Dendrimer-mediated Synthesis of Magnetic Nanoparticles: CoPt

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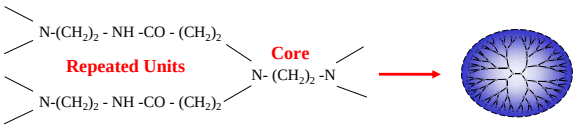
Motivation

• 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 synthesizing CoPt nanoparticles in aqueous solutions using poly(amidoamine) (PAMAM) dendrimers and either UV irradiation or chemical reducing agent to reduce precursor metal ions to the zerovalent alloy.

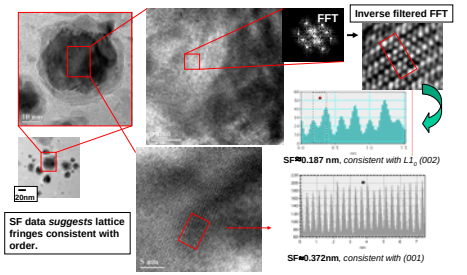
Dendrimers as Functional Components
Starburst PAMAM Dendrimers



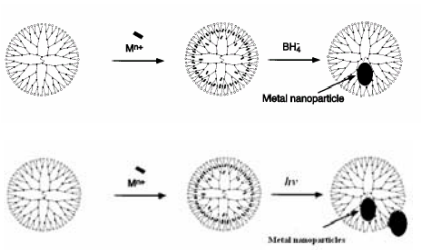
Dendrimers are 3-D, highly branched, macromolecules with a core/repeat unit/terminal shell structure.

Generally classified by generation, e.g., G4: -OH terminated
64 endgroups
MW ~ 14000
4.5 nm (dia. in soln.)

Preliminary Data: Spatial Frequency (SF) from HRTEM: Photoreduced CoPt Nanoparticles

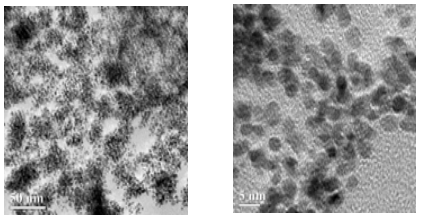


Synthesis Methods of M^{n+} /Dendrimer System



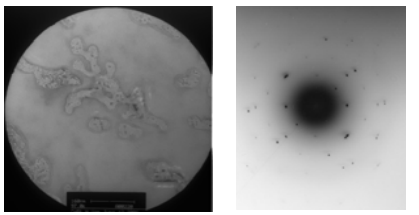
The dendrimer monolayer can coordinate metal ions (H_2PtCl_6,$CoCl_2$) in its interior. Subsequent reduction forms dendrimer-mediated metal nanoparticles.

Chemical Reduced CoPt/G4 Nanoparticles



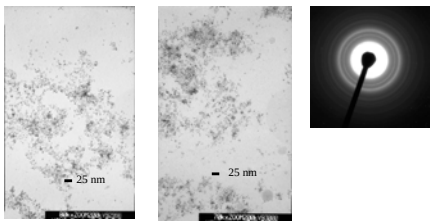
• Particles are monodisperse and have an average size of 3±0.5 nm

TEM Images of PhotoReduced $Co_{63}Pt_{37}$ Synthesized with Different Reactants



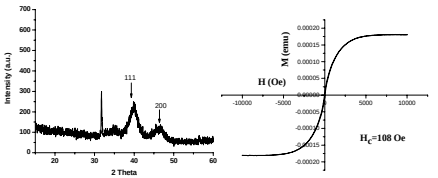
• Particles are synthesized from K_2PtCl_4 and $CoCl_2$.
• The ratios of d spacings indicate this structure is either primary cubic or tetragonal.

Chemical Reduced CoPt/G6 Nanoparticles



• Particles are separated very well and have an average size of 4±0.5 nm
• The diffraction patterns only show fcc phase

XRD and Magnetic Hysteresis Loop of Chemical Reduced CoPt/G4 Nanoparticles



Based on the Scherrer equation, the particle size of CoPt/G4 is about 3.5 nm.

Conclusions

• We have developed new methods for preparing bimetallic nanoparticle Co/Pt at room temperature, using dendrimers as synthetic templates and cluster stabilizers.

• The chemical reduction method only synthesizes disordered fcc CoPt nanoparticles. The nanoparticles are monodisperse and the size of the nanoparticles can be modified based on dendrimer size.

• Diffraction patterns obtained via TEM on selected areas show photoreduced CoPt particles have L10 crystal structure. However, the whole product maybe is a mixture phase of disordered fcc, ordered fcc and fct, because the particles do not exhibit the coercivity associated with single-domain particles of their apparent size.