Colloid Polym Sci (2009) 287:13–22
DOI 10.1007/s00396-008-1950-7

ORIGINAL CONTRIBUTION

Synthesis and aggregation study of tin nanoparticles and colloids obtained by chemical liquid deposition

M. F. Meléndrez · G. Cárdenas · J. Díaz V · C. Cruzat C · J. Arbiol

Received: 4 August 2008 / Revised: 7 October 2008 / Accepted: 15 October 2008 / Published online: 12 November 2008

Abstract Tin colloids (Sn-Colls) and nanoparticles were synthesized by a chemical liquid deposition method (CLD). Sn^0 was evaporated and codeposited with acetone, 2-propanol, and tetrahydrofurane vapors at 77 K to obtain colloidal dispersions. Sn-Coll were characterized by UV spectroscopy, transmission electron microscopy (TEM), high resolution transmission electron microscopy, selected area electron diffraction, thermal analysis, infrared spectroscopy [Fourier transform infrared (FTIR)], and light scattering. TEM micrographs of tin nanoparticles (Sn-Nps) revealed a particle size distribution between 2 and 4 nm for the three solvents used in the synthesis. UV studies showed strong absorption bands in the UV region, suggesting that the Sn-Nps obtained by CLD exhibit quantum confinement and typical bands of plasmons corresponded to aggregated particles. Electrophoresis measurement indicated a significant tendency of particle aggregation along time, which was verified by light scattering studies. The diffraction patterns revealed phases corresponding to metallic tin and FTIR studies showed the interaction Sn-solvent in the metal surface by Sn-O bonds, indicating a solvatation of metallic clusters. Thermal analysis revealed a good thermal stability of Sn-Nps. The mechanism of tin nanoparticles formation was also examined.

M. F. Meléndrez · G. Cárdenas (✉) · J. Díaz V · C. Cruzat C
Department of Polymers, Advanced Materials Laboratory,
Universidad de Concepción,
P.O. Box, 160-C, Concepcion, Chile
e-mail: galocardenas@udec.cl

M. F. Meléndrez
e-mail: mmelendrez@udec.cl

J. Arbiol
TEM-MAT, Serveis Scientificotecnics, Universitat de Barcelona,
08028, Barcelona, Catalonia, Spain

Keywords Nanoparticles · Colloids · Vapor deposition · Fractal aggregates

Introduction

Due to the potential application in diverse fields, metal nanoparticles have attracted great attention in recent years [1]. These ultrafine particles often exhibit unusual physical and chemical properties that are distinct from either simple molecules or bulk materials. Current research in this area is motivated by the possible application of these unique properties. Although many methods, such as chemical reduction [2, 4], metal vapor deposition [5], electrochemical synthesis [6], thermal decomposition [7], and microwave irradiation [8], have been used to prepare metal nanoparticles, all of these techniques cannot be used to produce metal nanoparticles on a large scale [9]. Most synthesis methods present disadvantages in the purification of particles; therefore, chemical liquid deposition (CLD) offers an ideal method for the preparation of metallic nanoparticles by the codeposition of metallic vapors with organic solvents that stabilize the colloidal systems, producing smaller particles free of impurities. This method has been studied by Klabunde [10–12] and Cárdenas [13].

From CLD, Pd, Au, Ni, Zn, Cd, Zn, Mo, Fe, Co, and Ag nanostructured materials have been prepared [14, 15]. The synthesis study of Sn-Nps allows one to understand the particle agglomeration in colloidal systems and the effect of interband transition due to plasmon absorption [16]. This is also an important source to obtain SnO_2 thin films by their optical, chemical, and electric properties [17, 18]. Another way to synthesize metallic-Nps is by metallic vapor condensation (MVC) directly over frozen substrate at 77 K. This technique does not produce particle stabilization