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New Magnetically Ordered $CoBO_3$ Crystal

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Crystals of a new $CoBO_3$ compound were synthesized from a solution in melt. According to the X-ray diffraction data, $CoBO_3$ crystallizes in the calcite structure with lattice parameters $a_H = 4.631 \pm 0.005$, $c_H = 14.51 \pm 0.01$ Å. Measurements on SQUID and vibrating-coil magnetometers suggested that $CoBO_3$ is a magnetically ordered crystal with a saturation magnetization of 50 emu/g in the basal plane at 4.2 K and a Néel temperature of 53 K. © *2001 MAIK "Nauka/Interperiodica".*

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In recent years, antiferromagnetic 3D metal oxides have attracted widespread attention as Mott–Hubbard insulators with strong electron correlation. Upon doping, copper oxides become high-temperature superconductors, while manganese oxides exhibit the colossal magnetoresistance effect. A series of 3D metal borates MBO_3 (M = Ti, V, Cr, Fe) provide an example of one more class of isostructural oxides [1] with strong electron correlation, among which $FeBO_3$ is the most familiar, and its solid solutions $V_{1-x}Fe_xBO_3$ were found to undergo concentration transition of the metal–insulator type [2]. We developed a method for synthesizing a new member of this crystal family—$CoBO_3$. Up to now, the possibility of this compound existing has seemed to be highly conjectural. However, our systematic work on the preparation of compounds containing Co^{3+} ions and stable at relatively high temperatures provided a way of synthesizing $CoBO_3$ crystals from a solution in melt. The crystals were synthesized using components of the $Na_3[Co(NO_2)_6] \cdot (1/2)H_2O$–$Na_2B_4O_7 \cdot 10H_2O$–$B_2O_3$–$PbO$–$PbF_2$ system and obtained as black plates with a diameter up to 0.5 mm.

This work reports the results of studying the crystal structure and magnetic properties of $CoBO_3$.

To identify the compound, a plate-shaped crystal of size about 0.3 mm was placed in a KM-4 (KUMA-diffraction) X-ray diffractometer. The reflection intensities and Bragg angles suggested that the parameters of this compound were similar to those of crystal borates $TiBO_3$, VBO_3, $CrBO_3$ [1], and $GaBO_3$ [3]. One could

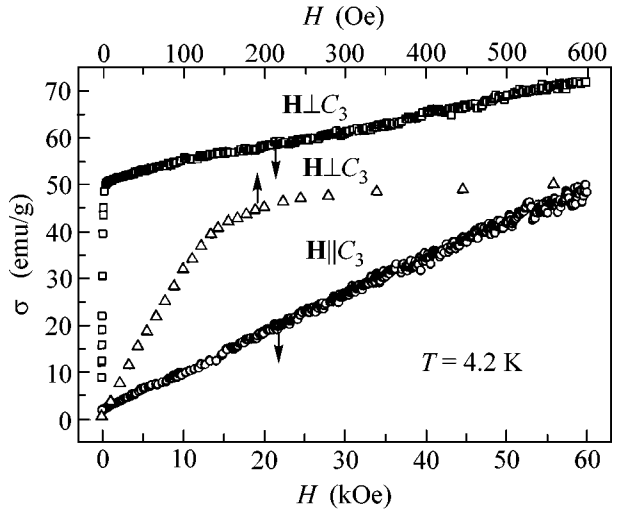

Fig. 1. Field dependences of the magnetization of $CoBO_3$ crystals at $T = 4.2$ K.

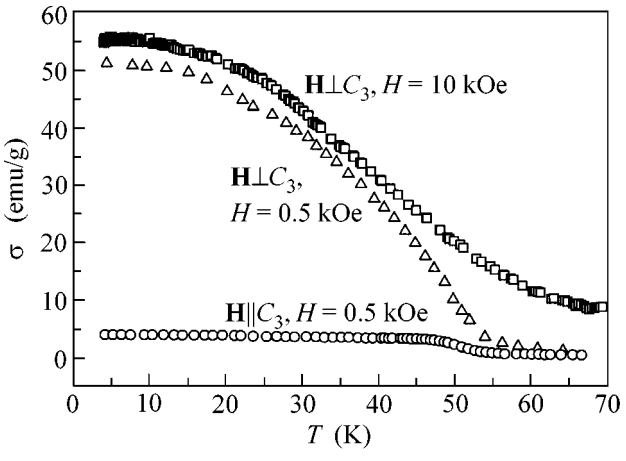

Fig. 2. Temperature dependences of the magnetization of $CoBO_3$ crystals.

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thus infer that the sample under study had a $CoBO_3$ composition and crystallized in the calcite structure with lattice parameters $a_H = 4.631 \pm 0.005$ and $c_H = 14.51 \pm 0.01$ Å (space group D_{3d}^6).

The magnetic measurements were performed on SQUID and vibrating-coil magnetometers over the temperature range 4.2–77 K in fields up to 60 kOe for crystals with a diameter ranging from 0.2 to 0.5 mm. The field dependences of the magnetization of the $CoBO_3$ samples at a temperature of 4.2 K are shown in Fig. 1. The temperature dependence of the magnetization is presented in Fig. 2. The squares correspond to $H = 10$ kOe, and the triangles are for $H = 500$ Oe. The circles are the data for $H = 500$ Oe.

These data suggest that $CoBO_3$ is an antiferromagnet with weak ferromagnetism and the magnetic moment lying in the basal plane. The extrapolation of magnetization gives $T_N = 53$ K.

For comparison, we present the data on σ for other weakly ferromagnetic crystals at $T = 0$ K: 4 emu/g in $FeBO_3$ [4] and 12 emu/g in $CoCO_3$ [5]. These data give evidence for the presence of strong anisotropic interactions in cobalt borate.

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