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Synthesis and structural control of gold nanoparticles-coated polystyrene composite particles based on colloid thermodynamics

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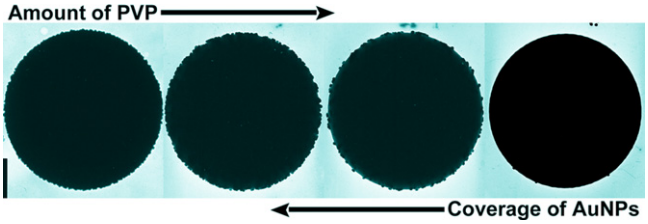
HIGHLIGHTS

- AuNPs-coated PS composite particle is prepared based on colloid thermodynamics.
- This unique heterocoagulation is affected by a series of thermodynamic factors.
- The structure and morphology of composite particle can be effectively controlled.

GRAPHICAL ABSTRACT



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ABSTRACT

Gold nanoparticles-coated polystyrene (AuNPs-coated PS) composite particles with raspberry-like morphology are successfully prepared by blending the preformed aqueous dispersions of PS microspheres and AuNPs based on colloid thermodynamics. A series of thermodynamic factors is systematically investigated for the influence on the heterocoagulation between the PS microspheres and AuNPs. The synthesized AuNPs-coated PS composite particles have been extensively characterized by scanning electron microscopy, transmission electron microscopy, thermogravimetry and zeta potential measurement. The results indicate that the structure and morphology of the resultant AuNPs-coated PS composite particles are significantly affected by the amount of poly(vinylpyrrolidone), the pH and composition of medium.

1. Introduction

Noble metal nanomaterials, especially gold nanoparticles (AuNPs), have been extensively investigated over the past few decades owing to their unique electronic, optical, and catalytic properties. These fascinating properties of AuNPs benefit from precise control over their size, shape, interparticle distance, and surface nature, and lead to interesting applications in the fields of catalysis, surface-enhanced spectroscopy, controlled drug release, thermal therapy, and so on [1–14]. However, a critical problem of the usage of AuNPs is arisen as a result of their stabilization against coagulation because of van der Waals attractions, and therefore, the lack of sufficient stability of AuNPs has impeded the development and applications of such nanoparticles in the real world [15–17].

To date, a large number of strategies have been designed in order to overcome the aforementioned drawback. Among them, the fabrication of hybrid materials by immobilizing AuNPs on spherical supports is a main domain in rapid expansion, and two main routes were exploited to achieve the preparation process [10,11,18–30]. The first route was to generate the AuNPs in the presence of substrate particles, and then adhere onto the surface of substrate particles. The second route was to obtain the composite particles by blending the preformed dispersions of AuNPs and substrate particles. For the first route, to name only a few, Nam et al. employed cationic gold ligands and sulfonated polystyrene (PS) particles to fabricate AuNPs-coated PS composite particles successfully and controllably by in situ reduction reaction

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