CoFe$_2$O$_4$-TiO$_2$ NANOCOMPOSITES: SYNTHESIS BY MICROEMULSION REACTION APPROACHES, AND CHARACTERIZATION

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In the last years, the field of nanocomposites has attracted the attention of materials scientists, based on the premise that using a wide range of building blocks (with dimensions in the nanosize range) makes it possible to design new materials with improved characteristics or enhanced properties [1]. The ability to tailor nanocomposites has been demonstrated by several synthesis methods. Amongst the surfactant-based techniques, the microemulsion method offers a series of advantages, namely, the use of simple equipment, the possibility to prepare materials with a high degree of particle size and composition control. Recently, Sanchez-Dominguez et al. (2009) developed a novel and straightforward approach based on oil-in-water (O/W) microemulsions, from a practical and environmental point of view, the possibility of preparing inorganic nanoparticles (NPs) using O/W instead of W/O microemulsions may be highly advantageous, since the major phase is water. The method consists in the use of organometallic precursors, dissolved in nanometer scale oil droplets, and stabilized by a monolayer of hydrophilic surfactant, followed by the addition of a precipitating agent [2]. In this work, we extend the O/W microemulsion method to prepare dual phase nanocomposites, integrated by cobalt ferrite (CoFe$_2$O$_4$) and titanium dioxide (TiO$_2$) NPs. CoFe$_2$O$_4$-TiO$_2$ nanocomposites have been of interest due to its magnetic-photocatalytic properties [3]. The first synthesis approach, named mixture of microemulsion reactions (MRM), consisted in the simple mixture of a TiO$_2$ NPs microemulsion and CoFe$_2$O$_4$ NPs microemulsion. As a second approach, an in-situ reaction was promoted, using CoFe$_2$O$_4$ NPs (dispersed in O/W microemulsion) as nucleation and growing seeds for TiO$_2$. As-obtained CoFe$_2$O$_4$-TiO$_2$ nanocomposites were washed, dried and heat-treated, with the aim to promote and enhance TiO$_2$ and cobalt ferrite crystallization, respectively. Finally, heat treated CoFe$_2$O$_4$-TiO$_2$ nanocomposites were characterized by several techniques such as XRD, HRTEM-STEM, BET, UV-VIS and VSM.

XRD patterns of CoFe$_2$O$_4$-TiO$_2$ nanocomposites presented the main diffraction peaks of cobalt ferrite and TiO$_2$ (anatase), confirming the co-existence of both phases. Although nanocomposites were synthesized with the same molar ratio, there was a clearly difference in the intensity and shape of diffraction peaks, as a consequence of the synthesis approaches. HRTEM-STEM images showed that CoFe$_2$O$_4$-TiO$_2$ nanocomposites were composed of crystalline nanoparticles with sizes below 20 nm; the corresponding electron diffraction patterns also confirmed the cobalt ferrite and anatase composition. Elemental mapping images displayed a homogeneous distribution for the seed approach, contrary to the MRM strategy. However, both nanocomposites exhibit high surface areas, 147.1 m$^2$/g for MRM, and 138.6 m$^2$/g for the seed approach (determined by BET). UV-Vis spectra demonstrated that CoFe$_2$O$_4$-TiO$_2$ nanocomposites absorbed along the UV and visible spectra, as a result of both phases combination. Magnetic curves (obtained by VMS) displayed very slim hysteresis loops due the non-magnetic TiO$_2$ contribution.

As a general conclusion, the results highlight the usefulness of the developed approaches, based on the microemulsion reaction methods, for the straightforward synthesis of CoFe$_2$O$_4$-TiO$_2$ nanocomposites. The characteristics and properties shown by synthesized nanocomposites are suitable for magnetic
recovery applications in photocatalysis. Preliminary photocatalytic studies will also be presented.

**Keywords:** nanocomposites, cobalt ferrite, titanium dioxide

**References:**


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