CHANGES IN THE ELECTRONIC STRUCTURE OF $NiFe_2O_4$@SiO_2 NANOCOMPOSITES BY SYNTHESIS PROCESS AND ANNEALING

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Nickel ferrite $NiFe_2O_4$ (NFO) magnetic nanoparticles are promising materials for magnetic hyperthermia in cancer treatment [1]. To enhance biocompatibility and chemical stability, the nanoparticles can be embedded in silica, forming NFO@SiO_2 nanocompounds.

For our research, NFO@SiO_2 was obtained using two methods: co-precipitation followed by microemulsion [1] and the wet-chemical method (WCM) [2]. Annealing at various temperatures was performed to enhance the stability of NFO and improve the properties of the nanocompounds. The structural, electronic and magnetic properties were tested, among others, using X-ray absorption spectroscopy at SOLARIS at PHELIX and PIRX beamlines.

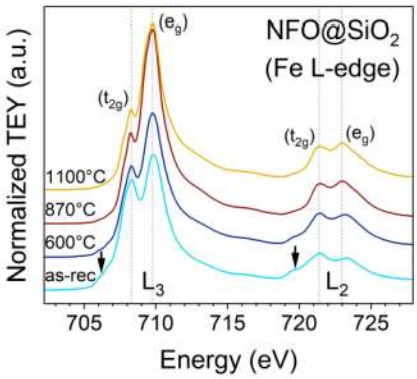

Figure 1 – X-ray absorption spectrum of NFO@SiO_2, obtained by WCM, reveals the influence of annealing temperature on the electronic structure of iron, including the presence of Fe^{3+} and some traces of Fe^{2+} (marked by arrows).

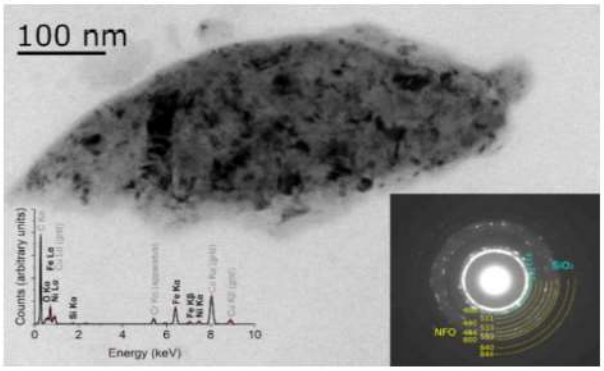

Figure 2 - Transmission electron microscopy image of NFO@SiO_2 obtained by WCM and annealed at 1100°C. The results of energy dispersive spectroscopy (bottom left) and selective area electron diffraction (bottom right) confirm the presence of expected elements and phases: nickel ferrite (NFO, ref. 01-090-8282) and cristobalite α (SiO_2 ref. 00-039-1425).

[1] A. Czempik et al., Ceramics International 50 (2024) 20473- 20494

[2] Y Ichiyanagi et al., phys. stat. sol. (c) 1, No. 12, 3485–3488 (2004)