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THE EFFECT OF PRESSURE ON MAGNETIZATION AND MAGNETIC PHASE DIAGRAM OF MONOCRISTALS OF Tb-Dy ALLOYS

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Abstract. The effect of pressure on magnetic phase transitions in monocrystals of Tb-Dy alloys is studied. It is shown that the destruction of antiferromagnetic structure and the establishment of ferromagnetic ordering is due to magneto-elastic interactions.

Key Words: pressure, magnetic phase transition, magnetization, magnetostriction

It is the purpose of this paper to investigate phase transitions in monocrystals of Tb-Dy alloys. Magnetization at atmospheric pressure and at 10 kbar, magnetostriction, magnetic anisotropy, thermal expansion and susceptibility in magnetic fields of up to 50 kOe and in temperature range of 4.2-300 K are measured. Experimental techniques are described in (Nikitin S.A. et al., 1987).

Temperature dependences of specific magnetization $\mathcal{G}(T)$ in Tb$_{0.5}$Dy$_{0.5}$ at atmospheric pressure (curves 2, 4, 5) and at 10 kbar (curves 1 and 3) ($\mathcal{H}/\mathcal{g}$) are presented in Fig. 1. The pressure shifts the curves of $\mathcal{G}(T)$ into the low
It is stated that the temperatures of helicoidal antiferromagnetism paramagnetism phase transition $\Theta_2$ and ferromagnetism-helicoidal antiferromagnetism phase transition $\Theta_1$ decrease under the pressure of 10 kbar by 5.9 and 10.8 K, respectively.

Phase diagrams of Tb$_{0.5}$Dy$_{0.5}$ at atmospheric pressure (curve 1) and at 10 kbar (curve 2) are given in Fig. 2. At atmospheric pressure $\Theta_1 = 146$ and $\Theta_2 = 201.5$ K.

The investigations made enabled us to calculate the amount of various energy contributions into the thermodynamic potential. The computational technique is described in (Nikitin S.A., 1984; Ewenson W., Zin S., 1969). The calculations made use of experimental results of (Palmer S., Lee E., 1973). For transition description jump of free energy of exchange interaction between layers $\Delta F_{ex}$, jump of magneto-elastic energy due to magnetostrictive lattice distortions in basal plane $\Delta F_{me}^b$ and total change of magneto-elastic energy $\Delta F_{me}$ (Ewenson W., Lin S., 1969) were taken into account. Jump of magnetic anisotropy energy $\Delta E_a = -K_6$ was neglected as the
value of $K_6$ in the temperature range of $\Theta_1 - \Theta_2$ is extremely small. Calculation results are presented in Fig. 2 (energy change per atom: $-\Delta E_{me}$ curve 3, $-\Delta E_{me}$ curve 4, $\Delta F_{ex}$ curve 5). In the vicinity of $\Theta_1'$, $\Delta E_{me}$ in absolute value is approximately equal to $\Delta F_{ex}$ and, as a result, energy barrier $\Delta H_{cr}$ separating the two phases vanishes. Consequently, the increase of exchange energy in helicoidal antiferromagnetic-ferromagnetic transition is made up for by the decrease of magneto-elastic energy. A conclusion can be drawn that helicoidal antiferromagnetic-ferromagnetic transition in Tb-Dy alloys is due to the action of spontaneous magnetostrictive deformations that arise in magnetic ordering.

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