MAGNETISM IN DOUBLE DISTORTED PEROVSKITES $Ca(Cu_xMn_{3-x})Mn_4O_{12}$

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Double distorted perovskites $Ca(Cu_xMn_{3-x})Mn_4O_{12}$ possess record values of colossal magnetoresistance in a wide temperature range below Curie temperature. The parent compound $CaMn_7O_{12}$ is a weak ferrimagnet below $T_C \sim 49$ K [1]. It consists of two magnetic sublattices: one contains Mn^{3+} cations in square oxygen coordination (the C sublattice) and the other one holds $Mn^{3+/4+}$ cations in octahedral oxygen coordination (the B sublattice). Cu^{2+} ions occupy the C sublattice sites and this leads to redistribution of an additional charge density between Mn cations in the B sublattice, thus to the increase of Mn^{4+} concentration. The final member of the row, $CaCu_3Mn_4O_{12}$, contains only Mn^{4+} ions in the B sublattice. $CaCu_3Mn_4O_{12}$ is a ferrimagnet with $T_C \sim 355$ K [2, 3]. To determine the mechanism of magnetic ordering in double distorted perovskites, we investigated magnetic properties of $Ca(Cu_xMn_{3-x})Mn_4O_{12}$ (x = 0.5, 1, 2) compounds.

The investigated compounds were prepared with application of a new method - aerosol spray pyrolysis of nitrates solution with the following decomposition at 700°C and annealing at 850°C. The phase homogeneity was checked by X-ray analysis. The magnetization measurements were performed utilizing a commercial SQUID magnetometer MPMS (Quantum Design) in the temperature range T=2-360K and magnetic field up to 5 T. High field magnetization were measured at T = 5 K in pulsed magnetic field up to 50 T [4].

The temperature dependencies of magnetization of $Ca(Cu_xMn_{3-x})Mn_4O_{12}$ are shown in Fig.1. The increase in Cu content is accompanied by a rise of the Curie temperature from ~95 K till ~290 K. At low temperatures, spin-glass effects are seen in FC and ZFC measurements. This behavior can be due to random occupation of the C position by Cu^{2+} and Mn^{3+} ions. The low field dependencies of magnetization of $Ca(Cu_xMn_{3-x})Mn_4O_{12}$ are shown in Fig.2. The hysteresis loop was observed in $CaCu_{0.5}Mn_{6.5}O_{12}$ (see the inset of Fig.2). In low magnetic field the magnetization saturates only for $CaCu_2Mn_5O_{12}$ and reaches ~15 μ_B/f.u., while for $CaCu_{0.5}Mn_{6.5}O_{12}$ and $CaCuMn_6O_{12}$ it does not saturate.

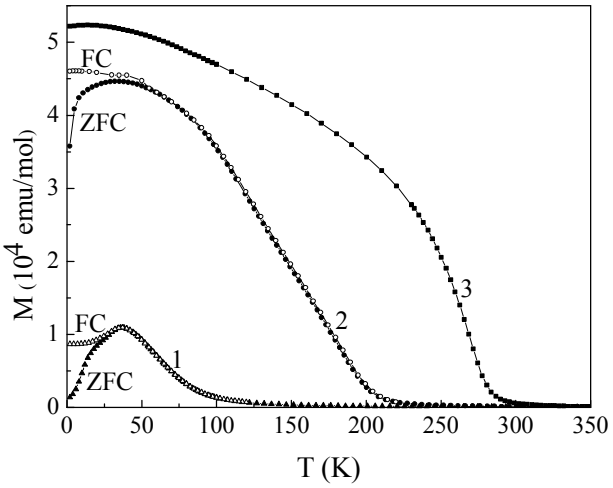

Fig.1 Temperature dependencies of magnetization of $CaCu_{0.5}Mn_{6.5}O_{12}$ (1), $CaCuMn_6O_{12}$ (2) and $CaCu_2Mn_5O_{12}$ (3), B = 0.1 T.

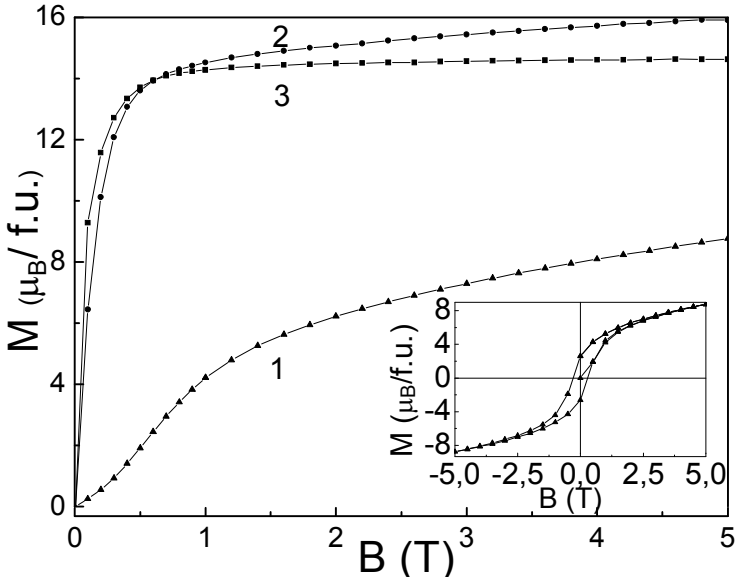

Fig.2 Field dependencies of magnetization of $CaCu_{0.5}Mn_{6.5}O_{12}$ (1), $CaCuMn_6O_{12}$ (2) and $CaCu_2Mn_5O_{12}$ (3), T = 2K. In the insert: hystersis loop of $CaCu_{0.5}Mn_{6.5}O_{12}$.

High field measurements of magnetization of $Ca(Cu_xMn_{3-x})Mn_4O_{12}$ (see Fig.3) show that in $CaCuMn_6O_{12}$ the magnetization saturates only in fields B ≥ 45 T and reaches a value of ~20 μ_B/f.u.. This behavior will be explained within the Goodenough-Kanamori approach of exchange interaction.

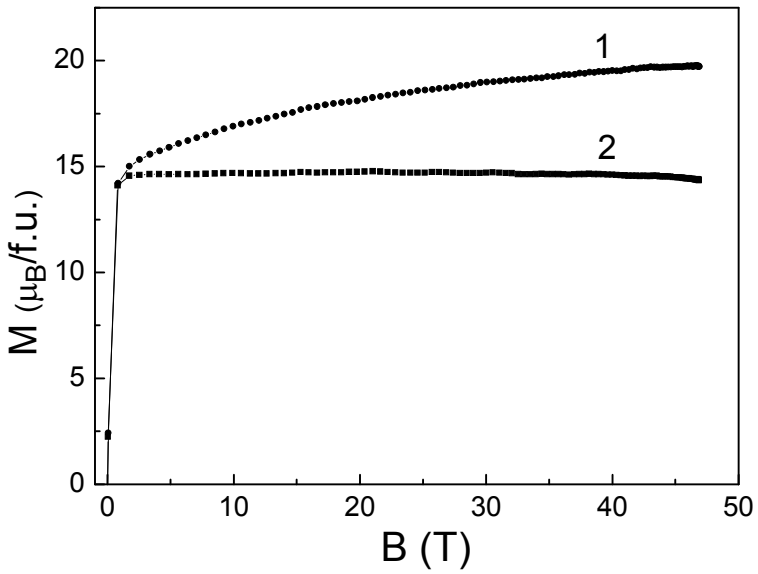

Fig.3 Field dependencies of magnetization of $CaCuMn_6O_{12}$ (1) and $CaCu_2Mn_5O_{12}$ (2), T = 5 K.

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