INFLUENCE OF MAGNETIC ANNEALING ON THE ELECTRIC RESISTANCE OF CHROMIUM

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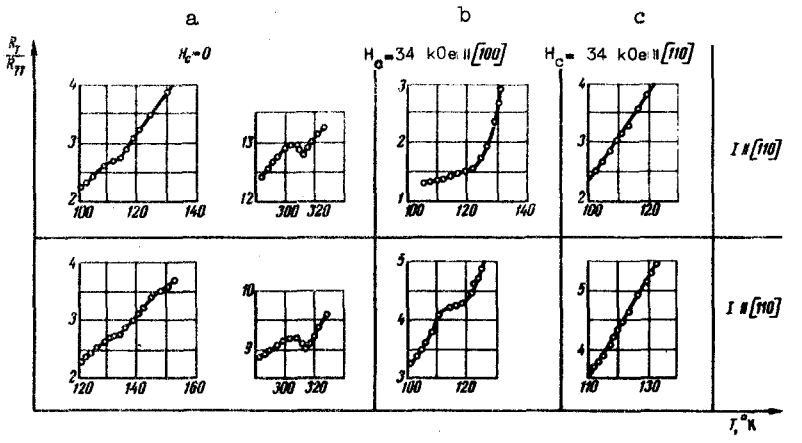
Chromium goes over into the ordered state at the temperature T_N = 312°K. The question of the magnetic structure of chromium cannot be regarded as completely answered. It is usually assumed at present that a magnetic structure of the type of a standing wave, characterized by a wave vector $\vec{Q}$ and by a polarization vector $\vec{\eta}$, is realized in chromium [1 - 3]. In the temperature range 120 - 312°K (the AF_2 phase) the polarization vector $\vec{\eta}$ is perpendicular to $\vec{Q}$, and at temperatures below 120°K (AF_1 phase) $\vec{\eta}$ is parallel to Q. The transition from the AF_1 phase to the AF_2 phase and from the antiferromagnetic to the paramagnetic state is accompanied by anomalies of a number of physical properties, including anomalies on the temperature dependence of the electric resistance (R = f(T)) [4, 5].

We have investigated the temperature dependence of the electric resistance and the effect exerted on it by magnetic annealing. Chromium samples measuring 4 × 1.5 × 1 mm and having a ratio R(293°K)/R(4.2°K) = 500 were cut from a single crystal by the electric spark method in such a way that the longitudinal axis of the sample was parallel either to the [100] axis or to the [110] axis. The current and potential leads were welded on by the capacitor-discharge method.



Electric resistance vs. temperature in the region of the transition points T_N and T_{S-F}: a) prior to annealing, b and c) after magnetic annealing.

The temperature dependence of the resistance R = f(T) clearly revealed anomalies corresponding to the temperature T_N and to the spin-flip temperature T_{S-F} (Fig. a). The Neel temperature was the same for all samples, T_N = 311±2°K, while the temperature at which the anomaly corresponding to the magnetic phase transition appears differed for samples with different crystallographic orientations. For all samples whose longitudinal axis was parallel to [110] we

obtained T_{S-F} = 115 ± 2°K, and for samples whose longitudinal axis was parallel to [100] we got T_{S-F} = 134 ± 2°K.

All samples were subjected to magnetic annealing by cooling from T_1 = 360°K to T_2 = 77°K in a transverse magnetic field H = 34 kOe either parallel to [100] or to [110]. The change of the temperature dependence of the electric resistance R = f(T) depends on the direction of the annealing field H relative to the crystallographic direction. For H parallel to [100], the anomaly at T_{S-F} becomes stronger and occurs at T = 120 ± 2°K, both for the sample with the longitudinal axis parallel to [100], and for the sample with longitudinal axis parallel to [110] (Fig. b). Heating above T_N restores the initial character of the R = f(T) completely. In the case of magnetic annealing in a field H_c parallel to [110], the anomalies of the temperature dependence of the electric resistance in the vicinity of 115 - 135°K disappears (Fig. c). It was impossible to restore the initial character of the R = f(T) variation by heating the samples to T = 390°K. Magnetic annealing in a field H making an angle of 45° to the [100] and [010] axes produces apparently the same effect as compression along the [001] axis [6, 7], and this process is not completely reversible. It should also be noted that the sample ruptured along the long axis [001] after a number of magnetic annealings in a field H = 34 kOe.

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TEMPERATURE COEFFICIENT OF LINEAR EXPANSION AND MAGNETOSTRICTION OF POLYCRYSTALLINE CHROMIUM

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The transition of the chromium lattice from cubic to orthorhombic at the Neel temperature T_N, and from rhombic to tetragonal at the spin-flip temperature T_{S-F} [1], should naturally be accompanied by anomalies of the elastic properties [2].

We have investigated the temperature expansion and the magnetostriction of polycrystalline samples of chromium in the temperature interval 77 - 350°K. The measurements were made by the ordinary tensometric method using a compensation pickup [3]. This pickup was introduced to eliminate the galvanomagnetic and temperature effects of the pickups themselves.