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FABRICATION AND CHARACTERIZATION OF SILVER-TIN DIOXIDE CORE-SHELL STRUCTURED NANOCOMPOSITE PARTICLES

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Abstract. Core-shell structure nanoparticles with silver core and tin dioxide shell were synthesized via a facile soft-chemical process. Optical absorption spectra of tin dioxide deposited silver core nanoparticles, obtained by UV-Visible spectroscopy, showed distinct shifts, both in peak position and its intensity, compared with bare silver nanoparticles, which indicated that silver-tin dioxide core-shell nanoparticles appeared to be formed. The core-shell structure formation was characterized by X-ray diffraction (XRD) and transmission electron microscopy (TEM). XRD pattern showed distinct major peaks corresponding to cubic silver and minor peaks due to tetragonal tin dioxide phases. TEM results, from which we could estimate the nanoparticles size as well as their shell thickness, demonstrated that thin tin dioxide shells encapsulated the silver core particles.

1. Introduction

Core-shell nanoparticles have recently been the focus of a lot of scientific efforts because of the combination of different properties in one particle based on different compositions of the core and the shell. Furthermore, many interesting technological applications can be foreseen for this kind of material, in addition to others in analytical chemistry (chromatography), separation technology (ion exchange), catalysis, biochemistry and medicine, etc. [1, 2]. These types of particles can be defined by their different core and shell compositions. The core often (though not always) shows the relevant property (e.g. semiconductors, metals, magnetic oxides, encapsulated molecules), while the shell can stabilize the core; create compatibility between the core and the environment; or can change the charge, functionality, or reactivity of the surface as well as modification of particular properties of the core [3-7]. This is especially important if the shell is a polymer and the final core-shell particle can be homogeneously

synthesized at 60 °C with a reaction time of 60 min. The core Ag particles are about 18-20 nm in diameter, and resultant core-shell structure of the Ag-SnO_2 nanoparticles is clearly observed in this image. The thickness of SnO_2 shell is about 5 nm. However, the particle size of SnO_2 in the shell layer was about 1–2 nm (which can be estimated from XRD data according to Scherrer formula for crystallite grain size).

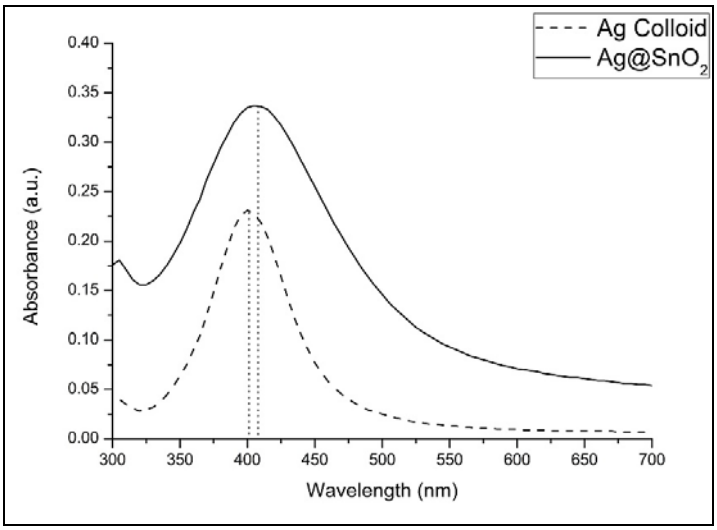

Fig. 1. UV-Vis absorption spectra of the Ag colloid and Ag-SnO_2 core-shell nanoparticles colloids. A 10 nm red-shift in the peak position and an increase in the absorbance of nanoparticles are observed due to shell formation.

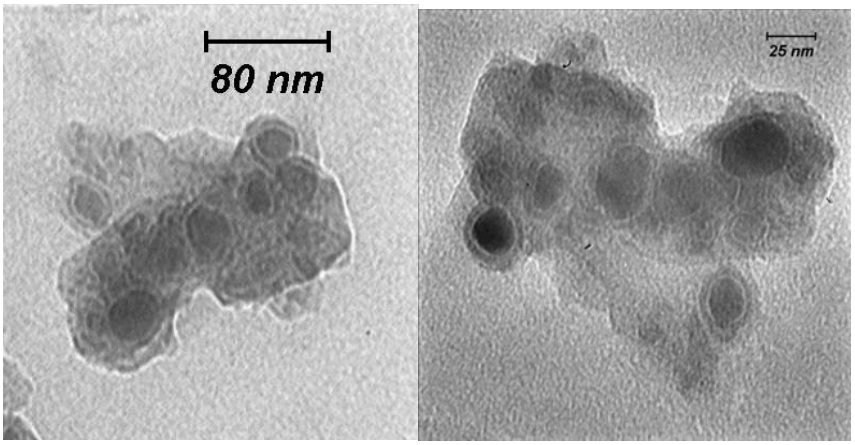

Fig. 2. TEM images of the Ag-SnO_2 core-shell structure nanoparticles.

Figure 3 shows the electron diffraction pattern of Ag-SnO_2 core-shell structure nanoparticles synthesized by a simple hydrothermal method. As seen from Fig. 3, the sample has shown three distinct peaks at 33.94, 36.60, and 51.74 corresponding to (101), (200), and (211) Bragg reflections of the tetragonal rutile structure of tin dioxide. Moreover, three intense reflections at 38.28, 44.49, and 64.60 can be attributed to (111), (200) and (220) planes of face-centered cubic structure of silver metal. The crystal structure of the SnO_2 coated on the Ag nanoparticles is consistent with cassiterite (JCPDS card no.: 41- 1445). There was a slight sharpening of the bands for the sample heat treated at 200 °C. Small intensity of the tin dioxide nanoparticles is may be due to the very small size of the nanocrystallites. Any peak corresponding to Ag-Sn compound was not observed, which

corroborated that the materials retain their physical structures and hence are expected to form a nanocomposite rather than alloy.

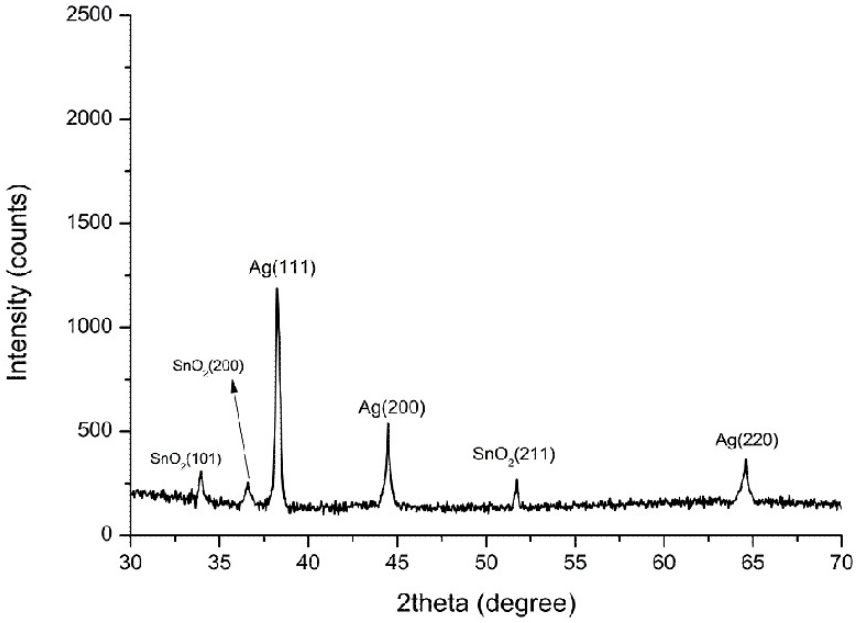

Fig. 3. XRD pattern of Ag-SnO2 core-shell nanoparticles.

4. Conclusions

To sum up briefly, Ag-SnO_2 core-shell structure nanoparticles were successfully synthesized by a facile hydrothermal process. The thickness of the SnO_2 shell was about 5 nm, and the primary crystallite size of the SnO_2 was estimated from XRD data to be 1-2 nm. The peak position of the SP absorption band of the Ag nanoparticles was red-shifted from 400 to 410 nm, due to the formation of the SnO_2 shell. The increasing intensity of the SP band of Ag-SnO_2 core-shell nanoparticles during the reaction was attributed to an increase in the crystallinity of the SnO_2 shell, as well as an increase in the refractive index of the medium around Ag cores.

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