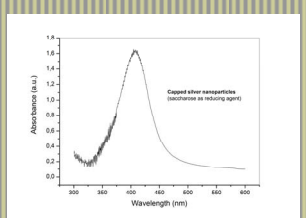
Increasing the content of silver nanoparticles in solution with reaction time (saccharose as reducing agent)





UV spectra of silver nanoparticles without PGA and capped silver nanoparticles with PGA (glucose as reducing agent)





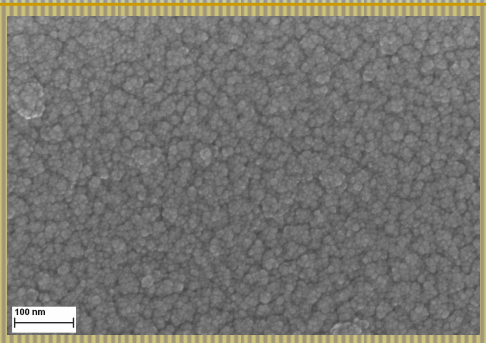
UV spectra of silver nanoparticles without PGA and capped silver nanoparticles with PGA (saccharose as reducing agent)

Results

The UV spectroscopy has been used to verify the formation of silver nanoparticles without and with PGA in the solution. The UV measurements were performed on GBC, Cintra 101 UV-VIS Spectrophotometer in the frequency interval of 300-600 nm. UV-Vis absorption results confirmed formation of silver nanoparticles prepared in liquid by chemical reduction method (silver nitrate $AgNO_3$ reduced by disaccharide- saccharose or reduced by monosaccharide-glucose). Silver nanoparticles were capped with poly (alpha, gama L-glytamic acid) by homogenization of colloidal silver and polymeric solution.

The absorption spectra of the silver colloids and PGA-capped silver colloids are presented. In the UV-Vis absorption spectra of PGA capped silver nanoparticles obtained with saccharose as reducing agent narrow surface plasmon absorption peak at 410 nm were observed. This confirms the nanocrystalline character of the particles and the low degree of their polydispersity , which is in the agreement with our FESEM observations.

To clarify the microstructure of the silver nanoparticles FESEM observation has been carried out.
The FESEM measurements were performed on a SUPRA 35 VP Carl Zeiss field-emission scanning electron microscope. The samples were prepared by re-dispersing in ethanol by means of an ultrasonic bath and filtering the dispersions using polycarbonate membranes. Carbon was used to prevent charging.
From FESEM images it can be noted that capped silver particles obtained with disaccharide- saccharose are very uniform and with sizes on nanometer scale. Particles have spherical shapes and surfaces without cracks or pores. Size distribution of all nanoparticles was unimodal and with sizes of about 10 nm.



FESEM images of PGA capped silver nanoparticles obtained with saccharose as reducing agent

Conclusion

Poly (α, γ, L-glutamic acid) (PGA) is an anionic biocompatible macromolecule that has been used for drug delivery in a variety of clinical trials. In this study PGA was used as organic layer for silver nanoparticles obtained with two different reducing agents (saccharose and glucose). The capping agent (PGA) was chosen to make the silver nanoparticle more biocompatibile and to protect nanoparticles from agglomerating in the medium. The obtained silver nanoparticles are very unform and with sizes of about 10 nm. The obtained silver nanoparticles were highly stable and water soluble.