Journal of Magnetism and Magnetic Materials 96 (1991) 26–28
North-Holland

Magnetic part of specific heat in high-purity Dy single crystal

S.A. Nikitin, A.M. Tishin, S.F. Savchenkova, Yu.I. Spichkin, O.D. Chistykov, S.V. Red'ko and Yu.A. Nesterov

Department of Physics, Moscow State University, 119899 Moscow, USSR

Received 24 September 1990; in revised form 24 October 1990

The specific heat and spontaneous magnetization of high-purity Dy single crystal are measured in the temperature range 4.2–300 K. The magnetic contribution to the specific heat is determined and the magnetic part of the entropy is calculated. The magnetic ordering in the paramagnetic region above the Néel temperature is discussed.

1. Introduction

The magnetic and elastic properties of Dy single crystal have been studied in ref. [1] and the temperature hysteresis of elasticity modulus E and dynamic susceptibility χ have been observed in the paramagnetic region above the Néel temperature $\Theta_2 = 179$ K up to $T_H \approx 290$ K (at $T = T_H$ hysteresis vanishes). The maximum of internal friction Q^{-1} at T_H has also been observed. Earlier, in ref. [2], the hysteresis of intensity of magnetic reflex, the angle of helicoid and the factor of neutron depolarization have been studied using the neutron diffraction method. This hysteresis was still present tens of degrees Celsius above Θ_2 (Θ_2 – the point of phase transition from antiferromagnetic to paramagnetic state). The authors of ref. [3] pointed out that the magnetic part of the entropy of Dy increased for temperatures well above Θ_2. In ref. [4] the magnetic contribution of specific heat of Dy was found above Θ_2. Observed phenomena can be explained by the existence in the paramagnetic region of short-range magnetic ordering as clusters of ordered spins which concentration is different under heating and cooling. The authors of the theoretical work [5] have shown that in the paramagnetic region the "local phase transformation" with reconstruction of short-range ordering may exist. Obviously this transformation may cause the peak on the Q^{-1} temperature dependence at T_H.

In connection with many papers about short-range magnetic ordering in the paramagnetic region [1–4] the investigation of the properties of transformation of magnetic ordering of high-purity Dy single crystal is important. In such a crystal the effects caused by impurity and crystal imperfections are negligible. In the present paper the specific heat c_p and spontaneous magnetization σ_S of Dy single crystal are measured. The obtained results allow us to study the experimental temperature dependence of the magnetic part of specific heat (c_M) and compare it with values calculated from molecular-field theory [6]. The parameter c_M is sensitive to transformation of magnetic structure and its disordering.

2. Experimental details

We use samples of Dy single crystal with a ratio of specific resistance at 4.2 and 300 K of $\rho_{300}/\rho_{4.2} \approx 200$. The samples are refined by vacuum sublimation in a resistance furnace with a graphite heater under a residual pressure of 10^{-6} Torr. The refined metal is deposited on the watercooled copper condenser forming druses with orientation along one of three crystallographic directions

0304-8853/91/$03.50