**THESIS INFORMATION**

Thesis title: ***Fabrication of multi-branched gold nanomaterial and triangular silver nanoplate using biological polymers as protecting agents and investigation their antibacterial activities***

Speciality: Theoretical chemistry and physical chemistry

Code: 62 44 01 19

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**1. SUMMARY OF THESIS CONTENTS:**

There is an increasing demand for the development of nanomaterials preparation method with the goal of reducing the undesirable hazards to expand the scope of applications in biotechnology and medical fields. In this work, a facile and environmentally friendly method was deployed to controlled synthesize multi-branched and dendritic gold nanoparticles with the using of green reducing agent ascorbic acid in the presence of three different biological polymers (collagen, gelatin and chitosan). This dissertation is a systematic study of parameters affecting the control of shape and size of nanoparticles including temperature, pH, concentration of reaction additives and reaction time. To be specific, morphological transformation between dendritic and multi-branched nanostructure can be achieved by governing the pH value of solution. The role of each polymer as structure-directing agent through the electrostatic and steric interaction was also revealed.

Triangular silver nanoplates have been synthesized through the seeding mediated method with the presence of citrate-stabilized silver seeds and the mixture of gelatin-chitosan as the stabilizer. Different morphologies of silver nanostructures such as triangular nanoplates, hexagonal nanoprisms or nanodisks can be prepared in appropriated condition.

Nanomaterials were further characterized by measuring their physicochemical properties with Ultraviolet Visible spectroscopy (UV-Vis), X-Ray diffraction (XRD) technique, transmission electron microscopy (TEM), dynamic light scattering (DLS) and zeta-potential. Subsequently, the specific interaction between functional groups of biopolymers and nanoparticles was analyzed by Fourier transform Infrared spectroscopy (FT-IR).

The synthesis multi-branched AuNPs stabilized by collagen was carried out at pH 4.0 and a temperature of 40oC with the appropriate collagen, HAuCl4, and ascorbic acid concentration. The average diameter of multi-branched gold nanoparticles is about 51-68 nm. With the using of gelatin, the dendritic AuNPs can be obtained at pH 3.0 and temperature of 40oC, the average size is about 75-112 nm. Chitosan capped multi-branched gold nanoparticles were prepared by the ascorbic acid reduction of HAuCl4 at pH 6.0 and 70oC of temperature, the average size of formed nanocrystal is about 47 nm. The branched AuNPs were found to be highly biocompatible at 100 μg/ml concentration when performed by the SRB assay with human foreskin fibroblast cells.

Triangular silver nanoplates had average side length of 65-80 nm at pH value of 6.0, measured by transmission electron microscopy (TEM). Based on the twinned crystal model of the initial nanoparticle seeds and the structure-directing role of gelatin-chitosan mixture, growth mechanism of triangular silver nanoplates has been proposed in theory.

 The better antibacterial activity of triangular silver nanoplates was evaluated in the comparison with that of spherical shape when tested against Gram-positive and Gram-negative bacteria species. The MBC value for each strain of *S. aureus* and *P. aeruginosa* is 8.0 μg/mL; for *E. coli* and *V. cholera* is 6.0 μg/mL. The MIC value for each of *S. aureus*, *P. aeruginosa*, *E. coli* and *V. cholera* is 4.0 μg/mL.

 Silver nanoparticles stabilized by collagen have been synthesized with various types of saccharide including D-fructose, D-glucose, and sucrose at pH value of 7.0. Formed silver nanoparticles are spherical shape with average diameter smaller 10 nm, which could be potentially applied in preparing antibacterial hand sanitizer.

**2. NEW RESULTS OF THE THESIS:**

* Controlled synthesis of multi-branched and dendritic gold nanoparticles by a one-step and green method using natural polymers (collagen, gelatin and chitosan). Proposed the formation mechanism of branched gold nanoparticle as well as revealed the structure-directing and protecting roles for each of these polymers.
* Modified the seed mediated method for preparing the triangular silver nanoplates with the mixture of gelatin and chitosan. The conversion between the hexagonal and triangular silver nanoplates was controlled. The growth mechanism of silver nanoplates was discussed based on the facet-blocking role of gelatin and chitosan.
* Estimating the antibacterial activity of triangular silver nanoplates and the biocompatibility of multi-branched gold nanoparticles.

**3. APPLICATIONS/POSSIBILITIES OF APPLICATION IN PRACTICE OR QUESTION ISSUES TO CONTINUE THE RESEARCH**

Results from the study can be used to:

* The results of synthesis multi-branched gold nanoparticle would be favorable for further application in biological fields. The mixture of gelatin and chitosan could be the novel structure-directing agent for controlling synthesis of other morphologies of silver nanoparticles.

Suggesting issue that require further studied

* The result of fabricating gold and silver nanoparticle could open up many applications in antibacterial materials and treating cancer cells.

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