Synthesis and Characterization of Silica/Metal Nanoparticle Spheres

Litao Bai, Haiying Wan, Gregory Thompson, Shane Street*

MINT Center and Department of Chemistry
The University of Alabama

Introduction

Magnetic metal nanoparticles have potentially significant applications in high-density magnetic recording media, magnetic refrigeration system, ferrofluids, and biomedicine. Coating magnetic metal with silica can enhance the stability against oxidation by air and agglomeration by magnetic attraction. Moreover, interparticle interaction can be controlled by the thickness of the shell. Dendrimers are globular, highly branched, monodisperse polymeric materials. They are roughly spherical, sterically crowded on the exterior, less so in the interior. Their interior cavities can be used to coordinate metal ions. These ions can be reduced chemically or by photo-reduction to get dendrimer-metal clusters. We use dendrimer synthesized CoPt nanoparticles and coat with silica shells to increase the stability and control interparticle interactions. Our results show that the thickness of silica shell and dispersion of CoPt nanoparticles influence the coercivity significantly.

Experiment Design

Stöber method was used to synthesize monodisperse silica microspheres:

3ml CoPt@dendrimer water solution +7ml ethanol+20µl TEOS, then 0.5ml concentrated ammonia were dropped in. The size of the silica microspheres is determined by concentration of ammonia and amount of TEOS.

Hydrolysis: Si(DC2H5)4+4H2O=Si(OH)4+4C2H5OH
Condensation: Si(OH)4→SiO2+4H2O

TEM images show that CoPt is dispersed in silica spheres. By control the amount of TEOS and ammonia, silica spheres with different size can be synthesized. EDX show the present of CoPt and silica. From AGM test result, we can find that the thickness of silica shell and dispersion of CoPt nanoparticles influence coercivity significantly.

Future work:
1. Investigate how the thickness of silica shell and dispersion of magnetic particles influence the coercivity of sample.
2. Extend this method to other metals, and study how the coating influence the magnetic character of these metals.
3. Synthesize monodispersed microspheres and make highly ordered nanostuctures with self-assembly of silica microspheres.

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