Anomalies of magnetic and magnetoelastic properties in $Nd_{1-x}Ca_xMnO_3$

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Abstract

Magnetic, anisotropic, and magnetoelastic properties have been investigated for $Nd_{1-x}Ca_xMnO_3$ monocrystals (x=0; 0.25; 0.05; 0.3) in pulsed magnetic fields up to 250 kOe in temperature range 10-100 K. Jumps of magnetization and magnetostriction induced by the strong magnetic field $H||b$ have been observed at H>100 kOe in the x=0, 0.25, 0.05 compounds. We attribute this phenomena to a reorientation of the weak ferromagnetic moment from c to b-axis. Corresponding H-T phase diagrams were obtained.

Key words: magnetostriction ;magnetization; spin reorientation

$RMnO_3$ compounds are interest to investigate due to possible spin reorientation transitions and study the influence of rare earth ion on magnetic and anisotropy of system. They have a P_{bmn} structure and it accept the existence of weak ferromagnetic moment. $RMnO_3$ is an A type antiferromagnetic structure A_yF_z [1], [2]. Exchange interaction between R and Mn gives a contribution to weak ferromagnetic moment and magnetic anisotropy. Existence or non-existence of compensation point is defined by the sign of this exchange. Magnetization and magnetostriction have been measured in strong pulse magnetic fields for $Nd_{1-x}Ca_xMnO_3$ compounds. For manganese subsystem investigation we take non-magnetic ion of La. $LaMnO_3$ has a distorted pervoskite structure and spins of Mn^{3+} have antiferromagnetic ordering below T_N=141 K along b-axis and weak ferromagnetism along c-axis. Magnitude of the weak ferromagnetic moment and transversal susceptibility are 3 emu/g and $18*10^{-4}$ relatively. Longitudinal magnetostriction of $LaMnO_3$ were measured in pulse magnetic field along b-axis crystal. Magnetostriction anomalies linked with spin reorientation from b to c-axis have been observed. Critical fields of spin reorientation have a weak temperature dependence. We replace ion of La by magnetic ion of Nd. Curves of magnetization measured in strong magnetic field for $NdMnO_3$ (Figure 1) can be described by $\sigma=\sigma_0 + \chi$ H , σ_0 -spontaneous magnetization and χ -susceptibility. Spontaneous moment versus temperature has been gained by extrapolation of magnetization isotherms in zero magnetic field (Figure 2). Spontaneous magnetization strongly increase with a temperature decreasing and it can be explained by magnetization of Nd ions by Mn ions exchange field (Figure2). At strong magnetic field applying long b-axis magnetization jumps have been observed (Figure 3). These jumps take place according to spin reorientation from b to c-axis as for $LaMnO_3$.Critical fields values of spin reorientation were extracted and phase T-H diagrams were obtained. Critical fields values de-

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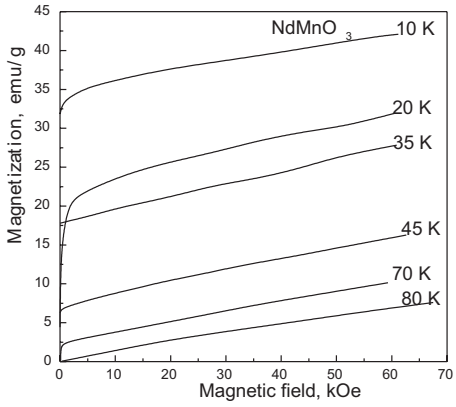

Fig. 1. Magnetization dependence of $NdMnO_3$ single crystal at several temperatures.

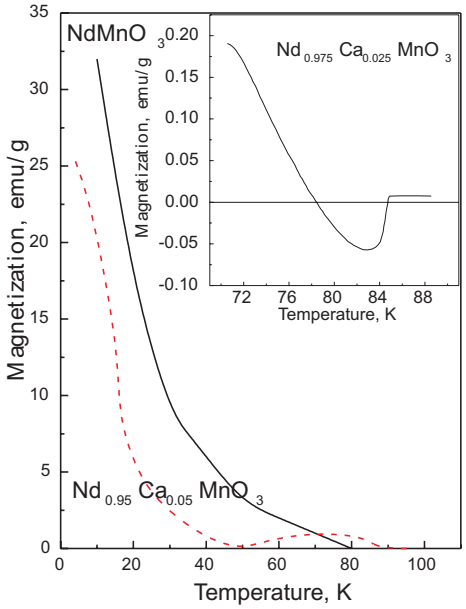

Fig. 2. Magnetization of $Nd_{1-x}Ca_xMnO_3$ single crystals

creased with a temperature decrease and it can be explained by an magnetic ion contribution to anisotropy.

Magnetization of $NdMnO_3$ versus temperature have dependence from which negative exchange between Nd and Mn can be assumed. In this case compounds with a small dope of Nd ions by Ca ions in single crystals of $Nd_{0.975}Ca_{0.025}MnO_3$ and $Nd_{0.95}Ca_{0.05}MnO_3$ were investigated. Curves of magnetization versus temperature have been obtained from measurements of magnetization in static magnetic field. The sign of Nd-Mn exchange is negative and it leads compensation point appearance (Figure 2) . With increase of Ca doping compensation poin temperature shifts to a lower tem-

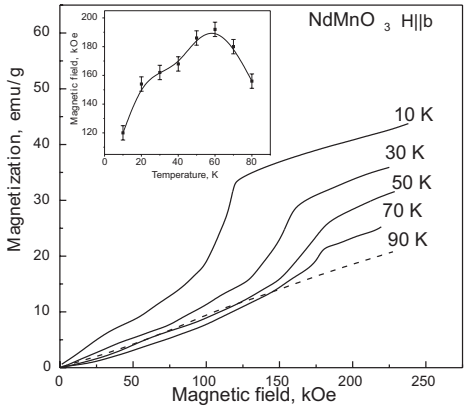

Fig. 3. Magnetization of $NdMnO_3$ single crystals along b-axis and critical fields of spin reorientation

perature region. Magnetization and magnetostriction measurements for doped compounds have no difference fo pure $NdMnO_3$ results. H-T phase diagrams gained both from magnetostriction and magnetization were similar to all crystals.

For $Nd_{0.7}Ca_{0.3}MnO_3$ compound where according to [3] ferromagnetic ordering take place in T_C=115 K, magnetization curves suturates at magnetic field values above 100 kOe. Magnetization values were near 90 emu/g at T=10 K that was smaller than predicted value at full parralel Mn and Nd magnetic moments.

Acknowledgements

This work was supported by RFBR (00-02-16500, 00-15-96695 and 02-02-06069).

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