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MAGNETOTHERMAL METHOD TO DETERMINE THE EFFECTIVE NUMBER OF BOHR MAGNETONS PER ATOM IN AUSTENITIC CHROMIUM-NICKEL STEELS

The main structural component of chromium-nickel steels of type 18–8 is austenite. Austenitic chromium-nickel steel of industrial production was chosen for the study. Steel samples were subjected to deformation. The specific magnetic susceptibility was determined with an accuracy $\pm 0.05 \cdot 10^{-8} \text{ m}^3/\text{kg}$ [1]. The samples were heated and cooled in an argon at-mosphere. The specific magnetic susceptibility during heating and cooling was measured in a magnetic field $H=2.95 \cdot 10^5 \text{ A/m}$.

The experimental temperature dependences of the reciprocal specific magnetic susceptibility of steel austenite before (curve 1) and after (curve 2) plastic deformation are shown in Fig. 1.

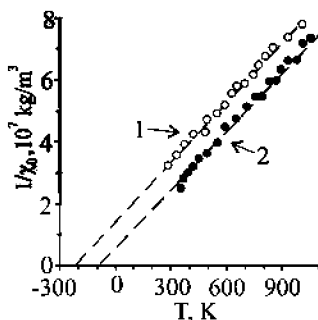


Figure 1 – Temperature dependence of the inverse specific magnetic susceptibility of the austenite under study before (curve 1) and after (curve 2) deformation

The temperature dependences $\chi_0(T)$ of undeformed and deformed austenite have been processed. Dependencies are described by the Curie-Weiss law in certain temperature ranges

$$\chi_0 = \frac{C}{T - \theta} = \frac{1}{3} \frac{N_A \cdot p^2 \cdot \mu_B^2}{\rho \cdot K_B \cdot (T - \theta)}, \quad (1)$$

$$C = \frac{1}{3} \frac{N_A \cdot p^2 \cdot \mu_B^2}{\rho \cdot K_B}, \quad (2)$$

where χ_0 – specific magnetic susceptibility of austenite, C – Curie constant, N_A – Avogadro's number, ρ – matter density, μ_B – Bohr magneton, p – effective number

of Bohr magnetons per atom, θ – paramagnetic Curie point determined by extrapolation of the linear part of the $1/\chi(T)$ dependence to the temperature axis.

The constant C from formula (1) was determined. The effective magnetic moment ($\mu_{\text{ef}} = p \mu_B$) was calculated from the constant C by formula (2). The obtained experimental and calculated results are given in the Table 1.

Table 1 – Obtained magnetic parameters of the studied steel

magnetic parameter	undeformed austenite	deformed austenite
$\chi_0, 10^{-5} \text{ cm}^3/\text{g}$	3.28	5.92
$C, 10^{-5} \text{ cm}^3 \cdot \text{K}/\text{g}$	1450 ± 20	1720 ± 20
$\theta, \text{ K}$	-220	-100
μ_{ef}	$0.98 \cdot \mu_B$	$1.21 \cdot \mu_B$

For undeformed austenite, the dependence of $1/\chi_0$ on T is linear for the entire temperature range (320-1000 K) and is satisfactorily described by the Curie-Weiss law. For deformed austenite at high temperatures, starting from about 400 K (inflection point) and above, this dependence is also linear and obeys the Curie-Weiss law. Below 400 K, this dependence is not described by the Curie-Weiss law.

The change in χ_0 with temperature for our steel is completely reversible.

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