Abstract

The controlled synthesis of magnetic nanoparticles is a scientific subject of great interest in the field of nanotechnology. This is due to the special properties which these materials exhibit and the wide range of applications they can cover - ranging from electronics to medicine and biology. Among the kinds of magnetic nanoparticles which have appeared, the most prevalent in literature are the ferrites (MFe_2O_4, M = Mn, Fe, Co, Ni). Ferrites are spinel oxides with ferrimagnetic structure.

In the present study, we prepared and studied eleven different samples of manganese ferrite nanoparticles ($MnFe_2O_4$), using the solvothermal method. The goal was to investigate how the experimental conditions can affect the final products. As precursor compounds, we used complexes of acetylacetonate with trivalent iron ($Fe(acac)_3$) and - for the first time - with trivalent manganese ($Mn(acac)_3$) . The differences in the experimental conditions were related to the proportion of precursors, the type of the surfactant we used (PEG-8000, Oleylamine, TEG) and finally the presence or absence of polar or non-polar solvents like distilled water and diphenyl ether.

The characterization of the samples was achieved using the following techniques: XRD, TEM, SEM, VSM, SQUID, TGA, FTIR and ICP-AES. The results showed that it is possible to regulate the amount of manganese within the ferrite, choosing the appropriate surfactant. In this way, we found how to alter the magnetic properties of the nanoparticles. The change in the proportion of precursors, did not affect the formation and the size of nanoparticles, yet it led to self-organization of them in spherical structures with magnetization higher from bulk ferrites. The surfactant with the smaller molecular weight (TEG) led to the formation of smaller size nanoparticles. The presence of water caused the formation of two phases - magnetite and hematite - except from the sample with oleylamine as surfactant.

Regarding the method chosen, it is clear that the solvothermal method, although it is very simple in its application, can provide repeatability and nanoparticles with very good crystallinity, which is reflected in their high magnetizations.