Mn-Zn ferrite nanoparticles probed by synchrotron pair distribution function analysis and anomalous X-ray scattering

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Among the numerous applications of $Mn_{1-x}Zn_xFe_2O_4$ nanoparticles we can highlight biomedical applications as magnetic tracer in Alternate Current Biosusceptometry (ACB), Magnetic Resonance Imaging (MRI), for diagnosis of cancer and others diseases as diabetes and Parkinson, whose severity can be monitored by analyzing the disturbances of the gastrointestinal motility [1,2]. Specifically, the former (ACB) method is promising because of its low cost, it is non-invasive method and because it can be conducted without ionizing radiation. Major advances have been achieved by developing a bio-nanocomposite based on ferrites for the theranostics [3] as well, of breast cancer, by carrying drugs or hyperthermia. Recently, we reported that $Mn_{0.75}Zn_{0.25}Fe_{2.8}O_4$ nanoparticles with different surface charge can be produced precipitating them by NaOH with different concentrations [2]. This behavior is observed if an excess of Iron is introduced to the ferrite. Five samples precipitated with different NaOH concentrations were analyzed by X-ray synchrotron diffraction (XRD) which revealed a less crystalline phase contribution alongside the main peaks of the cubic spinel ferrite phase. Pair Distribution Function (PDF) analysis was used to probe the local structure and showed that Fe-Fe, Mn-Mn and Zn-Zn bond distances in the 3.0 up to 3.5 Å range are different from the ones usually reported in the literature. Lastly, for the sample with best magnetic behavior anomalous X-ray scattering (AXS) using three energies close to the absorption edges of Mn, Zn and Fe was applied to determine its cation distribution complementing the previous result from PDF analysis.

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