Preparation of Polydivinylbenzene/Au Core-Shell Beads

K.X. Phan\textsuperscript{1,a}, M. S. Cho\textsuperscript{2,b}, J. D. Nam\textsuperscript{3,c}, H.R Choi\textsuperscript{4,d}, J. C. Koo\textsuperscript{5,e}, and \( ^{+} \) Y. Lee\textsuperscript{6,f}

\textsuperscript{1,2,3,6} School of Applied Chemistry, Sungkyunkwan University
\textsuperscript{4,5} School of mechanical engineering, Sungkyunkwan University
Suwon, Korea 440-746

\textsuperscript{a}pkxuyen@skku.edu \textsuperscript{b}email:mstop21@skku.edu, \textsuperscript{c}email:jdnam@skku.edu, \textsuperscript{d}email:hrchoi@me.skku.ac.kr, \textsuperscript{e}email:jckoo@me.skku.ac.kr, \textsuperscript{f}correspondence- email:yklee@skku.edu

\textbf{Keywords:} polydivinylbenzene, core-shell, gold-phenanthroline complex

\textbf{Abstract.} A novel core-shell material composed of closely packed gold shells on poly (divinylbenzene) (PDVB) cores was fabricated via the reduction of a gold complex. PDVB beads (2-5 \( \mu \)m) were synthesized by precipitation polymerization. The surface of the PDVB beads was modified by three different methods, viz. sulfonation, chloromethylation, and thiolation. The modification of the surface of the PDVB beads was designed to allow the facile attachment of the gold layer onto the PDVB cores. The gold seeding layer was initially formed on the modified PDVB cores by the chemical reduction of a gold-phenanthroline complex. The subsequent growing reactions of \( \text{NH}_2\text{OH} \) and \( \text{HAuCl}_4 \) increased the gold coverage to more than 90\%. The structure of the PDVB/Au core-shell material was characterized by SEM, XPS, and FT-IR.

\textbf{Introduction}

Recently, there has been an immense amount of interest in the fabrication of composite nanoparticles, such as core-shell structural materials [1-3]. In particular, the fabrication of metallic nanoshells, which consist of an insulating spherical core surrounded by a thin, uniform metallic shell, is an attractive area of investigation, because of their potential use in the fields of surface-enhanced Raman scattering, catalysts, biochemistry, optical filters, and flip chip fabrication procedures [4-6]. Up to now, several routes have been investigated for the synthesis of such core-shell structures. A number of different colloidal “cores” such as \( \text{TiO}_2 \) [7] and \( \text{SiO}_2 \) [8] have been investigated. Additionally, polymer spheres with submicron and micron sizes have also received considerable attention. The capping of poly(methyl methacrylate)-poly(methacrylic acid) latex spheres with a semiconductor (CdS) or metal (Ag) was accomplished directly in the electrical double layer of the microspheres, which were later used in the fabrication of photonic crystals [9]. Phadtare et al. demonstrated the direct assembly of colloidal gold on polyurethane spheres [10]. They also reported the fabrication of gold shells on polystyrene (PS) cores. Khan and co-workers [5] attempted to carry out a systematic study to examine the morphology of metallic gold overlayers deposited onto conducting polymer-coated PS via the electroless plating method previously described by Kang and co-workers [11-13]. In order to ensure that there is close contact between the gold layer and the PS, the PS surface should have sufficient hydrophilicity, which can be provided by the sulfonation reaction. However, the decoration on the linear or partially crosslinked PS is difficult to control, because the PS cores do not attain a sufficiently high degree of sulfonation without some deformation occurring in the particle shape. Moreover, in most of the cases described above, the physical attraction...