

Sub-nanometer control in the synthesis of bimetallic nanoparticles using microemulsions

C. Tojo^{*}, D. Buceta^{†,‡}, M. B. Vukmirovic[‡], F. L. Deepak[§], M. A. López-Quintela[†]

^{*}Physical Chemistry Department, University of Vigo, E-36310 Vigo, Spain

[†]Laboratorio de Magnetismo y Nanotecnología, Instituto de Investigaciones Tecnológicas, University of Santiago de Compostela, E-15782, Santiago de Compostela, Spain

[‡]Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973, USA

[§]International Iberian Nanotechnology Laboratory, Braga 4715-330, Portugal

ctojo@uvigo.es

Abstract

We present a theoretical model to predict the atomic structure of Au/Pt nanoparticles synthesized in microemulsions. Under similar experimental conditions than those explored by simulation, Au/Pt nanoparticles were synthesized and characterized using HR-STEM. Cross section with EDX analysis was performed in order to get their internal nanostructure. To compare experimental and simulation results, theoretical STEM profiles were calculated from the structures obtained by simulation. Excellent concordance with the experimental results shows that the structure of the nanoparticles can be controlled at sub-nanometer resolution simply by changing only the concentration of the reactants (see the Figure) [1]. The results of this study not only offer a better understanding of the complex mechanisms governing reactions in microemulsions, but open up a simple new way to synthesize bimetallic nanoparticles with *ad-hoc* controlled nanostructures. This strategy could be applied for tailoring the design of other bimetallic nanoparticles, such as Pd/Pt, Ag/Au, etc.

Simulation results prove that the interplay between the compartmentalization of reaction media and reactant concentration induces changes in the sequence of metal deposition of Au/Pt nanoparticles: Pt reduction is accelerated by the increase in concentration much more than Au reduction, which is controlled by intermicellar exchange rate, because the Pt salt is accumulated inside the microemulsion droplets. This accumulation favors the chemical reaction like in a *cage effect*: the increase in local concentration of Pt salt gives rise to a faster reduction, and consequently, the differences in reduction rates of both metals are attenuated [2]. This deeply affects the nanoparticle structure, giving rise to a higher degree of mixture of both metals in the nanoparticle core. Because the local accumulation of slow reactants is higher at higher concentrations, this effect will be more pronounced as the concentration is increased.

References

[1] D. Buceta, C. Tojo, M. B. Vukmirovic, F. L. Deepak, M. A. López-Quintela, submitted for publication.

[2] C. Tojo, M. de Dios, D. Buceta and M. A. López-Quintela, Phys. Chem. Chem. Phys. **16** (2014) 19731.

Figures

