THE INVESTIGATION OF THE MAGNETIC SUSCEPTIBILITY OF HEMATITE NEAR THE MORIN TEMPERATURE

M.Lj.Napijalo, L.Novaković, A.Srećković
The Institute of Physics, Belgrade and the Faculty of Natural Sciences, Belgrade

Hematite (α-Fe_2O_3) has a crystal structure of the corundum type |1| and is an antiferromagnet in the temperature ranges smaller than 960 K, while at higher temperatures it becomes a paramagnet |2|. It has a complex behavior in the antiferromagnetic phase |2|, and is a real collinear antiferromagnet up to Morin temperature T_M, which lies at 260K|3|; the magnetic moments of Fe^{3+} ion are oriented in the direction |111|. The magnetic moments of these atoms have colinear distribution in parallel with |111| planes above the Morin temperature, i.e. the magnetic moments are conted to the planes in such a way that in the direction |111| a weak ferromagnet momentum appears |2,4|.

The authors investigated the Morin phase transition by measuring dependence of magnetic susceptibility χ on temperature, using Gouy method on powder sample of high purity -99.999% (Koch-Light) in the temperature from -40°C to the ambient temperature. In this temperature range the sample temperature was defined with an error less than 0.1°C and the temperature change along the sample (about 15 cm) was less than 0.1°C|5|.All measurements were performed in the same magnetic field: at the maximum magnetic induction of 7kG in the gap of electromagnet with cylindrical pole caps of 15 cm in diameter.

The aim of the investigation was the temperature magnetic hysteresis near the Morin temperature: cyclic heating and cooling with a constant velocity of about 0.25°C/min was carried out. In order to investigate the possible influence of anisotropy of substance and possible reorientation effect of powder grains. The experiments were done with the following samples:

1. powder sample without adhesive;
2. powder sample whose grains are fixed with paraffine as an adhesive;
3. powder sample whose grains are deposited in the molten paraffine with simultaneous action of magnetic field (B = 7kG) perpendicular to the sample axis; and
4. powder sample, whose grains are deposited in the molten paraffine with simultaneous action of magnetic field (B = 1kG) parallel to the sample axis.

Determination of several complete temperature cycles was done for each sample. In Fig. 1 the first cycle for sample No.2 is shown. We are to consider one of the basic results

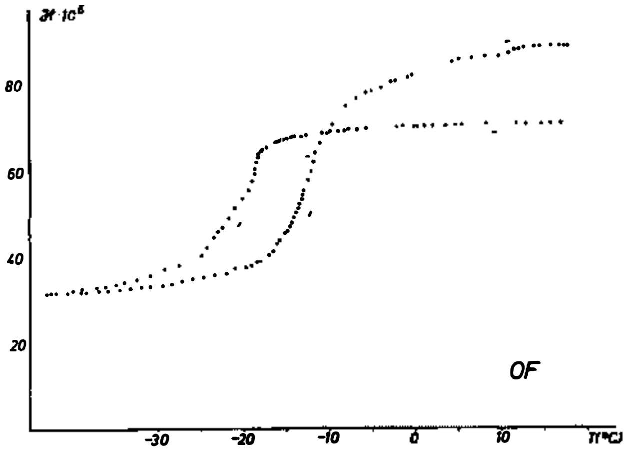

Fig. 1.

obtained in these measurements.

Susceptibility values and wideness of hysteresis cycles change from samples. Nevertheless, the Morin temperature defined as the arithmetic mean of the temperatures defined both for the heating and cooling processes for these samples, independent of the ordinal number of the cycle, is at

$$T_M = (257 \pm 0.5)\,K$$

at that, the Morin temperature for one heating or cooling is determined according to the position of inflection points on the curve $\chi(T)$, which corresponds to the diffuse phase transitions|6|.

References:

1. Galasso, F.S., Structure and Properties of Inorganic Solids, Pergamon Press, Oxford,1970,p.235.
2. Izyumov, Y.A. and Ozerov, R.P., Magnitnaya nejtronografiya, "Nauka", Moskva, 1966, p.340.
3. Bibliography of magnetic materials and tabulation of magnetic transition temperatures, compled by T.F.Connolly and E.D.Copenhaver, IFI Plenum, New York, 1972.
4. Herpin A., Théorie du magnétisme, Presses Universitaires de France, Paris, 1968, p.533.
5. Novaković L., Magnetic properties of hematite near the Morin temperature, M.S.thesis, Faculty of Sciences, Belgrade, 1974 (on serbo-croate).
6. Rolov, B.N., Razmytye fazovye perehody, "Zinatne", Riga, 1972, ch.2.