Synthesis and Characterization of Nanostructured Ferrites

Xylona Williams, Jian Zhang and Lamar Meda

Department of Chemistry
Xavier University of Louisiana

LA-SiGMA
Louisiana Alliance for Simulation-Guided Materials Applications

Introduction

Spinel ferrites of MFe_2O_4 where M is a divalent transition metal are a class of important magnetic materials. The magnetic properties of ferrites such as superparamagnetism, magnetic relaxation, saturation magnetization and coercivity depend on the particle size and morphology.

The objective of our research is to synthesize high performance nanostructured magnetic ferrites for biomedical applications, such as hyperthermia and magnetic resonance imaging contrast agent.

Powder X-ray Diffraction and Determination of the Mean Crystallite Size

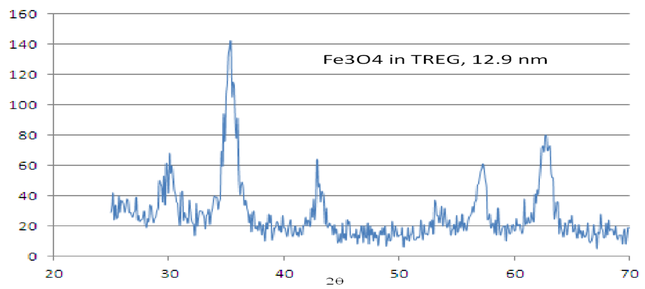
Debye-Scherrer formula

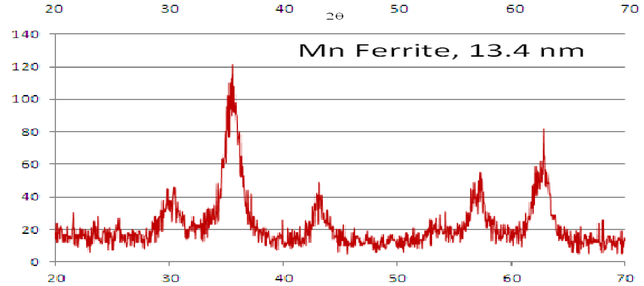
$$\tau = \frac{0.9\lambda}{\beta \cos\theta}$$

1. Synthesis of Nanoparticles in Polyol Medium

A polyol is an alcohol containing multiple hydroxyl groups. It has high boiling point, reducing, complexing, surfactant, and amphiprotic characters. The nanoparticles synthesized in polyol medium are water soluble.

Magnetite nanoparticles are prepared in triethyleneglycol at 280C using a single reactant, Fe(acac)3. Mn ferrite nanoparticles are prepared in triethyleneglycol at 280 C using Fe(acac)3 and Mn(acac)2.

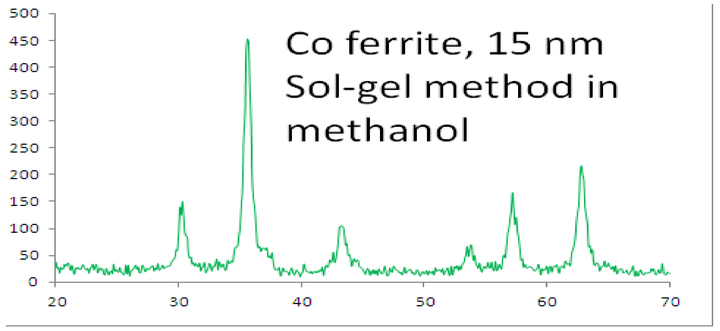


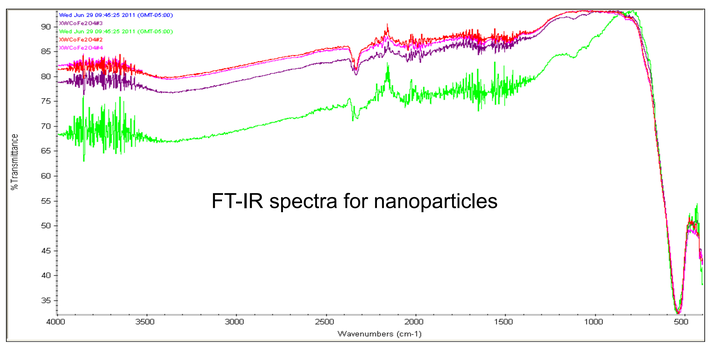


2. Template Assisted Synthesis of Co Ferrite Nanotubes using Sol-Gel Processing

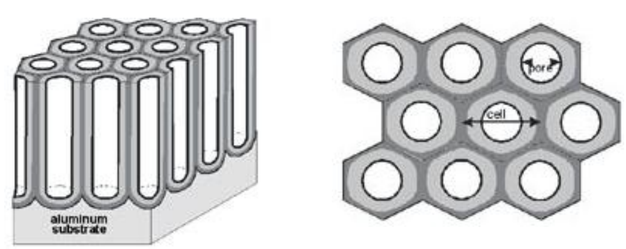
Preliminary work to determine the solvent and calcination temperature for gels

- Sols were prepared using Fe(acac)3 and Co(CH3COO)2 or Co(acac)2 in three solvents : aqueous, methanol and ethanol with acetic acid added.
- Gelation process was fastest for sol with methanol as solvent
- Calcination was performed at 400 C and 500 C. Pure cobalt ferrite nanoparticles was obtained at 400 C with particle size ranging from 15 to 20 nm.
- Infrared spectra indicated that particles were almost free of solvent after calcination at 400 C.





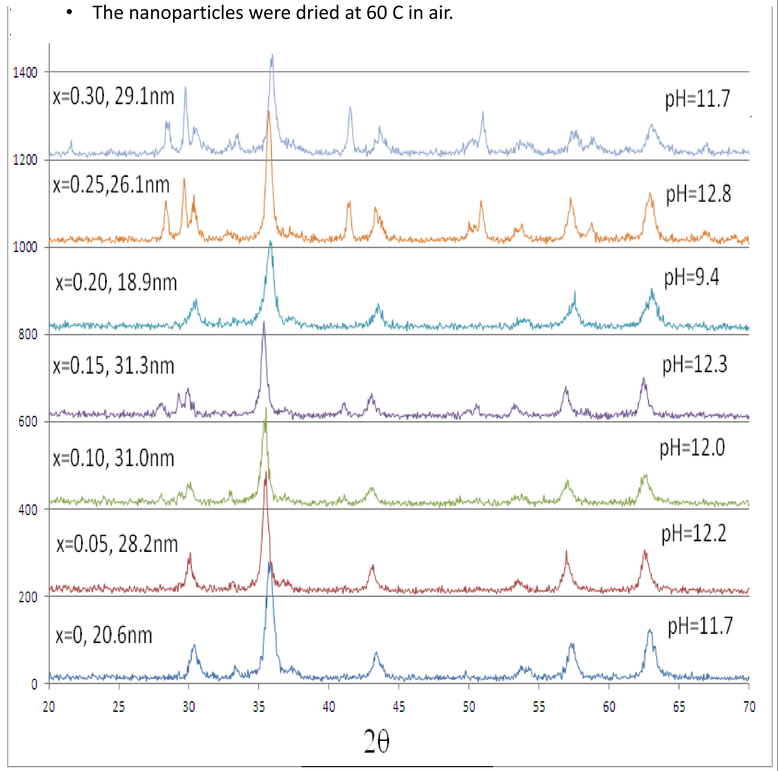
Next Step: fabrication of Co ferrite nanotube using pored alumina membrane as templates



3. Hydrothermal Synthesis of Gd Substituted Cobalt Ferrite: CoFe2-xGdxO4 (x = 0 – 0.3)

Synthesis:

- 0.2M Co(NO3)2, 0.5M Fe(NO3)3 and 0.2M Gd(NO3)3 solutions were mixed in stoichiometrical ratio .
- The mixture was titrated to pH value of 9.5 -12.5 using 4.0M NaOH solution
- While stirring
- The titrated mixture was sealed in Teflon lined bomb, and heated in an oven at 180C for 12 hours.
- The solid was separated from the solution after cooled and washed with deionized water and ethyonal.
- The nanoparticles were dried at 60 C in air.



In Summary

- Gd cannot be doped in CoFe2O4 when $x \geq 0.25$
- pH values of solution before hydrothermal reaction had great effects on the formation of nanoparticles. pH values should be controlled between 9 to 10 in order to obtain pure Gd doped phase and small size.

Acknowledgements

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