Phosphates Glasses via coacervation route containing cadmium ferrite magnetic nanoparticles.

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Introduction

Coacervation is a processs that makes possible to incorporate inorganic compounds, such as nanoparticles and also rare earths in the polyphosphate structure at room temperature. Thus such material can be transformed into a glass using the melting-quenching process of such precursor.[1] The research field using glass and glass ceramics matrices containing magnetic nanoparticles is called spin-photonics, where photons can be used to standardize magnetic medium and to study the fundamental properties of the interaction of light with magnetic materials.[2,3] This study aimed to prepare and characterize a phosphate based glass containing magnetic nanoparticles of cadmium ferrite via coacervation route followed by melting-quenching. The materials obtained were studied by thermal analysis, Raman Spectroscopy, UV-Vis spectrospy and transmission electron microscopy.

Results and Discussion

Cadmium ferrite was prepared by the coprecipitation method.[4] The nanoparticles were coated with an insulating layer, forming the structure of the core@shell type. The coacervate ($NaPO_3$-$CaCl_2$) was obtained from the interaction between the sodium polyphosphate solution $(NaPO_3)_n$ (4.0 M) with a calcium chloride solution $CaCl_2.2H_2O$ (2.0 M). Three samples were prepared, one without nanoparticles, and two other containing 4% and 8 % in mass of $CdFe_2O_4@SiO_2$. The glass obtained from the coacervates was produced by melting the mixture at 1000 °C and subsequent quenching at room temperature. The coacevates showed efficient dispersion of the nanoparticles. Figure 1 shows the Raman spectrum of the coacervate that presents two main vibrational modes assigned to the υ_s(P-O-P) and υ_s(P-O_t) in 691 and 1173 cm^{-1}. For the coacervate glass - 4% $CdFe_2O_4@SiO_2$ the υ_s(P-O-P) and υ_s(P-O_t) appear in 694 and 1171 cm^{-1}, respectively, while for the coacervate glass - 8% $CdFe_2O_4@SiO_2$ in 702 and 1164 cm^{-1}, respectively. Besides, increasing the concentration of $CdFe_2O_4@SiO_2$ into the coacervate leads to decreasing of the relative intensity of the two vibrational modes analyzed and a higher bandwidth, mainly for the υ_s(P-O_t) mode in 1164 cm^{-1} in the coacervate - 8% $CdFe_2O_4@SiO_2$ glass.

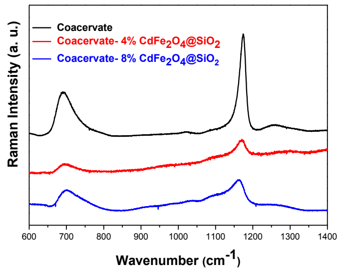

Figure 1. Raman Spectra for glasses whit and without magnetic nanoparticles.

Transmission electron microscopy (TEM) revealed in the Figure 2-a the presence of nanoparticles dispersed through the glass, in 2-b can observe the crystal planes of the $CdFe_2O_4$ proving that there was nanoparticles in the glass. The interplanar spacing calculated from FFT (Fast Fourie trasnformer) to d_{311} is 0,26 nm the value found in the literature is 0,259 nm.

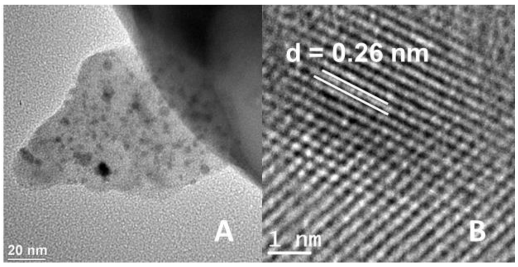

Figure 2. Transmission electron microscopy of glass containing 4% of $CdFe_2O_4@SiO_2$.

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Conclusions

The $NaPO_3$-$CaCl_2$ glassy matrix obtained via coacervation proved to be an efficient host for dispersion of the magnetic nanoparticles $CdFe_2O_4@SiO_2$, according to the Raman spectroscopy and TEM data.

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