EFFECT OF IONIC ORDERING ON THE MAGNETIC PROPERTIES OF NICKEL CHROMITE FERRITE

A. N. Goryaga and L. P. Mitina

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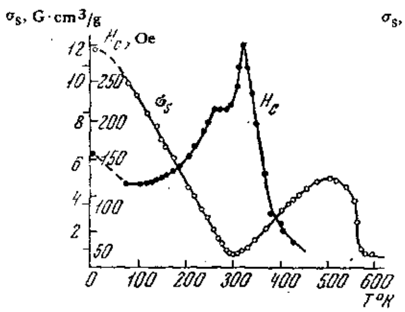

Fig. 1

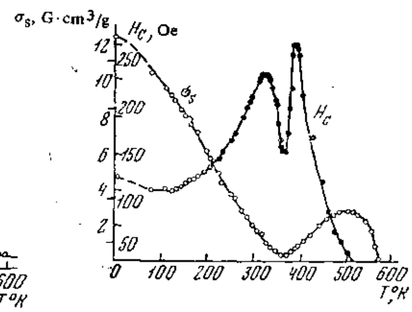

Fig. 2

It was shown in [1] that quenching of lithium chromite ferrites, i.e., fixing of the random disordered distribution of ions both within and between sublattices, leads to an increase in the magnetic moment $n_{0\beta}$, the Curie temperature θ_f and the compensation temperature θ_k. It has also been reported that the magnetic moment $n_{0\beta}$ for nickel chromite ferrites increases after quenching [2]. Nothing has been reported about the other properties [θ_f, θ_k and the $H_c(T)$ and $\sigma_s(T)$ curves]. We therefore carried out a study of the effective quenching on these properties in this material. Our sample was stoichiometric nickel chromite ferrite sample of composition of $NiFeCrO_4$, which we synthesized by a standard ceramic technique. The final sintering was carried out at 1350°C for 6 hr and followed by slow cooling. The temperature dependences of the saturation magnetization σ_s and of the coercive force H_c were measured by a ballistic method, between liquid-helium temperature θ_f. Then the sample was again treated to 1350° and then quenched in water from 1050°. The $\sigma_s(T)$ and $H_c(T)$ curves were then re-recorded.

From Fig. 1, which shows $\sigma_s(T)$ and $H_c(T)$ curves for the annealed sample, we see that H_c initially increases as $T \to \theta_k$, remaining constant in the range 250-300°K, begins to increase again at $T > \theta_k$, and then falls off rapidly. This temperature dependence of H_c differs from that of lithium ferrite chromites [1] and from that of ferrite garnets [3] having a compensation point. Complete compensation of the sublattice magnetic moments does not occur at point θ_k on the σ_s(T) curve.

After the sample is quenched, the σ_s(T) curve changes slightly (Fig. 2); the magnetic-moment compensation becomes more complete, the temperature θ_k and the magnetic moment $n_{0\beta}$ increase, but θ_f remains the same (see the accompanying table).

State	Magnetic moment, $n_{0\beta}$	θ_k, °K	θ_f, °K
Annealed	0,49	295	588
Quenched	0,522	370	588

Quenching had a particularly strong effect on the behavior of the coercive force. After quenching, a double maximum appeared at θ_k on H_c(T) curve, similar to the maximum found for the ferrite garnets in [3].

We can thus conclude that $NiFeCrO_4$ has a more homogeneous composition where there is a disordered arrangement of ions. A similar behavior is observed in ferromagnetic alloys, in which a marked blurring of the ferromagnetic transition occurs upon ordering: i.e., the inhomogeneity increases upon ordering. This behavior is found because disordered-phase regions remain along with the ordered phase in the incompletely ordered sample.

In conclusion the author thanks Professor K. P. Belov for scholarly guidance of this study.

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Department of General Physics for Biologists