Stephen Gibbs 2/21/14
University of Florida - Dr. Rinaldi Lab

Synthesis of Manganese Zinc Ferrite Magnetic Nanoparticles for Biomedical Applications

Stephen Gibbs[1], Lorena Maldonado-Camargo[1], Dr. Carlos Rinaldi[1,2]
[1]Department of Chemical Engineering
[2]J. Crayton Pruitt Family Department of Biomedical Engineering

Synthesis and suspension of magnetic nanoparticles to create a fluid that responds to a magnetic field, a so-called "ferrofluid," has opened the door to various biomedical applications. Among these are: targeted drug delivery, magnetic resonance imaging (MRI) contrast agents, and nanoscale energy delivery through heat dissipation, just to name a few. The goal of this project is to synthesize Manganese Zinc Ferrite (MZF) nanoparticles with narrow size distributions and surface coatings that make them suitable for biomedical applications. Of note, we are interested in exploring the dependence of the mechanism of magnetic relaxation on size of the particles, and how this affects performance in biomedical applications. When responding to an alternating magnetic field, a particle can relax by the Brownian Mechanism (physical rotation) or the Néel Mechanism (dipole rotation, no physical rotation). It has been observed that when the size of a magnetic nanoparticle increases above a critical diameter, it will switch from relaxation by the Néel mechanism to relaxation by the Brownian mechanism. Due to its particular crystalline structure, the MZF particle is expected to have a low anisotropy constant, which should increase the critical diameter for this transition in the relaxation mechanism.

Elemental composition analysis by ICP-MS of our samples confirms that we have successfully incorporated Manganese and Zinc into the nanoparticles. Results from TEM show highly monodisperse particles with physical diameters of ~20 nm. Dynamic magnetic susceptibility experiments indicate the particles respond through the Néel relaxation mechanism. In comparison, iron oxide nanoparticles of similar size are found to relax through a combination of Brownian and Néel mechanisms. Forthcoming results of performance characterization for applications in magnetically mediated energy delivery will be also presented.