

Induced by magnetic field spin reorientation in YMn_2O_5

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Abstract

In ferroelectric YMn_2O_5 weak ferromagnetism was found along a-axis of rhombic crystal. It was shown that the nature of ferromagnetic sublattices cant is determined by magnetoelectric ordering. Reorientation of magnetic moment was observed under strong magnetic field applied along b-axis of crystal, that was accompanied by sharp increase of magnetostriction and jumps of electric polarization. In EuMn_2O_5 , as in YMn_2O_5 , spontaneous and magnetic field induced phase transitions from incommensurate to commensurate phase were observed, accompanied by cardinal changing of magnetoelectrical properties.

Key words: Magnetostriction; spin reorientation

Rare -earth oxide YMn_2O_5 is describing by orthorhombic space group P_{bam} , according to neutronography [1] below T_N 40 K forms antiferromagnetic helicoidal structure of Mn^{3+} and Mn^{4+} spins and near $T_C = 20\text{K}$ ferroelectrical phase transitions with spontaneous polarization appears [2] [3]. Rotation moment measurements carried out in static magnetic fields up to 12 kOe has shown the existence of weak ferromagnetism along a-axis below $T_N = 42\text{K}$. This moment reaches the value of 0.8 emu/g at 4.2 K (Figure 1) that much larger than in [2]. It was shown that the nature of weak ferromagnetism linked with the existence electrical polarization along b-axis.

Strong magnetoelectrical link existence in this compounds leads to appearing of electrical polarization under magnetic field. Magnetoelectric effect in these compounds was investigated earlier mainly in weak magnetic fields [2]. We carried out magnetoelectrical measurements in strong pulse magnetic fields.

Electrical polarization at H along b-axis in the temperature range 20;40 K has a small value and quadratic dependence from field up to 250 kOe. How-

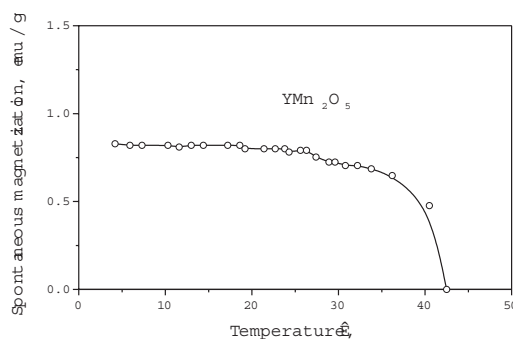


Fig. 1. Spontaneous magnetization of YMn_2O_5 singlecrystal.

ever at T_C 20 K polarization's dependence from temperature and magnetic field changes qualitatively. At this temperature range and fields $H < H_p$ electrical polarization was very small, than at $H > H_p$ it had sharp jump (Figure 2). Critical fields decreased from 200 kOe at 10 K to 150 kOe at 20 K. Such character of electrical polarization dependence is linked with spontaneous electrical polarization P_b appearance at $T_C = 20\text{K}$. Below own ferroelectric transition temperature polarization jumps $P_b(H)$ in strong magnetic field can be interpreted as effect linked with chang-

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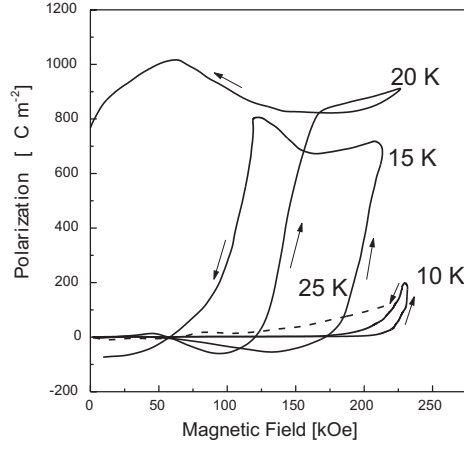


Fig. 2. Electrical polarization $P_b(H_b)$ dependence of YMn_2O_5 singlecrystal at several temperatures.

ing the sign of electrical polarization at magnetic field induced spin reorientation of magnetic moment, because b-axis is the antiferromagnetism axis. Spin reorientation process must followed by the appearance of magnetoelastic deformities. At longitudinal magnetostriction measurements along b-axis sharp anomalies were observed at $T \leq 20 K$ and $H = H_p$. These anomalies have a correlation with character of electrical polarization from field.

At magnetic field orientation along a-axis of crystal near $T=25 K$ character of electrical polarization dependence along c and b-axis sharply changed from temperature and field. Electrical polarization at $T \geq 25 K$ and $T \leq 25 K$ has a quadratic dependence from field. But at $T=25 K$ and $H=200 kOe$ $P_b(H_a)$ have sharp jumps of polarization with large hysteresis (Figure 3).

Possible reason of electrical polarization anomalies at 25 K and at $H = 250 kOe$ is the shift up the ferroelectric transition temperature. This own transition was observed at 20 K without field. Magnetoelectrical susceptibility of YMn_2O_5 along b-axis changes its sign at 20 K in weak magnetic field like it was for $EuMn_2O_5$ at $T=29 K$, where according to neutronography transition [4] from commensurate to incommensurate phase occurs. It is not excepted that in YMn_2O_5 at 25 K external magnetic field may induce phase transition from incommensurate to commensurate, which can be followed by electrical polarization anomalies.

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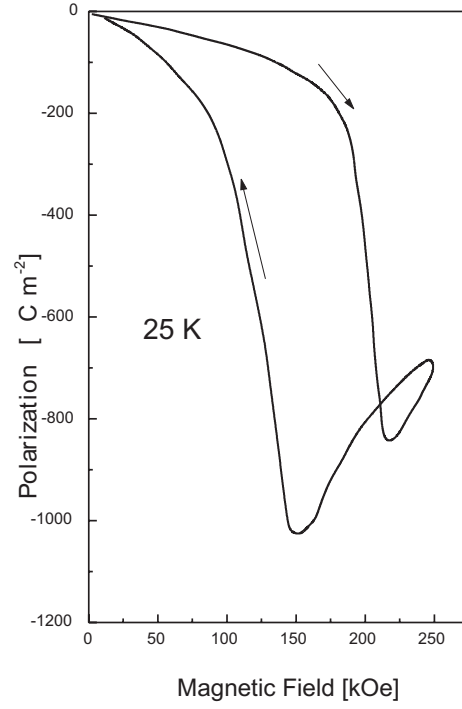


Fig. 3. Electrical polarization $P_b(H_a)$ YMn_2O_5 singlecrystal at 25 K.

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