11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Manganese and zinc ferrites: Synthesis and Characterization

M. L. Martins(1)*, A. A. Cavalheiro(2), A. O. Florentino(1), M. J. Saeki(1)

(1) Departamento de Química e Bioquímica, Instituto de Biociências, Unesp – Botucatu, SP, Brazil, e-mail: murillolongo@gmail.com
(2) Universidade Estadual do Mato Grosso do Sul, Campus de Naviraí, MS, Brazil
* Corresponding author.

Abstract – Manganese and zinc ferrite with the composition of $Mn_{0.77}Zn_{0.23}Fe_2O_4$ was prepared by the polymeric precursor method and calcined at 400°C, 700°C, 900°C and 1100°C for two hours. The element stoichiometries were confirmed by SEM-EDS analysis. DTA and XRD data showed that manganese and zinc ferrite was obtained at low calcination temperatures (400°C) and short time of treatment. The secondary phase (hematite) formed at 400°C<T<900°C and the ferrite phase crystallization does not depend on ionic diffusion.

Magnetic particles, as ferrites, are used in a wide range of medical field from alternated current biosusceptometry[1] to drug delivery[2], due to the high permeability, low magnetic losses and biocompatibility. However, the ceramic powders exhibit composition with low homogeneity and uncontrolled grain growth mainly when sinthetized by the convencional solid state reaction, that makes necessary the development of alternative synthesis methods[4]. The present work aim to approach the synthesis of manganese and zinc ferrites by the polymeric precursor method in order to obtain materials with higher homogenity and consequent better magnetic properties.

The manganese and zinc ferrite powders with the composition of $Mn_{0.77}Zn_{0.23}Fe_2O_4$ were prepared and calcined in air at 400°C, 700°C, 900°C and 1100°C for two hours. The stoichiometry for Mn, Zn and Fe was confirmed by SEM-EDS elemental analysis (Tab.01). The Differential Thermal Analysis (DTA) of the sample calcined at 400°C shows exothermic processes near to 680°C and 900°C wich can be associated to the ferrite phase formation and crystallization (Fig.01). The X-ray diffraction (XRD) data show that the sample calcined at 400°C crystallizes as ferrite monophase, but in an inverted spinel structure (high content of iron occupying the manganese tetrahedral site and manganese occupying the iron octahedral site). The samples calcined at 700°C and 900°C shows the secondary phase, of hematite, probably as a consequence of the phase transition from inverted to the normal spinel. These results, in addition with the DTA analysis suggest that the hematite phase reincoporation to the spinel structure and its crystallization occurs at the same time. The sample calcined at 1100°C shows to be monophasic in ferrite with normal spinel structure. The XRD data are shown at Table 02.

It can conclude that the pure manganese and zinc ferrite can be obtained by the polymeric precursor method at low calcination temperatures and short time of treatment. The formation of hematite during the manganese and zinc ferrite synthesis process depends on the calcination temperature. It is possible to obtain ferrite monophase with normal spinel structure at treatment temperature higher than 900°C. The crystallization of the phases does not depend on ionic diffusion unlike the solid state synthesis method.

Table 01. SEM-EDS Elemental analysis data to $Mn_{0.77}Zn_{0.23}Fe_2O_4$ samples

Calcination Temperature (°C)	%Fe	%Mn	%Zn
400	66.22	25.80	7.97
700	65.85	26.13	8.02
900	65.85	26.08	8.07
1100	66.20	25.82	7.98

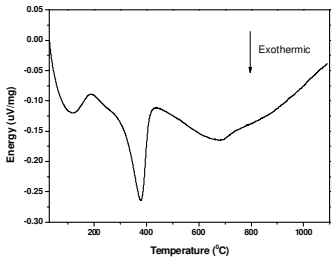

Figure 01. DTA Analysis of the sample calcined at 400°C

Table 02. XRD data to the $Mn_{0.77}Zn_{0.23}Fe_2O_4$ samples

Temperature (°C)	%P*	a (Å)	(1-δ)**	x_O	FWHM***	Ferrite Composition
400	100	8.425	0.56	0.2563	0.66	$(Mn_{0.23}Zn_{0.21}Fe_{0.56})(Fe_{1.72}Mn_{0.28})O_4$
700	66	8.4369	-	0.2636	0.32	$(Zn_{0.5}Mn_{0.5})(Fe_{1.75}Mn_{0.25})O_4$
900	72	8.4458	-	0.2610	0.17	$(Zn_{0.33}Mn_{0.67})(Fe_{1.79}Mn_{0.21})O_4$
1100	100	8.4453	0.07	0.2629	0.15	$(Zn_{0.23}Mn_{0.70}Fe_{0.07})(Fe_{1.86}Mn_{0.14})O_4$

[1] L A Corá, P R Fonseca, M F Américo, R B Oliveira, O Baffa, J R A Miranda. Influence of compression forces on tablets disintegration by AC Biosusceptometry. European Journal of Pharmaceutics and Biopharmaceutics 69 (2008) 372–379.
[2] S C McBain, H HP Yiu, J Dobson. Magnetic nanoparticles for gene and drug delivery. International Journal of nanomedicine 3(2) (2008) 169-180.