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Synthesis and Characterization of Manganite Nanocomposites for Magnetic Refrigeration Applications

Thesis

Submitted for the Degree of Master of Science as a Partial Fulfillment for Requirement of the Master in Science in Physics

By

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English summary

Summary

In this thesis, we have studied the effect of substitution of Ag^{1+} on the physical, magnetic and the magnetocaloric properties for the manganites nano compounds of the system $La_{0.8}Sr_{0.2-x}Ag_xMnO_3$ (LSAMO) with (x = 0.0, 0.05, 0.1, 0.15 and 0.2).

We have synthesized these samples using Sol-Gel method. The samples have been annealed at 600 °C for 4 hrs, then to 800 °C for 2 hrs. We confirmed this annealing procedure using thermogravimetric and differential thermal analysis (TGA/DTA).

The microstructure of the samples has been studied by using X-Ray Diffraction and High Resolution-Transmission Electron Microscope (HR-TEM).

The measurements of the magnetic field dependence of the magnetization (M-H curves) have been done at different temperatures (ranging from 245 K to 400 K in steps of 4 degrees) using Vibrating Sample Magnetometer (VSM).

We have studied the magnetocaloric effect for the prepared samples and confirmed the agreement between our experimental results and the theoretical predictions of Landau theory and the mean-field theory.

The results can be summarized as follows:

First: The physical properties:

By studying the XRD for the prepared samples, we found that:

- All samples are single phase without any detectable secondary phases or impurities and they are all having the same the rhombohedral perovskite structure with R3C space group.
- By adding Ag^{1+}, the crystallite size decreases, the lattice parameters also decrease and the tolerance factor becomes below the unity, which leads to a deformation from ideal cubic perovskite to rhombohedral perovskite structure.

Investigating the HR-TEM images, we obtained:

- The values of the average particle size of each sample and compared it with calculated crystallite size obtained from XRD results.
- The shape of the particles and the particle size distribution for each sample using image J and SPSS programs.

Second: The magnetic properties:

By adding Ag^{1+}, the magnetic properties changed, as follows:

- It was found that, the Curie temperature decreases from 338 K for x=0.0 to 306 K for x=0.2. This behavior may be attributed to the decrease of the bond angle Mn^{3+}–O–Mn^{4+} in B-sites resulting due to subsequent decrease in average ionic radii in the A-site $<r_A>$, (La^{3+}, Sr^{2+}, Ag^{1+}), by Ag^{1+} ions substitution.
- The broadening of the Curie transition region decrease by Ag^{1+} ions substitution (i.e. magnetic transition gets sharper by increase of Ag^{1+} ions substitution up to x=0.2).
- The coercive field of the samples decreases as Ag^{1+} ions content increases (i.e. softness of the samples increases).

Third: Studying the magnetocaloric effect (MCE):

Using thermodynamic laws, Maxwell relations and magnetic isotherms, we calculated the magnetic entropy change (ΔS_M) for all samples in the range up to and beyond curie temperature (T_C), and hence calculated the relative cooling power (RCP). It was found that: