Effect of oxygen content on magnetic properties of $La_{1-x}Ag_xMnO_3$ magnetic nanoparticles

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In our paper we study the effect of oxygen content on magnetic properties of $La_{0.80}Ag_{0.15}MnO_{3+\delta}$ and $La_{0.70}Ag_{0.25}MnO_{3+\delta}$ systems of nanoparticles which were prepared by glycine – nitrate method and annealed at 800°C for 48 hours in different atmosphere (air, O_2 and Ar). The annealed samples crystallize in rhombohedral crystal structure ($R\overline{3}c$ space group). The contribution is extension of our study devoted to magnetic properties and magnetocaloric effect of $La_{0.70}Ag_{0.25}MnO_{3+\delta}$ nanoparticles [1] and in generally is related to preparation of nanoparticles for hyperthermia. We supposed that the heat treatment in Ar does not change the content of oxygen in the sample, only the crystal structure changes from orthorhombic to rhombohedral. The heat treatment in the oxidative atmosphere increases the content of oxygen and T_C increased from 235.8 K (Ar) to 321 K (air) and 322 K (O_2, the volume of the elementary cell decreased and simultaneously the bonding angle Mn–O–Mn increased which both lead to the rise of T_C [1]. The increase of oxygen content results in enhancement of double exchange interaction due to the population of Mn^{4+} ions. In this paper we present a comparative analysis of thermogravimetric (TG), X-ray powder diffraction, magnetization and AC susceptibility measurements which allows us to obtain correlation among oxygen content, volume of elementary cell and magnetic properties. TG measurements performed on $La_{0.70}Ag_{0.25}MnO_{3+\delta}$ samples show a small gaining of mass at about 720°C and subsequent drop of the mass for all samples up to about 800°C for the first heating cycle; the largest one for sample treated in O_2 and smallest one for Ar sample. Another drop of mass represented by an increase of volume of unit cell and decrease of T_C takes place at about 1000°C for sample fabricated in oxidative atmosphere. All these processes are taken part at higher temperatures in the case of $La_{0.80}Ag_{0.15}MnO_{3+\delta}$. Heat treatment up to 1400 °C during TG measurement of $La_{0.80}Ag_{0.15}MnO_{3+\delta}$ treated in O_2 leads to huge drop of mass resulting in nearly the same elementary cell volume 353.082 Å^3 at room temperature and $T_C = 239$ K which are comparable with sample fabricated in Ar. All drops of mass in TG we associate with reduction of oxygen content and the temperature range in vicinity of the first drop represents region with maximal gaining of oxygen in the process of sample preparation which affects T_C. Our study confirmed that the volume of elementary cell increases with decreasing oxygen content and simultaneously T_C decreases.

References:

[1] M. Zentková *et al.*, Journal of Magnetism and Magnetic Materials 549, 169002 (2022)

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