Fabrication of modified-poly(divinylbenzene)/Au core–shell structure

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Abstract

A novel PDVB/Au core–shell structure was prepared by the chemical reduction of a gold–phenanthroline complex on the surface of a poly(divinylbenzene) (PDVB) cores (2–4 μm). The PDVB cores were synthesized by precipitation polymerization, and the surface was modified by introducing thiol and sulfonic acid groups. The modified surface structure was examined by FT-IR, XPS and EDS and the degree of sulfonation was measured according to its ion exchange capacity (IEC, 5.72 meq/g). The modified PDVB cores were immersed in a solution of a gold–phenanthroline complex and subsequently reduced to form gold nanoseeds. These were further grown in a solution of HAuCl4 and NH2OH to form gold nanoshells. The effects of the functional groups on the PDVB cores on fabrication of the core–shell structure were carefully examined. SEM and XPS were used to characterize the gold nanoshells. The presence of the functional groups could be of great assistance for the gold shell formation.

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1. Introduction

Electronic package technology has many applications in the electronics industry, and is particularly useful in the computer, information technology, mobile communications, and high technology electronic appliance industries [1–3]. In particular, flip chip technology has numerous applications in the smart cards, liquid crystal displays, and communication system industries [4,5]. Flip chip technology was developed based on anisotropic conductive connection processes using solder as the conducting particles. Commercially conducting particles are composed normally composed of materials such as Ni, Au/polymer, Ag, and insulating resins [6,7]. In this context, conducting polymers, which have greater reliability lower resistance and higher adhesives strength, guarantee a better flip interconnection on an organic substrate. For this purpose, several routes for the fabrication of gold shells on polystyrene (PS) cores have been investigated [8,9]. Khan et al. [10] examined the morphology of metallic gold overlays deposited onto conducting polymer-coated PS using an electroless deposition method. Their results showed that the gold nanoparticles were randomly dispersed over the surfaces of the PS particles. It is believed that these gold-coated, conducting polymer-coated PS particles might be useful as a novel supportive catalyst. Davidov and co-workers [1] combined self-assembly and surface seeding methods using polyelectrolytes as adhesive glue between the PS core and gold nanoparticles. They produced clusters of Au nanoparticles on a PS surface instead of a continuous gold shell. Gao and co-workers [11] and Ming and co-workers [12] previously developed continuous metallic nanoshells on PS particles using a layer-by-layer deposition technique with 4-aminophenol as the binder, and a solvent-assisted route, respectively. However, very rough gold shells were obtained in both cases.

In most cases, it is very difficult to tune the thickness and surface roughness of the metallic shells, and only rough gold shells are obtained. In an attempt to overcome this drawback, a novel (modified-PDVB)/Au core–shell structure was investigated by reducing a gold–phenanthroline complex to produce Au nanoparticles followed by gentle growth of gold layer using the HAuCl4/NH2OH system. The PDVB cores (2–4 μm) were synthesized by precipitation polymerization to yield a fully crosslinked structure [13–20]. The surface of the cores was

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