Improvement of Mechanical Stability and Dispersion of Hollow Porous Au/FePt Nanocapsules with Thermally Fused Netlike Shell

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Introduction

A novel multifunctional nanocapsule with hollow interiors and porous Au/FePt shells has been developed for image-guided photothermal therapy and drug delivery. This architecture has strong plasmon resonance in NIR range, high magnetic response, and drug loading capability. In our previous work, we successfully fabricated hollow porous Au/FePt nanocapsules using silica spheres as template and improved their pore structure and magnetic properties of the thermally fused netlike shell by high-temperature high-pressure treatment (HTHP) in suspension. However the agglomeration and destruction of Au/FePt nanocapsules were observed after HTHP. In this work, a silica coating was prepared on the surface of Au/FePt/silica composite spheres to protect them from agglomeration and destruction during HTHP. The Au/FePt nanocapsules showed a better dispersion and higher mechanical stability even after removing silica spheres and the silica coating layer.

Experiment

Firstly, as-prepared Au/FePt silica spheres were modified with Polyvinylpyrrolidone (PVP). Then the PVP-modified Au/FePt silica spheres were dispersed in a mixture of ethanol, deionized water, and ammonia aqueous solution. TEOS was added drop-wise to the mixed solution. After being stirred for 2 h, the products were washed and then redispersed in ethanol. The ethanol solution of silica-coated Au/FePt silica spheres were HTHP-treated at 573 K for 1 h. The purified particles were stirred in NaOH solutions to dissolve both of silica coating and silica cores. Finally hollow Au/FePt nanocapsules were purified, and their morphology, crystallographic structure, optical and magnetic properties were investigated.

Results and discussion

TEM images of the Au/FePt/silica composite spheres at various steps are shown in Fig.1. A solid and uniform silica coating with the thickness of about 50 nm was prepared on the surface of Au/FePt/silica composite spheres. After HTHP, metallic nanoparticles deposited on the silica template sphere were thermally fused together, forming the Au/FePt netlike shell. The influence of silica coating during the fusion process of metallic nanoparticles was investigated in details by transmission electron microscopy (TEM) and X-ray diffraction. There was no obvious difference in the fusion process between Au/FePt silica spheres with and without the silica coating. After dissolving the silica coating and silica sphere, hollow Au/FePt nanocapsules with the pores of ~40 nm in diameter were obtained. TEM images and data of particle size distribution showed these hollow capsules have a better dispersion and higher mechanical stability. Magnetic properties of the nanocapsules were not influenced by the silica coating.

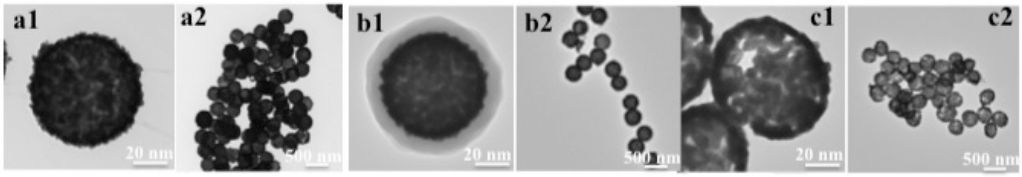

Fig.1 TEM images of Au/FePt/silica composite spheres (a1, a2), silica-coated Au/FePt/silica composite spheres (b1, b2), and hollow porous Au/FePt nanocapsules (c1, c2)