Structural and magnetic properties of Core-Shell $ZnO@Fe_3O_4@ZnO$ by colloidal thermal decomposition method

<u>Thiago E. P. Alves</u>[1,3] (PG), Adolfo F. Junior[2,3]* (PQ)

[1]Instituto de Química-UFG, [2]Instituto de Física-UFG, [3]Grupo Física dos Materiais-UFG
**afrancojunior@gmail.com*

Keywords : colloidal thermal decomposition, *superparamagnetism, core-shell.*

Abstract

The metal oleat precursor in reflux can produce nanoparticles of $ZnO@Fe_3O_4@ZnO$ core-shell with superparamagnetic behavior.

Introduction

Zinc Oxide is a semiconductor with a wide band gap (3,37 eV) and a versatile material to study. Among its various properties, photocatalysis for pollutant degradation can highlight their optical properties. However, one of the challenges for catalysts has been its reuse or recycling which is a complex and expensive methods in large scale[1]. A good solution for recycling these materials would be their aggregation in a magnetic material, thus, can be separated magnetically. The ferrites (Fe_3O_4) for other hand have very diverse magnetic properties depending on their size, composition and shape of particles. Ferrites have been produced for a variety of applications in science by different synthetic methods[2]. Core-shell materials can be formed of phases with different chemical and physical properties, then, several researchers have produced hybrid composite materials of the kind ZnO/Fe_3O_4. In this work we have synthesized materials like ZnO, $ZnO@Fe_3O_4$ and $ZnO@Fe_3O_4@ZnO$ and studied their sctuctural and magnetic properties.

Results and Discussion

The synthesis utilized colloidal thermal decomposition by refluxing for oleates metal in octadecene. Thus, ZnO nanocrystals were formed in the first step. Then, they were used as a new seed to reflux in order to coat the particles with Fe_3O_4. Subsequently they were again coated with ZnO. Structural characterization was carried out by XRD and TEM, and confirming the synthesis of structures, and enabling the calculation of particle diameter about 10 nm (fig. 1) by Scherrer equation ~ 9 nm and TEM ~ 11 nm. The magnetic properties were measured from the magnetic hysteresis curve measured by a VSM at room temperature. The hysteresis loop showed the typical diamagnetism for the ZnO samples and the ferromagnetic behavior for $ZnO@Fe_3O_4$ and $ZnO@Fe_3O_4@ZnO$ samples. The saturation magnetization showed good values comparable to the literatures. Other measures are being carried out to study the core-shell.

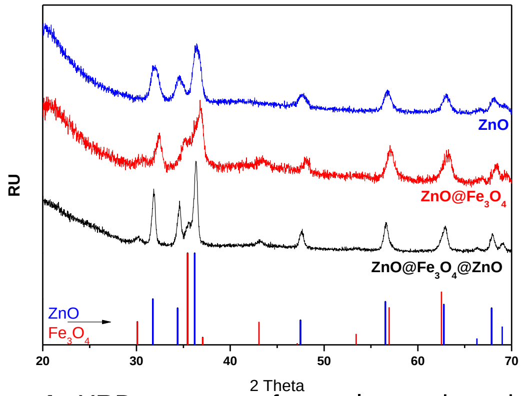

Figure 1. XRD patterns of samples and cards for comparison - ICSD 94002 (ZnO) e 49549 (Fe_3O_4).

The ZnO sample has a good size distribution. However, when covered clusters are formed, they still in the nanoscales. It's confirmed because the material presented superparamagnetism behavior (figure 2). That would only be possible at the nanoscale.

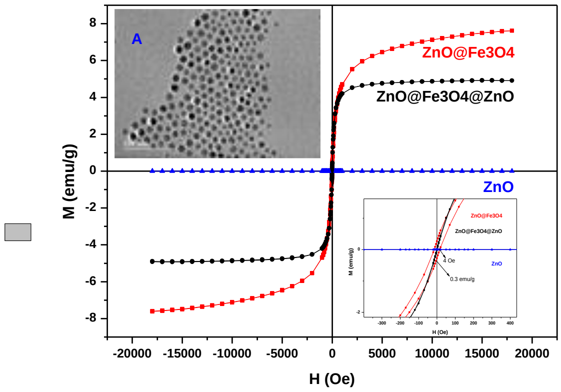

Figure 2. Hysteresis loop and ZnO micrograph (inset A).

Conclusions

Colloidal Thermal decomposition produces ferromagnetic nanoparticles $ZnO@Fe_3O_4$ and $ZnO@Fe_3O_4@ZnO$ with a diameter of around ~ 11 nm. The superparamagnetism was also observed.

Acknowledgments

IQ-UFG, IF-UFG, IFG, CAPES, CNPQ and FAPEG.

[1] Karunakaran, C.; Pazhamalai, V. e Jayaraman, J. *Langmuir*. **2014**, *30*, 15031-15039.

[2] Liu, H.; Wu, J.; Min, J. H.; Zhang, X. e Kim, Y. K. *Materials Research Bulletin*. **2013**, *48*, 551-558.