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Fabrication and Catalysis of SiO_2–Coated Ag@Au Nanoboxes

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Nanoscale noble-metals have attracted enormous attention from researchers in various fields of study because of their unusual optical properties as well as novel chemical properties. They have possible uses in diverse applications such as devices, transistors, optoelectronics, information storages, and energy converters. It is well-known that nanoparticles of noble-metals such as silver and gold show strong absorption bands in the visible region due to their surface-plasmon oscillation modes of conductive electrons. Silver nanocubes stand out from various types of Silver nanostructures (e.g., spheres, rods, bars, belts, and wires) due to their superior performance in a range of applications involvinglocalized surface plasmon resonance, surface-enhanced Raman scattering, and biosensing. In addition, extensive efforts have been devoted to the investigation of Gold-based nanocomposites to achieve high catalytic performances and utilization efficiencies. Furthermore, as the catalytic reactivity of Silver nanostructures depends highly on their morphology, hollow Gold nanoparticles having void interiors may offer additional catalytic advantages due to their increased surface areas. Especially, hollow nanospheres possess structurally tunable features such as shell thickness, interior cavity size, and chemical composition, leading to relatively high surface areas, low densities, and reduced costs compared with their solid counterparts. Thus, hollow-structured noblemetal nanoparticles can be applied to nanometer-sized chemical reactors, efficient catalysts, energy-storage media, and small containers to encapsulate multi-functional active materials. Silver nanocubes dispersed in water have been transformed into Ag@Au nanoboxes, which show highly enhanced catalytic properties, by adding $HAuCl_4$. By using this concept, SiO_2-coated Ag@Au nanoboxes have been synthesized via galvanic replacement of SiO_2-coated Ag nanocubes. They have lower catalytic ability but more stability than Ag@Au nanoboxes do. Thus, they could be recycled. SiO_2-coated Ag@Au nanoboxes have been found to catalyze the degradation of 4-nitrophenol efficiently in the presence of $NaBH_4$. By changing the amount of the added noble metal salt to control the molar ratio Au to Ag, we could tune the catalytic properties of the nanostructures in the reduction of the dyes. The catalytic ability of SiO_2-coated Ag@Au nanoboxes has been found to be much more efficient than SiO_2-coated Ag nanocubes. Catalytic performances were affected noteworthily by the metals, sizes, and shapes of noble-metal nanostructures.

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