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Excited state in nanofluid containing perovskite manganate particles

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Abstract: The nanofluids containing the surface activated particles have great application potential in modern technology. In this paper, we studied the optical properties of the ceramic particles of forms $Ca(FeMn)O_3$ and $(CaPr)(MnRu)O_3$ dispersed in water solution by using SPAN-80 as surface activated agent (called surfactant). The UV-Vis absorption and photoluminescence spectroscopies were involved. The results showed that the prepared nanofluids possess the different optical properties in comparision with their crystalline counterparts. In facts, they showed clear blue shifts of spectral lines, changes of band gap, and especially enhancements of emission intensities.

Keywords: Perovskite; Manganate; Structure; Electronic.

1. Introduction

As modern spintronic materials with many interesting properties, the perovskite manganates deserve a special attention of scientists worldwide. There are a variety of changes taken in the electronic, magnetic, thermal and mechanical properties of these materials when elements in A and B positions of the perovskite stoichiometric formula ABO_3 are substituted by the third elements, either metals, transition metals or non-metals. There are many methods for the fabrication of the nanostructure perovskites. However, the control of size and shape by the simple synthesis is a big challenge.

As known, the nanoparticles dispersed in liquid media (such as the water-based $Ca(FeMn)O_3$ and Ru-doped $(CaPr)MnO_3$ nanofluids) possess larger surface contact areas than in bulk solid state. For optical measurement, this increase of optical capture (or scattering) cross-section leads usually to the

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increase in absorption of light, and consequently in many cases, in the increase of the catalytic activity of the nanofluids. In this research, we used water and acetone as solvents, with SPAN-80 as surfactant.

2. Experiments

At first, the Ca(FeMn)O_3 and Ru-doped (CaPr)MnO_3 ceramic samples were fabricated by classical solid reaction method from highly purified precursors (purity greater than 99,9%). We grinded 0,6 g Ca(FeMn)O_3 and Ru-doped (CaPr)MnO_3 in pure water, then 30 ml water was added to create the 2% solutions (weight basis). These solutions were stirred for 1 hour and left stood 20 minutes in the presence of an ultrasound source. After ultrasonification, the solutions were centrifuged at 3500 rounds per min in approx, 30 mins. The residues were filtered and the obtained 10ml clear liquid was separated. Then, 40 ml acetone solution containing 0,15 ml SPAN-80 was added to create a 0,5% nanofluid (weight basis). The milky colloidal samples were obtained by mixing the solutions together and denoted by their ratios: 1:1 (sample 1), 1:3 (sample 2), 1:5 (sample 3), 5:1 (sample 4), 3:1 (sample 5).

The UV-Vis spectra of the above samples in the wavelength range from 200 to 900 nm were obtained by using the UV-3101 PC in the Center for Materials Science, Faculty of Physics, Hanoi University of Science. The photoemission spectra were obtained by using the FL322 equipment with the He-Cd excitation light source (wavelength of 325 nm).

3. Results and discussion

Figure 1 and 2 show that the IR absorption spectra of Fe and Ru doped samples. (Now, we named that the samples doped with Fe is L1 and with Ru is L2). Fig. 1 reveals that the absorption of L1 is not strong in a visible region, but L2 shows the enhencement of absorption in the wavelength range from 450 to 600 nm (samples 2 and 5, respectively). However, sample 3 of L1 and L2 show the opposite trend. The absorption in UV region was not clearly observed yet.

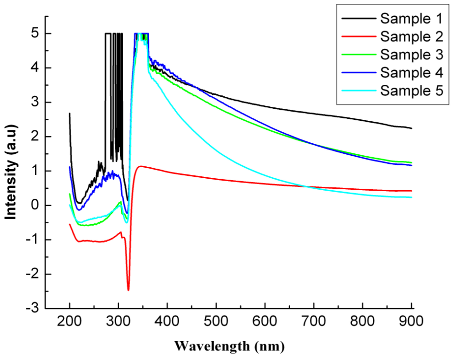

Fig. 1.The IR absorption spectra of Ca(FeMn)O_3 (L1 samples).

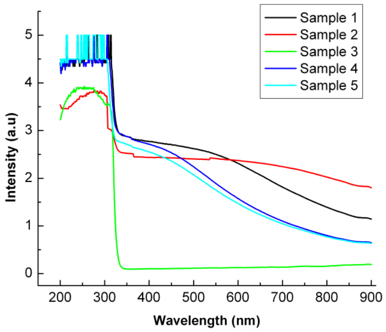

Fig. 2. The IR absorption spectra of (CaPr)MnO_3 doped Ru (L2 samples).

Figure 3 and 4 show that the photoemission spectra of L1 and L2 are similar. They both have one strong emission peak near 450 nm. In the spectrum of L2, there was observed a blue-shift of this peak to shorter wavelength of 425 nm, and a broadening of peak width was also observed for the peak at 540 nm.

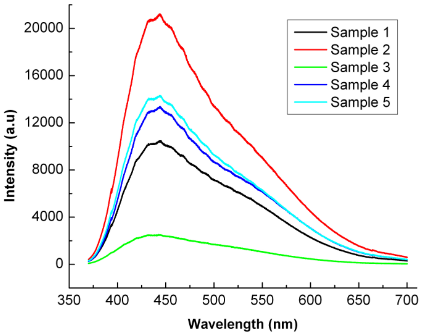

Fig. 3. The photoemission spectra of Ca(FeMn)O_3.

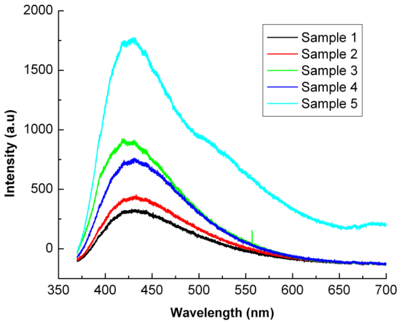

Fig.4. The photoemission spectra of (CaPr)MnO_3 doped Ru.

The photoemission spectra of solid-samples have never been observed, basically because of strong interparticle absorption. The photoemission of perovskite manganates is very interesting phenomenon and we think it may be related to the surface effect and the size of nanoparticles being activated by colloidal agent (SPAN-80). Detailed analysis will need more time to perform with more advanced techniques, including the theoretical evaluation by quantum chemical methods. We leave this for consideration in the future.

4. Conclusion

We have presented an initial research on the optical properties of the ceramic compounds Ca(FeMn)O_3 and Ru-doped (CaPr)MnO_3 in their colloidal form. The results showed that the dispersion of ceramic particles by colloidal agents (SPAN-80) led to the significant increase of absorption and emission ability of these samples (whose bulk states showed weak or did not show such effect). The effects presented are believed to be observed for the first time in our laboratory.

Acknowledgments

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