The magnetic properties and charge-ordering phase transition of $La_{1-x}Ca_xMnO_{3-\delta}$ ($x = 0.46$; 0.50) compounds

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Recently, increasing attention is focused on compounds of $La_{1-x}Ca_xMnO_{3-\delta}$ due to its interesting magnetic properties and charge ordering phase transitions. Among them the compounds with x = 0.46 and 0.50 occupy special positions. For doping range of $x \leq 0.50$, the materials exhibit a paramagnetic to ferromagnetic transition. For the higher doping range, the doped charge carriers localize and order with stripe modulations at low temperatures. Thus, the ground state in this high doping range is an antiferromagnetic insulator with the ordering of doped charge carriers. The samples of $La_{0.54}Ca_{0.46}MnO_{3-\delta}$ and $La_{0.50}Ca_{0.50}MnO_{3-\delta}$ were prepared by a solid-state reaction method. The X-ray diffraction (XRD)-patterns show that the samples are of a single-phase orthorhombic-perovskite structure. Their properties are investigated by energy dispersive x-ray spectroscopy (EDS), differential thermal analysis (DTA) and thermal gravitional analysis (TGA). The charge ordering phase transition have been found around 150 K by magnetic and resistivity measurements. This is a double-type transition for both ferromagnetic to paramagnetic and metal to insulator transitions. The concentrations of oxygen and Mn^{3+}, Mn^{4+} ions have been determined by dichromate method. The results are discussed in competition between double exchange (DE) and superexchange (SE) interaction.