Nanoscale physics

Nanostructural clustering, structure defects and magnetic properties of the magnetoresistance $La_{0.6}Sr_{0.15}Bi_{0.15}Mn_{1.1-x}Ni_xO_{3-\delta}$ ceramics

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According to X-ray diffraction data, all ceramic $La_{0.6}Sr_{0.15}Bi_{0.15}Mn_{1.1-x}Ni_xO_{3-\delta}$ samples with x = 0, 0.05, 0.1, 0.15, 0.2 and 0.3 were single-phase and contain a rhombohedral $R\bar{3}c$ type of distortion. The lattice parameter of a perovskite structure slightly changed with increase in x. On the basis of the defect formation mechanism and the obtained experimental data, it has been established that the real structure is a defect and contains variable valence manganese Mn_A^{2+}, Mn_B^{3+} and Mn_B^{4+} ions as well as cationic $\mathrm{V}^{(c)}$ and anionic $\mathrm{V}^{(a)}$ vacancies. The presence of vacancies leads to the appearance of superstoichiometric manganese Mn_A^{2+} ions in A-positions of the perovskite structure with a formation of nanoscale planar clusters of ~ 10 – 25 nm, which has been confirmed by the results of magnetic measurements at T = 77 K. In the compositions with x = 0.05 and 0.1, the anomalous magnetic hysteresis is due to 90° exchange antiferromagnetic interactions ($\mathrm{Mn}_A^{2+} - \mathrm{O}^{2-} - \mathrm{Mn}_B^{(3,4)+}$) between the nanostructural cluster and the ferromagnetic matrix structure. During substitution of superstoichiometric manganese for Ni ions is a decrease in the phase transition temperatures and the magnitude of magnetoresistance effect as well as an appearance of a wide phase separation region which consists of coexisting inhomogeneous magnetic phases also including the nanoscale antiferromagnetic clusters.