Dendrimer-Mediated Co/Pt Nanoparticle Synthesis

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Motivation

• Nanoparticles are becoming increasingly important in many areas, including catalysis, biomedical applications, and information storage. In particular, magnetic nanoparticles are attractive for data storage devices in various media. Nanoparticle size and shape will influence magnetic properties; therefore, controlling particle growth is extremely important.
• In this study, we focus our attention on preparing CoPt nanoparticles in aqueous solutions using poly(amidoamine) (PAMAM) dendrimers and UV irradiation to induce photoreduction of precursor metal ions to the zerovalent metal.

Dendrimers as Functional Components

Starburst PAMAM Dendrimers

Dendrimers are 3-D, highly branched, macromolecules with a core/repeat unit/terminal shell structure. Generally classified by generation, e.g., G4: -OH terminated, 64 endgroups, MW ~ 14000, 4.5 nm (dia. in soln.)

Conclusions

• We have developed a new method for preparing bimetallic nanoparticles Co/Pt at room temperature, using dendrimer as a synthetic template and cluster stabilizer.
• UV-vis spectra show peaks due to complexation between metal ions and dendrimer molecules that disappear after irradiation (1 minute) and a new peak due to the crystal formation which increases withincreasing the irradiation time. This may indicate photo reduction is a very fast reaction.
• Diffraction patterns obtained via TEM show these Co50/Pt50 particles have L10 crystal structure corresponding to a primitive tetragonal unit cell that is consistent with successive stacking of Pt and Co atom planes along <001>. This is true regardless of irradiation time.

UV Irradiation of Mn+ /G4-OH System

Prepare the mixture solution with the molar ratio of terminal group of dendrimer to metal ion as 2:1.
The solutions were stirred for 15 minutes, then bubbled with N2 for 30 minutes.
The solutions were irradiated by UV light (253 or 320nm) for 3 - 24 hours.

UV-Vis Spectra

These particles have a L10 crystal structure corresponding to a primitive tetragonal unit cell that is consistent with successive stacking of Pt and Co atom planes along <001>. This is true regardless of irradiation time.

Cell parameters: a = 3.808 Å and c=3.636 Å.

XPS Spectra of Co50/Pt50 Nanoparticles

The peak Co2p around 780.2 eV is due to zerovalent Co instead of Co2+, which is expected to exhibit a peak at around 780.3 eV.
The peak Pt4f around 71.3 eV is due to zerovalent Pt instead of Pt4+, which is expected to exhibit a peak at around 72.8 eV.

Magnetic Hysteresis Loop for Co50/Pt50 Nanoparticles

Particles prepared by 12 hours irradiation time

The bright field micrograph exhibits Co/Pt particles to be of faceted morphology and of sizes depending on the irradiation time.

TEM Images of Co50/Pt50 Nanoparticles

Diffraction Pattern of Co50/Pt50

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