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Synthesis and physicochemical characterization of tunable silica–gold nanoshells via seed growth method

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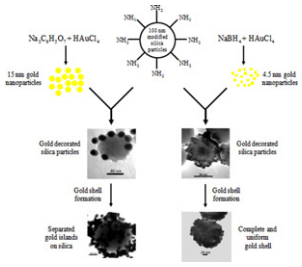
HIGHLIGHTS

- SPR of gold nanoparticles below 20 nm shows a red shift by increasing size.
- Excess amount of modifier causes agglomeration of silica cores.
- Using 15 nm gold particles for seeding 100 nm silica causes separated gold islands.
- Shell thickness and tunability of nanoshells depend on size of gold particles.

GRAPHICAL ABSTRACT



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ABSTRACT

Gold nanoshells are a class of nanocomposites consisting of a core surrounded by a gold shell. They are known to exhibit attractive optical property due to the excitation of surface plasmon resonance. This paper reports synthesis and characterization of gold nanoshells using two different sizes of gold colloids obtained by citrate and borohydride for nucleation step. Silica nanoparticles with an average diameter of 100 nm were synthesized and were modified with 3-aminopropyltriethoxysilane (APTES). The functionalized silica nanoparticles were initially decorated with gold colloids. Then gold hydroxide was reduced into decorated silica particles to obtain gold shell. The results reveal that the silica surface coverage with gold nanoparticles and gold shell thickness depends on size of gold nanoparticles. They show that smaller gold colloids provide better coverage at seeding step; hence, a uniform and complete shell is the consequence for these kinds of particles. Furthermore, tunability of gold nanoshells into appropriate wavelength according to desire application while using 4.5 nm gold nanoparticles for decoration is more facile due to possibility to control shell growth progress and shell thickness.

1. Introduction

In recent years, unique optical, magnetic and chemical properties of nanoparticles lead to a variety of applications such as diagnosis of diseases, drug delivery, catalysis and water treatment. Hence, many researchers have been studied properties and applications of nanostructures and different methods to synthesize them. Recently, synthesis and characterization of nanoshells is an interesting subject for a large number of researches because of their special optical property [1,2].

Nanoshells are a type of nanoparticles composed of a dielectric core such as silica coated with an ultrathin metallic layer, which is typically gold. Nanoshells are capable to absorb or emit different wavelengths from the visible region to the infrared. The optical response of nanoshells depends on core diameter to shell thickness ratio and nanoshell total diameter. In fact, by controlling the core/shell ratio, surface plasmon resonance (SPR) of nanoshells can be extended from visible to IR [3,4]. Due to nanoshells unique optical property, they have gained considerable attention for medical applications especially cancer therapy. Since almost all of them are

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