69703
S/126/60/009/03/029/033
E032/E414

Temperature Dependence of Spontaneous Magnetization in a Monocrystal of a Manganese Ferrite in the Low Temperature Region

magnetization direction [111] was parallel to the axis of the cylinder. The measurements of the magnetization were carried out in a solenoid by a ballistic method. A cryostat (Ref 8) was introduced into the solenoid. The magnetization was measured to ± 1% and the temperature to ± 0.5°. Fig 1 shows a plot of the magnetization (at constant temperature) as a function of the applied field. As can be seen from this figure, the saturation magnetization is reduced by 1/3 on going from 4.2 to 319°K. Fig 2 shows a plot of the spontaneous magnetization as a function of $T^{3/2}$. The dotted curve represents a plot of the spontaneous magnetization as a function of T^2. It is found that the former relationship is in better agreement with experiment. The slope of the straight line in the case of the $T^{3/2}$ plot is in good agreement with theoretical calculations (Ref 3 and 4). It is found that the $T^{3/2}$ law holds right up to temperatures above room temperature, which is in accordance with the results of Dyson (Ref 9),

Card 2/3

69703

S/126/60/009/03/029/033
E032/E414

Temperature Dependence of Spontaneous Magnetization in a Monocrystal of a Manganese Ferrite in the Low Temperature Region

who showed that the spin wave theory leading to the $T^{3/2}$ law can be extended to temperatures in the range between absolute zero and one half of the Curie temperature. The Curie temperature for the sample used in the present work was 563°K. There are 2 figures and 9 references, 6 of which are Soviet, 2 English and 1 French.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im M.V.Lomonosova (Moscow State University imeni M.V.Lomonosov)

SUBMITTED: July 13, 1959

Card 3/3

85700

S/056/60/038/006/043/049/XX
B006/B070

24.7900 (1055,1144,1160)

AUTHORS: Belov, K. P., Belov, V. F., Popova, A. A.

TITLE: Single Crystals of Magnesium Manganese Ferrites With a Narrow Ferromagnetic Resonance Absorption Curve

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 6, pp. 1908 - 1910

TEXT: The present "Letter to the Editor" gives some experimental results obtained from some spinel-type ferrites with a narrow resonance absorption line. The line width ΔH was measured for different magnesium manganese ferrites with different oxide ratios of Mn and Mg. The single crystals studied were bred by the method of Verneuille. The specimens were spherical in shape with a diameter of 0.8-1 mm; their surfaces were polished. The measurements were made at a frequency of 9470 Mc/sec. The results of measurement, namely, the values of ΔH, of the saturation magnetization $4\pi I_s$, and of resistivity ϱ are shown in Table 1. Fig.1 shows the anisotropy of the line width in the (110) plane of a specimen having the composition last mentioned in the Table at room temperature (continuous

Card 1/2

85700

Single Crystals of Magnesium Manganese Ferrites With a Narrow Ferromagnetic Resonance Absorption Curve

S/056/60/038/006/043/049/XX
B006/B070

curve). The anisotropy of ΔH at room temperature had an amplitude of (3.5 ± 0.5)oe. The broken line shows the anisotropy of the resonance field H_p. The anisotropy character of ΔH is in agreement with the phenomenological calculations of G. V. Skrotskiy and L. V. Kurbatov (Ref.5). Fig.2 shows ΔH, $4\pi I_s$, and the constant of magnetic anisotropy K_1 as functions of T (in the temperature range 0 - 300°C) for a specimen having the composition last mentioned in the Table. There are 2 figures, 1 table, and 5 references: 3 Soviet and 2 US.

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography of the Academy of Sciences USSR)

SUBMITTED: March 18, 1960

Card 2/2

85703

S/056/60/038/006/046/049/XX
B006/B070

24.7600 (1035,1043,1160)

AUTHORS: Belov, K. P., Goryaga, A. N., Lin' Chzhan-da

TITLE: Electrical and Galvanomagnetic Properties of Lithium Ferrite Chromite in the Vicinity of the Compensation Point

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 6, pp. 1914 - 1915

TEXT: Some ferrites showing a compensation point (Θ_k) (in which the magnetic moments of the sub-lattices are in equilibrium) exhibit strongly anomalous temperature dependence of the spontaneous magnetization, and the magnetostrictive properties above and below Θ_k are largely different. In gadolynium ferrite garnet, for example, they are determined below Θ_k essentially by the gadolynium sub-lattice, and above Θ_k by the iron sub-lattice. Further studies of the role of sub-lattices in ferrimagnetism are communicated in this "Letter to the Editor". Electrical and galvanomagnetic effects in lithium ferrite chromite with a compensation point

Card 1/3

85703

Electrical and Galvanomagnetic Properties of Lithium Ferrite Chromite in the Vicinity of the Compensation Point

S/056/60/038/006/046/049/XX
B006/B070

were measured. Fig.1 shows the temperature dependence of the longitudinal galvanomagnetic effect for different magnetic field strengths for $Li_2O \cdot 2.5Fe_2O_3 \cdot 2.5Cr_2O_3$. The temperature dependence of the electrical resistance was measured for the same ferrite. Fig.2 shows $\log R = f(1/T)$ for d.c. (Curve 1) and a.c. (200 kc/sec, Curve 2). The temperature dependence of magnetization at H=250oe is also plotted. The behavior of the individual curves is discussed. The bend of the curves at Θ_k is to be attributed, according to Ye. A. Turov and Yu. P. Irkhin, to the compensation of the volume fields of the magnetic sub-lattices at Θ_k. There are 2 figures and 5 references: 2 Soviet, 2 French, and 1 Belgian.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: March 29, 1960

Card 2/2

84392

S/056/60/039/004/010/048
B004/B070

24.7600 (1035, 1138, 1160)

AUTHORS: Belov, K. P., Ped'ko, A. V.

TITLE: Anomalies in the Temperature Dependence of Coercive Force in Ferrite Garnets of Rare Earth Elements in the Region of the Compensation Point

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 4(10), pp. 961-964

TEXT: In an earlier work (Ref. 2), the authors found anomalies in the temperature dependence of the coercive force H_c of ferrite garnets of rare earths ($3M_2O_3 \cdot 5Fe_2O_3$; M = Gd, Dy, Ho, etc.) in the neighborhood of the compensation point θ_k (Ref. 1). In the present paper they give a detailed report of their investigations. As is shown in Fig. 1, for polycrystalline $3Gd_2O_3 \cdot 5Fe_2O_3$, H_c increases in the neighborhood of θ_k ($\theta_k = 12^oC$) to 100 oersteds, decreases strongly and again increases to the same value so that the curve $H_c = f(T)$ shows a "splitting" of the

Card 1/3

84392

Anomalies in the Temperature Dependence of Coercive Force in Ferrite Garnets of Rare Earth Elements in the Region of the Compensation Point

S/056/60/039/004/010/048
B004/B070

maximum. The resultant I_S of spontaneous magnetization tends to zero at θ_k, yet H_c is not vanishing on account of the structural defects of the ferrite crystal. Fig. 2 shows that the anomalies continue to exist for different densities of gadolinium ferrites (3.15 g/cm^3, 5.9 g/cm^3), but become smaller as the density increases. The anomaly is less affected by thermal treatment (quenching, 4 hour heating, Fig. 3) than by the change in density. Fig. 4 shows the curves $H_c = f(T)$ for monocrystalline $3Gd_2O_3 \cdot 5Fe_2O_3$; $3Ho_2O_3 \cdot 5Fe_2O_3$, and $3Er_2O_3 \cdot 5Fe_2O_3$ (compensation temperatures +16, -136, and $\sim$-195°C). Here, the region of anomaly is so small that it is hard to observe experimentally the splitting of the maximum. The authors assume a single domain structure for which $H_c \sim K/I_S$ holds (K = constant of magnetic anisotropy, I_S = resultant spontaneous magnetization). Since K changes little and I_S decreases rapidly, there occurs a strong increase of H_c. The authors think that the observed broadening of the absorption line of ferromagnetic resonance (Ref. 4)

Card 2/3

84392

Anomalies in the Temperature Dependence of Coercive Force in Ferrite Garnets of Rare Earth Elements in the Region of the Compensation Point

S/056/60/039/004/010/048
B004/B070

is related to the anomalous increase of H_c. They mention a paper of K. M. Bol'shova and T. A. Yelkina (Ref. 3) and thank V. A. Timofeyeva for single crystals supplied. There are 4 figures and 4 references: 2 Soviet, 1 French, and 1 British.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: May 16, 1960

Card 3/3

BELOV, K.P.; ZAYTSEVA, M.A.; KADOMTSEVA, A.M.

Magnetic properties of the lanthanum and praseodymium orthoferrites in the partial substitution of the Fe^{3+} ions for Al^{3+} ions. Zhur. eksp. i teor. fiz. 39 no.4: 1148-1150 O '60. (MIRA 13:11)

1. Moskovskiy gosudarstvennyy universitet.
(Rare earth ferrates--Magnetic properties)

88426

S/056/60/039/006/011/063
B006/B056

24.7900 (1147, 1158, 1160)

AUTHORS: Belov, K. P., Malevskaya, L. A., Sokolov, V. I.

TITLE: Resonance and Magnetic Properties of Garnet-type Yttrium Ferrites at Low Temperatures

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 6(12), pp. 1542-1547

TEXT: The authors investigated the temperature dependence of the anisotropy of the resonance field and the resonance line widths of single- and polycrystalline yttrium ferrite specimens ($3Y_2O_3 \cdot 5Fe_2O_3$) with garnet structure in the temperature range 2 - 300°K. At the same time, line widths and magnetization curves in static fields were measured on polycrystalline specimens. The ferromagnetic resonance was investigated at 8500 Mc/sec. For the temperature measurement, a copper constantan thermocouple was used. The crystals were grown by V. A. Timofeyeva at the Institut kristallografii AN SSSR (Institute of Crystallography of the AS USSR). Fig. 3 shows the measured temperature dependence of the resonance field for polycrystalline (1) and monocrystalline specimens (2). The results obtained

Card 1/5
2

88426

Resonance and Magnetic Properties of Garnet-type Yttrium Ferrites at Low Temperatures S/056/60/039/006/011/063 B006/B056

by measuring the resonance field strength in dependence of the direction relative to the crystallographic axes in the (110)-plane (in which all main axes were located) are for T = 300, 77, 20, and 2.0°K in the four diagrams shown in Fig. 2. Measurements of the temperature dependence of the ferromagnetic resonance absorption line widths showed that the ferromagnetic resonance absorption in yttrium ferrite garnets shows practically no anisotropy, not only at room temperature, but also at helium temperatures. The line width ΔH increases with decreasing temperature, where single crystals between 20 and 40°K have steep maxima. At 40°K the line width is more than 15 times as great as at room temperature. Polycrystalline specimens have a much lower and broader maximum (4 - 60°K). The results obtained are compared with those obtained by Dillon, Spencer, Kittel et al. As a measurement of the static magnetization curves showed, magnetic viscosity is large in the temperature range of the line width maxima. The authors thank Professor A. I. Shal'nikov for his interest and advice and V. A. Timofeyeva for placing single crystals at their disposal. There are 6 figures, 1 table, and 4 references: 1 Soviet and 3 US.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

Card 2/2

ZHDANOV, German Stepanovich; BELOV, N.V., akad., retsenzent; ARKHAROV, V.I., prof., retsenzent; BELOV, K.P., prof., retsenzent; ZAKHAROVA, M.I., prof., retsenzent; GOL'DENBERG, G.S., red.; GEORGIYEVA, G.I., tekhn. red.

[Solid-state physics] Fizika tverdogo tela. Moskva, Izd-vo Mosk. univ., 1961. 500 p. (MIRA 14:6)
(Solids)

20120

9.4300 (1147, 1158)

S/181/61/003/002/018/050
B102/B204

AUTHORS: Belov, K. P., Pakhomov, A. S., and Talalayeva, Ye. V.

TITLE: Measurement of the galvanomagnetic effect in ferrites near Curie point

PERIODICAL: Fizika tverdogo tela, v. 3, no. 2, 1961, 436-440

TEXT: When measuring the galvanomagnetic effect, the magnetostriction, and other phenomena, it is necessary to take the effect produced by magnetocaloric effect occurring in the adiabatic application of the magnetic field in the ferromagnetic specimen into account. For the purpose of excluding the error arising by this effect (which becomes considerable near Curie point), measurements are not carried out immediately after the application of the field (adiabatic measurement), but only some time later, when the temperature equilibrium between specimen and the surrounding medium has been established (isothermal measurement). Whereas in metallic ferromagnetics the isothermal conditions are easily realizable, this presents difficulties in the case of ferromagnetic semiconductors because of their low thermal conductivity, and when X

Card 1/4

20120

S/181/61/003/002/018/050
B102/B204

Measurement of the galvanomagnetic ...

measuring the galvanomagnetic effect, considerable errors may arise. In the present paper, the conditions occurring in the measurement of the galvanomagnetic effect are investigated, above all the effect produced by the adiabatic temperature increase occurring when applying the field. K. Zaveta assumed that the maximum of the galvanomagnetic effect of the paraprocess near Curie point, which the authors discovered in ferrites, is exclusively a consequence of the effect produced by a magnetocaloric effect. It is now shown that the conclusions drawn by Zaveta are incorrect. The paper by Zaveta (FTT, 2, 106, 1960) is first discussed in detail. For the change in state due to applying the field, Zaveta gave the following formula: $\Delta R/R = aH^{2/3} + bH$; here the first term makes the contribution of the "true" galvanomagnetic effect, and the second makes the contribution of the "wrong" galvanomagnetic effect. This formula is, however, wrong, and it ought to read: $\Delta R/R = aH^{2/3} + b'H^{2/3}$, because all even effects near the Curie point depend in the same manner on H (viz. $\sim H^{2/3}$). From this wrong formula there result also the wrong conclusions drawn by Zaveta. For the purpose of being able to estimate the effect

X

Card 2/4

20120

S/181/61/003/002/010/050
B102/B204

Measurement of the galvanomagnetic ...

produced by the magnetocaloric effect, it is necessary to compare a and b'. The sum of the coefficients (a+b') may be determined from the measurements of $\Delta R/R = f(H^{2/3})$. b' (which Zaveta calls b), is proved to be wrongly determined by Zaveta. The method he used is not at all suited for determining b'. Here, the equations $\Delta T = -\frac{T}{C_H}\left(\frac{\partial\sigma}{\partial T}\right)_H \Delta H$ and $\Delta R/R = -\varepsilon\Delta T/k\theta^2$ are used for calculating the "wrong" galvanomagnetic effect. Herefrom, $(\Delta R/R)_{T\to\theta} = \frac{\varepsilon}{C_H k\theta}\left(\frac{\partial\sigma}{\partial T}\right)_H \Delta H$ is obtained for the Curie point. (σ - specific magnetization). For Mn ferrite single crystals thus $(\Delta R/R)_\theta = -6.9\cdot10^{-4}$ results from experimental determinations of the individual quantities (data obtained by other authors) and $(\Delta R/R)_\theta = -44.2\cdot10^{-4}$ is obtained from the authors' own data. Thus, the "wrong" effect is smaller by a multiple than the "true" effect. The "magnetocaloric" temperature increase ΔT at Curie point is found to be 0.07°C and causes a change of 8.3% of the

Card 3/4

20120

Measurement of the galvanomagnetic ...

S/181/61/003/002/018/050
B102/B204

maximum resistance change ΔR. It follows herefrom that the maximum of the true galvanomagnetic effect of the paraprocess at Curie point actually exists and is not only due to an "adiabatic" increase of resistance. The existence of this maximum is proven also by the existence of breaks in the log $\varphi(1/T)$-curves in the Curie point of these ferrites. It may occur only in such ferrites as have a low activation energy ε. M. A. Krivoglaz and S. A. Rybak are mentioned. There are 7 Soviet-bloc references.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova, Fizicheskiy fakul'tet (Moscow State University imeni M. V. Lomonosov, Division of Physics)

SUBMITTED: May 10, 1960

Card 4/4

S/181/61/003/005/014/042
B101/B214

24,7900 (1055, 1147, 1144)

AUTHORS: Belov, K. P. and Belov V. F.

TITLE: The problem of the anomalous increase of the line width of ferromagnetic absorption in ferrites near the Curie point

PERIODICAL: Fizika tverdogo tela, v. 3, no. 5, 1961, 1425 - 1427

TEXT: Reference is made to the fact that there is not only an anomalous increase ΔH of the width of the ferromagnetic resonance line near the Curie point, but also an increase of the coercive force H_c in polycrystals as well as in single crystals. It is concluded that both the phenomena are caused by the inhomogeneity of the ferrite structure rather than by the heat fluctuations of the simultaneous magnetization. Experiments were made on single crystals of Mn and Mg-Mn ferrites 50 - 60 mm long and having diameters of 5 - 7 mm. The temperature dependence of H_c near the Curie point and the initial magnetic permeability μ_0 (in a field of 0.005 oersted) were measured with an astatic magnetometer. The tem-

Card 1/2

APPROVED FOR RELEASE: 06/06/2000 CIA-RDP86-00513R000204510002-7"

23109

perature dependence of ΔH was measured in a short circuited waveguide section at a sphere, 0.8 mm in diameter cut out of ferrite crystals. The results for ferrite with different hausmannite content are shown graphically. It is concluded that the broadening of ΔH and the increase of H_c have the same origin. On account of the inhomogeneities of the ferrite there occur fluctuations in the spontaneous magnetization near the Curie point, giving rise to a "magnetically heterogeneous" state. This causes scattering of the resonance frequencies near the Curie point. A.A. Popova is thanked for making available the ferrite single crystal. An analogous study made by A. Clogston (see below) is mentioned. There are 4 figures and 6 references: 5 Soviet-bloc and 3 non-Soviet-bloc. The 3 references to English-language publications read as follows: G. Rodrigue, J. Pippin, W. Wolf and C. Hogan, Trans.IRE an Microwave Theory Tech. MTT, 6, 83, 1958; P. -G. de Gennes, C. Kittel and A. Portis, Phys. Ref., 116, 2, 1959; A. Clogston, H. Suhl, P. Anderson, L. Walker, Phys. Chem. Solids, 1, 159, 1956.

ASSOCIATION: Institut kristallografii AN SSSR, Moskva (Institute of Crystallography, AS USSR, Moscow)

Card 2/2

24,7700
15.2450

27301

S/181/61/003/008/031/034
B111/B102

AUTHORS: Belov, K. P., and Svirina, Ye. P.

TITLE: Hall effect in monocrystalline manganese ferrites

PERIODICAL: Fizika tverdogo tela, v. 3, no. 8, 1961, 2495 - 2497

TEXT: The changes of the number of carriers and of their mobility in monocrystalline manganese ferrites are studied as functions of temperature and composition. The crystals were grown by Verneuil's method and displayed an excess of hausmannite as compared to the stoichiometric composition. Experiments showed that the Hall constant R_0 (for this classical determination of R_0 in ferromagnetic substances see Ref. 3: K. P. Belov, Ye. P. Svirina, ZhETF, 37, 1212, 1959) was negative for the ferrites examined by the authors. The carrier concentration was calculated from $R_0 = \gamma/ne$, where $\gamma \approx 1$ is a constant characteristic of electron scattering in the semiconductor. Measurements in monocrystalline manganese ferrites revealed that the number of conduction electrons rises with rising temperature. ln n is a linear function of 1/T, and the activation energy of conduction

Card 1/2

27301

S/181/61/003/008/031/034
B111/B102

electrons is determined from its slope. From the ln n = f(1/T) curves it follows that monocrystalline manganese ferrites with an excess of hausmannite are typical semiconductors. Substitution of Fe ions by Mn ions leads to an increase of activation energy and to a decrease of the number of electrons, which in turn results in a decrease in resistivity. The fact that the mobility decreases with increasing temperature indicates that an electron exchange between ions of variable valencies, as assumed by E. Verwey and J. de Boer (Ref. 6: Rec. Trav. Chim. Pays. Boc., 55, 531, 1952) is not predominant in the conduction mechanism of the ferrites studied. The decrease of mobility with rising temperature shows that conduction electrons are predominantly scattered by lattice vibrations. A. A. Popov is thanked for having supplied the single crystals, and V. L. Bonch-Bruyevich, Doctor of Physical and Mathematical Sciences, for discussions. There are 2 figures and 6 references: 3 Soviet-bloc and 3 non-Soviet-bloc.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)

SUBMITTED: April 5, 1961

Card 2/2

32650

S/126/61/012/005/002/028
E039/E135

24.7900 (1055,1144,1147,1163)

AUTHORS: Belov, K.P., Belov, V.F., Malevskaya, L.A., ~~Ped'ko~~, A.V., and Sokolov, V.I.

TITLE: Concerning the anomalous temperature dependence of the width of the ferromagnetic resonance absorption lines in ferrites

PERIODICAL: Fizika metallov i metallovedeniye, v.12, no.5, 1961, 636-643

TEXT: An investigation was made of the temperature dependence of the width of the ferromagnetic resonance absorption lines in ferrites with spinel and garnet structure (mono- and polycrystalline) in three temperature regions: near the Curie point, in the neighbourhood of the magnetic compensation point, and in the low temperature region. At the same time measurements were made of the temperature dependence of magnetic characteristics in static magnetic fields. It is shown that for monocrystalline magnesium-manganese ferrite (6.9% MgO, 37.3% MnO, 55.9% Fe_2O_3) the width of the resonance absorption line ΔH increases rapidly at about 550 °K. For polycrystalline yttrium ferrite ΔH X

Card 1/3

32650

Concerning the anomalous S/126/61/012/005/002/028
E039/E135

remains fairly constant up to a temperature of about 560 °K at which a sharp increase again occurs; in the case of lower density ferrites of the same composition ΔH is much greater at low temperatures but falls to approximately the same value as for the higher density ferrite at 560 °K. In the case of the monocrystalline ferrite (2.2% MgO, 54% MnO, 43.6% Fe_2O_3) there is a very sudden increase in ΔH and also the coercive force H_c at the Curie point ~412 °K. For the garnet-gadolinium oxide ferrite ΔH and H_c show a rapid increase at ~270 °K. At low temperatures the ratio $\Delta H/\Delta H_K$ where ΔH_K is the line width at room temperature is given for the case of the garnet-yttrium ferrite; a marked maximum occurs about 40 °K for the monocrystalline form and at about 10 °K for the polycrystalline form. It is demonstrated that the effect of small amounts of terbia produces a very marked effect on the temperature dependence of $\Delta H/\Delta H_K$ for Y_2O_3. The temperature dependence of the magnetisation and coercive force in weak fields for garnet-gadolinium ferrite at low temperatures is also investigated. In the garnet-gadolinium ferrite there are the following types of

X

Card 2/3

32650

Concerning the anomalous ... S/126/61/012/005/002/028
E039/E135

interaction between ions:

a) Strong negative interaction between ions Fe^{3+}-Fe^{3+}.

b) Weak positive interaction between ions Gd^{3+}-Gd^{3+}.

c) Weak negative interactions between ions Fe^{3+}-Gd^{3+}.

G.V. Skrotskiy and L.V. Kurbatov are mentioned in the article. There are 10 figures and 15 references: 9 Soviet-bloc and 6 non-Soviet-bloc. The English language references read as follows:

Ref. 3: R. De Gennes, C. Kittel, A. Portis. Phys. Rev., 1959, v.116, 323.
Ref.10: A. Kip. Rev. Mod. Phys., 1953, v.25, 229, 7.
Ref.11: B. Calhoun, J. Overmeyer, W. Smith. Phys. Rev., 1957, v.107, 993.
Ref.13: J. Dillon, Phys. Rev., 1958, v.111, 6.

ASSOCIATION: Institut kristallografii AN SSSR
(Institute of Crystallography, AS USSR)
Fizicheskiy fakul'tet MGU
(Faculty of Physics, MGU)

Card 3/3

SUBMITTED: January 2, 1961

30058
S/048/61/025/011/002/031
B108/B138

15-2520 1147

AUTHOR: Belov, K. P.

TITLE: The effect of the magnetic sublattice structure of ferrites on their physical properties

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 11, 1961, 1320-1326

TEXT: It is well established that the structure of ferrites exhibits magnetic sublattices. When a composition has what is known as a compensation point Θ_c, the sublattices not only cause the magnetic characteristics to behave peculiarly around Θ_c, but also, at low temperatures anomalies in physical properties. The author studied the low-temperature anomalies of ferrites having a compensation point. The behavior of such ferrites in the range of nitrogen temperature was found to be similar to that at the ferromagnetic Curie point. To explain the reasons of the anomalies the garnet-type ferrite $\{Gd_3^{3+}\}(Fe_3^{3+})[Fe_2^{3+}]O_{12}$ is considered. This ferrite may be regarded as consisting of two sublattices. In order to study the iron

Card 1/5

30058
S/048/61/025/011/002/031
B108/B138

The effect of the magnetic sublattice...

sublattice separately from the gadolinium sublattice one has to substitute the G^{3+} ions by nonmagnetic ions, e.g., Y^{3+} or Lu^{3+}. Where the temperature dependence of the spontaneous magnetization of such a ferrite, for instance yttrium ferrite garnet, is known one may estimate the temperature dependence of the spontaneous magnetization of the gadolinium sublattice by comparing the gadolinium ferrite curves with the corresponding curves of the iron sublattice in, say, the yttrium ferrite. The anomalies of the gadolinium ferrite near 100°K are due to the fact that the weak positive interaction in the gadolinium sublattice ceases at low temperatures leaving only the negative $Gd^{3+} - Fe^{3+}$ exchange interaction. Lithium ferrite chromites with a Θ_c exhibit the same behavior. The iron sublattice shows the normal Weissian temperature dependence of spontaneous magnetization. Owing to the different exchange interactions of the sublattices, the physical properties of a ferrite are different above and below Θ_c and show strong anomalies near Θ_c (Fig. 6). The appearance of a Θ_c at low temperatures is due to the sublattices. The sublattice with the greater magnetic moment (virtually, at 0°K) and weak exchange interaction shows no sharp time dependence of spontaneous magnetization, the one with the smaller

Card 2/8

30958
S/048/61/025/011/002/031
The effect of the magnetic sublattice... B108/B138

magnetic moment shows a weaker exchange interaction and a Weissian shaped spontaneous-magnetization curve. This paper was read at the Conference on ferromagnetism and antiferromagnetism in Leningrad, May 5-11, 1961. Mention is made of A. N. Goryaga, Lin Chang-ta (Zh. eksperim. i teor. fiz., 41, 696 (1961)) and L. A. Malevskaya (see Association entry). There are 7 figures and 4 references: 3 Soviet and 1 non-Soviet.

ASSOCIATION: Fizicheskiy fakul'tet Moskovskogo gos. universiteta im. M. V. Lomonosova (Department of Physics of Moscow State University imeni M. V. Lomonosov)

Fig. 6. Anomaly of physical properties of gadolinium ferrite-garnet at low temperatures and near Θ_c. Legend: Θ_K stands for Θ_c, χ_n - paraprocess susceptibility, χ - magnetic susceptibility, H_c - coercive force, ΔH - width of the ferromagnetic resonance absorption curve, σ_s - spontaneous magnetization, E - Young's modulus, Q^{-1} - internal friction, (1) E, dyne/cm^2.

Card 3/~~4~~ 3

X

9.2571
24.7900 1482 1144 1143,1144
15.2660

30068
S/048/61/025/011/013/031
B104/B102

AUTHORS: Belov, K. P., and Malevskaya, L. A.

TITLE: Magnetic and resonance properties of yttrium ferrite garnets when substituting Tb^{3+}, Nd^{3+}, and Lu^{3+} ions for Y^{3+} ions

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 11, 1961, 1371 - 1375

TEXT: The authors studied the effect of the magnetic sublattice structure upon the magnetic properties of ferrites. For this purpose, they examined the magnetic and resonance properties of yttrium ferrite garnets, in which the yttrium ions were replaced partly or entirely by terbium, neodymium, or lutecium ions. The spontaneous magnetization of the ferrite garnets $(3-x)Y_2O_3 \cdot xTb_2O_3 \cdot 5Fe_2O_3$, is shown in Fig. 1 as a function of temperature. As may be seen (curves 1 and 2), these curves are abnormal. If the Tb content is increased, a compensation point of the magnetic moments of the sublattices appears (curve 3). According to a calculation by Néel's scheme, this point should be near 0°K. Rare-earth impurities are probably responsible for its shift to 10°K. On further increase of the Tb content, the

Card 1/4
3

30068

S/048/61/025/011/013/031
B104/B102

compensation point is further shifted to higher temperatures (curve 4). At low temperatures, a sharp increase of the coercive force H_c is observed as the Tb content rises. The vicinity of the compensation point is supposed to be the cause of this. J. Dillon (Phys. Rev., 111, 6 (1958)) and the authors (Zh. eksperim. i teoret. fiz., 40, no. 2, 711, (1961)) showed both experimentally and theoretically that the resonance line width ΔH passes through a maximum when minute Tb amounts are added to the ferrite. With an increase of the Tb content, the temperature anomaly of ΔH widens as a function of temperature. At very low temperatures (2^oK), ΔH is not diminished. This is explained by the fact that at low temperatures the ΔH broadening is caused not only by the Kittel-Dillon mechanism but also by the heterogeneous magnetic state due to the vicinity of the compensation point. The polycrystalline Y-Nd ferrites $(3-x)Y_2O_3 \cdot xNd_2O_3 \cdot 5Fe_2O_3$ were of garnet structure with $x \leqslant 2$. The lattice periods of these garnets increased with increasing Nd content, from 12.37 Å ($3Y_2O_3 \cdot 5Fe_2O_3$) to 12.50 Å ($Y_2O_3 \cdot 2Nd_2O_3 \cdot 5Fe_2O_3$). When Y^{3+} ions were completely replaced by Nd^{3+} ions, the resulting specimens had a perovskite structure. In agreement with Néel, the magnetic moments of ferrite garnets at absolute zero were found to be $\sigma_s = 6\sigma_c - (6\sigma_d - 4\sigma_a)$. σ_c, σ_d,

3

30068
S/048/61/025/011/013/031
Magnetic and resonance properties... B104/B102

and σ_a are the magnetic moments of the sublattices. Near absolute zero, saturation magnetization diverged from the values calculated by Néel. This is explained in that the magnetic moments of Nd^{3+} ions do not attain any ferromagnetic order in the sublattices, as exchange interaction is insufficient. In the ferrites $(3-x)Y_2O_3 \cdot xLu_2O_3 \cdot 5Fe_2O_3$, the magnetic moments did not change with x. The weak change of the Curie temperature ($\sim 10^0$) observed may be due to the change of lattice parameters. Structural inhomogeneities arise due to the smaller radius of Lu ions, and in their turn give rise to magnetic inhomogeneities. In these ferrite systems magnetic viscosity effects have been discovered: Y-Tb ferrites: 4-60°K, ∼10 oe, relaxation time of magnetization response: 5 - 10 min. Y-Nd ferrites: 4.2°K, 4000 oe, 30 - 40 min. Y-Lu ferrites: viscosity at 4.2°K, due to structure. There are 4 figures and 8 references: 3 Soviet and 5 non-Soviet. The three most recent references to English-language publications read as follows: Kittel C., Portis A., de Gennes P., Phys. Rev., 116, no. 2, 323, (1959); Dillon J., Phys. Rev., 111, 6 (1958); White R., J. Appl. Phys., 32, 1178 (1961).

Card 3/4
3

Physics Faculty, Moscow State U,

30071
S/048/61/025/011/016/031
B104/B102

24.7500 (also 1144)

AUTHORS: Belov, K. P., Levitin, R. Z., and Nikitin, S. A.

TITLE: Magnetoelastic properties of terbium and holmium

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 11, 1961, 1382 - 1384

TEXT: The temperature dependences of the magnetic properties of Dy, Tb, Tu, Er, and Gd have a complex character. While being ferromagnetic at low temperatures, they pass over, at a specific temperature θ_1, into the antiferromagnetic state with the Curie temperature θ_2. The antiferromagnetic state between θ_1 and θ_2 can be easily destroyed by an outer magnetic field. For Tb $\theta_1 = 223^{\circ}K$ and $\theta_2 \approx 234^{\circ}K$. The antiferromagnetic is destroyed by a field of about 200 oersteds. Below $230^{\circ}K$ the modulus of elasticity E displays a strong anomaly and the inner friction has a maximum at $223^{\circ}K$ (Fig. 1). At the temperatures θ_2 and θ_1 this anomaly passes through a maximum and a minimum, respectively. Longitudinal and transverse magnetostriction of Tb were measured at different temperatures as a function of the

Card 1/4 3

30071
S/048/61/025/011/016/031
B104/B102

Magnetoelastic properties of...

field strength ($\lambda \approx 750 \cdot 10^{-6}$ at 15 koe). The temperature dependence of the modulus of elasticity and of internal friction of Ho was examined near $\theta_2 = 196^{\circ}$K only (Fig. 3). The shear modulus, too, is anomalous in Ho. This proves that not only a pure bulk deformation occurs with the θ_2 transition. As for Dy, it is known that below θ_2 the axial ratio of the unit cell changes $\lambda \approx 1000 \cdot 10^{-6}$ at 15 koe. Neutron diffraction studies showed that Dy in the antiferromagnetic range (above θ_1) has a so-called helicoidal spin structure: the spins are helicoidally arranged in the lattice. It is believed that other rare-earth metals, particularly Ho and Tb, also possess this spin structure. There are 3 figures and 6 references: 3 Soviet and 3 non-Soviet. The three references to English-language publications read as follows: Thoburn W., Legvold S., Spedding F., Phys. Rev., 112, 56 (1958); Bamister I. R., Leg.old S., Spedding F., Phys. Rev., 94, 1140 (1954); Koehler W., Wollan E., Lecture delivered at a seminary on rare earths elements, USA, California, October 1960.

ASSOCIATION: Fizicheskiy fakul'tet Moskovskogo gos. universiteta im. M. V. Lomonosova (Physics Division of Moscow State University imeni M. V. Lomonosov)

Card 2/3

15266O

24220O 1121 1160 1137,1144

30073
S/048/61/025/011/019/031
B117/B102

AUTHORS: Belov, K. P., Zaytseva, M. A., Kadomtseva, A. M., and Timofeyeva, V. A.

TITLE: Magnetic anisotropy and hysteresis properties of rare-earth orthoferrites

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 11, 1961, 1389-1392

TEXT: Magnetic anisotropy was examined on single crystals of La, Pr, Nd, Sm, Eu, Gd, and Yb orthoferrites. The crystals were grown by spontaneous crystallization from their solution in a melt of lead compounds, lead oxide, and lead fluoride. The torque of the resulting crystals as a function of their angle of rotation with respect to an external magnetic field of up to 20 koe was measured with an anisometer. The torque curves drawn at room temperature resembled one another in the examined single crystals, and showed that the orientation of the magnetic moment in the axis of easiest magnetization is very stable against rotation of the outer field. This points to an exceedingly strong magnetic anisotropy of these

X

Card 1/3

orthoferrites. If the temperature is increased to the Curie point, the anisotropy of weak ferromagnetism is virtually not reduced. The characteristic phenomena of hysteresis and thermal remanence effects appearing in rare-earth orthoferrites can be explained also by the strong magnetic anisotropy. Thermal remanence phenomena were observed on polycrystalline La, Pr, and Yb orthosilicates (Ref. 5: Belov, K. P., Zaytseva, M. A., Kadomtseva, A. M., Zh. eksperim. i teor. fiz., 37, [illegible] (1959); Ref. 6: Watanabe, H. J. Phys. Soc. Japan, 14, 511 (1959)). Magnetization curves and hysteresis loops were recorded in magnetic fields of up to 20,000 oe by a pondermotive method. Specimens cooled in the magnetic field displayed asymmetric hysteresis loops with individual cycles. The thermal remanence was removed by a magnetic field of the order of 10,000 oe. This is indicative of the enormous coercive force of these orthoferrites. A partial substitution of nonmagnetic Al^{3+} ions for Fe^{3+} ions was performed in polycrystalline La and Pr orthoferrites. A sharp diminution of both coercive force and thermal remanence phenomena was observed along with a steep rise of magnetization. The latter may be explained by a prevailing diminution of the exchange field. On the other hand, the growth of magnetization is possibly associated with the greater difference in the magnetization of the two sublattices of Fe^{3+} ions, when they are partly replaced by nonmagnetic Al^{3+} ions. However, the Curie point is lowered in every case. Compositions in which Fe^{3+} ions were partly replaced by magnetic Cr^{3+} ions were examined. As compared with stoichiometric compositions, the coercive force diminishes sharply in La and Pr orthoferrites, when Cr^{3+} ions are introduced. As expected, and unlike Al^{3+} ions, Cr^{3+} ions do not change magnetization very much. The Debye diagrams taken by A. A. Katsnel'son and K. Yatskul'yan showed that all the examined compositions are solid solutions without any foreign phase. Ye. A. Turov is thanked for his help and for having discussed the results obtained. V. A. Naysh (Fizika metallov i metallovedeniye, 9, 10 (1960); 11, 161 (1960)) is mentioned. There are 5 figures and 6 references: 2 Soviet and 4 non-Soviet. The three references to English-language publications read as follows: Bozorth, R. M., Phys. Rev. Letters, 1, 362 (1958); Gilleo, M. A., J. Chem. Phys. 24, 1239 (1956); Watanabe, H., J. Phys. Soc. Japan, 14, 511 (1959).

S/048/61/025/012/001/022
B137/B9

AUTHORS: Belov, K. P., and Zalesskiy, A. V.

TITLE: Variation of resistivity on magnetization and the magnetic anisotropy of $Mn_xFe_{3-x}O_4$ ferrite single crystals

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 12, 1961, 1434-1436

TEXT: The anisotropy constant K_1 of solid solutions of magnetite and manganese ferrite ($Mn_xFe_{3-x}O_4$) is positive only in the range $0.6 < x < 0.8$ at room temperature. This can be attributed to the change in ion distribution on transition from the inverted spinel (magnetite) to the normal one (manganese ferrite). The magnetite has the magnetostriction constants $\lambda_{100} = -19 \cdot 10^{-6}$ and $\lambda_{111} = 81 \cdot 10^{-6}$, and the manganese ferrite $Mn_{0.98}Fe_{1.86}O_4$ has the constants $\lambda_{100} = -14 \cdot 10^{-6}$ and $\lambda_{111} = -1 \cdot 10^{-6}$. On transition from the manganese ferrite to the magnetite, the magneto-

Card 1/4

striction along the [111] axis changes its sign. According to A. Braginskiy (Chekhosl. fiz. zh., 9, no. 6, 755 (1959)), this change is observable in the range $1.00 \leqslant x \leqslant 1.06$. The anisotropy in the variation of resistivity of magnetite on magnetization is characterized by the constants $h_{100} = 13 \cdot 10^{-4}$ and $h_{111} = -6 \cdot 10^{-4}$; in the case of manganese ferrite with $x = 1.12$, these constants are $h_{100} = 4.25 \cdot 10^{-3}$ and $h_{111} = 0.9 \cdot 10^{-3}$. For this reason, a change in sign is also to be expected for the longitudinal galvanomagnetic effect along the [111] axis. Results of measurements of the temperature dependence of the constant K_1 from room temperature upward, as well as of the dependence of the constant of the galvanomagnetic effect on the composition at room temperature are presented. The single crystals were grown (Verneuil method) by A. A. Popova at the Institut kristallografii AN SSSR (Institute of Crystallography AS USSR), who also carried out the chemical analyses. The specimens were thick disks, ground along a certain crystallographic plane. The sharp dependence of the constant K_1 on the composition around the isotropic point entails high sensitivity of this quantity to inhomogeneities and other crystal defects.

The longitudinal galvanomagnetic effect was positive in the [100] direction for all compositions, but a change in sign occurred in the [111] direction at such compositions at which the magnetic anisotropy constant exhibits a dip. A definite relationship between magnetostriction and the variation in resistivity on magnetization can be observed. λ_{111} changes its sign opposite to h_{111}; λ_{100}, however, remains always negative. In the range $0.87 < x < 1.55$, the constant K_1 is negative at all temperatures and decreases continuously with rising temperature. In the range $0.69 < x < 0.85$, K_1 is positive at room temperature. At higher temperatures, it first increases somewhat and then decreases almost linearly. In the range $0.43 < x < 0.69$, K_1 is negative at room temperature. At higher temperatures, a change in sign occurs. If x decreases from 0.69 to 0.43, the isotropic point is shifted to higher temperatures and the positive component of the anisotropy constant becomes smaller. The constants h_{100} and h_{111} decrease linearly with temperature and remain unchanged at those temperatures at which the sign of K_1 changes. A. A. Popova is thanked for preparation and

Variation of resistivity on...

S/048/61/025/012/001/022
B137/B108

chemical analysis of the ferrite single crystals. There are 2 figures and 9 references: 3 Soviet-bloc and 6 non-Soviet-bloc. The four most recent references to English-language publications read as follows: Smit, J., Wijn, H. P. J., Ferrites. Eindhoven, 1959; Penoyer, R. F., Shafer, M. W., J. Appl. Phys., suppl., 30, no. 4, 315 (1959); Bozorth, R. M., Tilden, E. F., Williams, A. J., Phys. Rev., 99, no. 6, 1788 (1955); Yager, W. A., Galt, J. K., Merrit, R. F., Phys. Rev., 99, 1203 (1955)

ASSOCIATION: Institut kristallografii Akademii nauk SSSR (Institute of Crystallography of the Academy of Sciences USSR)

Card 4/4

23683
S/030/61/000/005/003/012
B105/B202

24.7900 (1144, 1147, 1395)

AUTHOR: Belov, K. P., Professor

TITLE: Physics of new ferromagnetic substances

PERIODICAL: Akademiya nauk SSSR. Vestnik, 31, no. 5, 1961, 33 - 38

TEXT: The author gives a general survey of research work in the field of physics of ferro- and antiferromagnetism: 1) study of the magnetic properties of new types of ferro and antiferromagnetic substances. In the periodic system of elements ferromagnetism is exhibited by the rare-earth metals Gd, Dy, Er, Tb, Ho and Tu, on certain conditions also by Mn and Cr and by Fe, Ni, and Co. 2) Study of the structure and the magnetic properties of ferrites. Science and engineering require the study of the structure and the magnetic properties of various oxide metal compounds (Fe, Ni, Co, Mn, Cr) and of a group of rare-earth metals. Also the study of ferrites of complex composition and structure is necessary. 3) Study of ferromagnetic resonance and magnetooptical phenomena in ferrites. The study of the behavior of ferrites in variable magnetic fields is considered useful. Also the extension of the frequency range for the study of magnetic phenomena in ferrites is of importance.

Card 1/2

23683
S/030/61/000/005/003/012
Physics of new ferromagnetic substances B105/B202

4) Electric and galvanomagnetic properties and phenomena connected with electron diffusion in ferromagnetic semiconductors. The explanation of the effect of ferro- and antiferromagnetism on the electricity carriers is an urgent problem. 5) Magnetic properties of thin ferromagnetic foils and powder. The study of the domain structure and its effect on the processes of magnetizing and magnetic reversal in similar materials is especially emphasized. Magnetic materials consisting of a conglomerate of fine, ferromagnetic particles exhibit an extraordinarily high coercive force. A strong magnetic energy and low losses to eddy-currents permit the application of these magnets in apparatus of high-frequency engineering. Ferromagnetic materials and magnetic phenomena are of a great importance to modern engineering. At present, a certain decrease of the volume and the speed of the studies of ferromagnetism can be observed in the USSR, although the problem of ferromagnetic materials is regarded as being of great importance.

Card 2/2

S/030/61/000/009/010/013
B105/B101

AUTHOR: Belov, K. P., Professor

TITLE: Studies of ferro- and antiferromagnetism

PERIODICAL: Akademiya nauk SSSR. Vestnik, 31 no. 9, 1961, 123-124

TEXT: An All-Union Conference on ferro- and antiferromagnetism was held in Leningrad on May 5-11, 1961. It was attended by members of academic institutions, schools of higher education, and branch research institutes of Moscow, Leningrad, Sverdlovsk, Krasnoyarsk, Khar'kov, Minsk, Gor'kiy, Riga, etc. Over 150 reports were made on studies of the properties of ferromagnetic metals, alloys, ferrites, and antiferromagnetics. Characteristics of the electronic structure of transition metals were discussed in connection with their magnetic properties. Another subject was the application of models of collectivated and localized electrons to ferro- and antiferromagnetism, as well as the application of different types of electron interactions (direct and indirect exchange). The so-called Green function method has been introduced to solve problems of the quantum theory of ferro- and antiferromagnetism. Part of the theoretical

Card 1/3

reports concerned the spin-wave theory, the complicated character of the spin system - lattice interaction, the application of thermodynamic and quasiclassical methods to the investigation of so-called non-collinear spin structures. Experimental studies of the properties of ferro- and antiferromagnetics are classified as follows: (1) Clarifying the physical nature of ferro-, ferri-, and antiferromagnetic states of the material concerned. Weak ferromagnetism arises in $CuSO_4$ and $CoSO_4$ single crystals due to the action of a magnetic field. High magnetic anisotropy was observed in single crystals of orthoferrites of rare-earth metals (La, Pr, Nd, Sm, Eu, Ib, etc). Coercive fields in them attained values up to 20,000 oe. The alloy $MnAu_2$ and the rare-earth metals Dy, Tb, Ho, Er, Tm (and, probably, Gd) possess a helical spin structure. The effect of the magnetic sublattice structure of ferrites upon their physical properties was discussed. Reports were made on the electrical and galvanomagnetic properties of ferrites and antiferromagnetics. A report by the Institut poluprovodnikov Akademii nauk SSSR (Institute of Semiconductors of the Academy of Sciences USSR) dealt with the synthesis of substances constituting ferromagnetics and ferroelectrics at the same time. (2)

Studies of ferro- and antiferromagnetism S/030/61/000/009/010/013
B105/B101

Processes of technical magnetization of ferro- and ferrimagnetics, and their domain structure. (3) Phenomena of ferro- and antiferromagnetic resonance, relaxation processes, and magnetic spectra in ferrites. The effect of various factors upon the broadening of the ferromagnetic resonance line both in ferrite single crystals and in ferrite poly-crystals was discussed. The fizicheskiy fakul'tet Moskovskogo universiteta (Physics Division of Moscow University) has been engaged with the theoretical calculation of the resonance precession of magnetization intensity in an inhomogeneous magnetic field taking the energy of magnetic crystal anisotropy into account. The ferromagnetic resonance in yttrium and manganic ferrite single crystals was studied at high power levels. A report concerned the development of new experimental methods of studying the magnetic properties of ferro- and antiferromagnetics.

Card 3/3

24.2200 (1137, 1147, 1158)
24.7900 1035, 1155, 1055

S/056/61/040/002/047/047
B102/B201

AUTHOR: Belov, K. P.

TITLE: Causes of the anomalous broadening of the lines of the ferromagnetic resonance absorption in ferrites near the Curie point

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 2, 1961, 711-713

TEXT: When measuring the temperature dependence of ferromagnetic resonance in ferrites, one observes both in single- and polycrystals an anomalous width of resonance absorption lines near the Curie point. This effect has been ascribed by several authors to the effect of thermal fluctuations of spontaneous magnetization, which are known to attain a maximum at the Curie point. In the present "Letter to the Editor" the author, however, bases upon an analysis of experimental data to show that the thermal fluctuations of spontaneous magnetization cannot be the principal reason for the marked broadening of the lines near the Curie point, and that the effect of structural factors must be regarded as such cause. The following reasons are given to substantiate this statement: 1) If the thermal fluctuations of spontaneous mag-

Card 1/3

netization were to describe quantitatively the temperature dependence of the line width $\Delta H(T)$ near the Curie point, the curve $\Delta H(T)$ would have to exhibit an analogous course as the curve $\chi_p(T)$ (temperature dependence of the susceptibility of the para-process). This, however, does not occur. While $\chi_p(T)$ has a maximum at Θ, ΔH grows continuously, and also the region of the maximum growth of ΔH is found at $T > \Theta$. It may be inferred therefrom that the fluctuations of spontaneous magnetization bear only little on the effect of the line broadening near Θ. 2) A more important cause of the broadening seems to be presented by the structural inhomogeneities of ferrites; these in their turn lead to inhomogeneities of spontaneous magnetization (volume fluctuations of spontaneous magnetization). Such inhomogeneities may be represented by: disordered magnetic-ion distribution, atomic vacancies, dislocations, et al. Spontaneous magnetization near Θ is very sensitive toward such inhomogeneities. They are also the cause of the fact that near Θ ferrites exhibit a growth of the coercive force H_c. The volume fluctuations of spontaneous magnetization lead to a spread of the resonance frequencies, which becomes manifest in a broadening of the resonance lines. 3) In connection with the anomalous line width near Θ also the anomalous line width near the point of compensation of the magnetic sublattices is of interest. Besides a growth of ΔH in the region of the compensation point, ferrites (like gadolinium-ferrite-garnet and lithium-ferrite-chromite) also exhibit an anomalous growth of H_c. (Here, the constant of magnetic anisotropy does not grow, but, on the contrary, drops a little). The growth of ΔH and H_c is here likewise explained by the magnetic heterogeneous structure of the ferrites, which appears near the compensation point. Almost no thermal fluctuations occur near this point. 4) What has been said of the causes of anomalous broadening near Θ in ferrites can be also extended to metallic ferromagnetics. Many of them also exhibit an anomalous broadening of the resonance absorption lines near Θ. V. N. Lazukin and A. I. Pil'shchikov are thanked for their discussions. G. V. Skrotskiy and L. V. Kurbatov are mentioned. There are 1 figure and 11 references: 5 Soviet-bloc and 6 non-Soviet-bloc. The two most recent references to English-language publications read as follows: W. de Gennes, C. Kittel, A. Portis, Phys. Rev. 116, 323, 1959; B. Calhoun, J. Overmeyer, W. Smith, Phys. Rev. 107, 993, 1957.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: December 8, 1960

22127

S/056/61/040/003/007/031
B102/B202

24.7700 (1147, 1158, 1160)

AUTHORS: Belov, K.P., Goryaga, A.N., Ling Chang-ta

TITLE: Galvanomagnetic properties of lithium ferrite chromite

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 3, 1961, 752 - 756

TEXT: The study of ferrites having a compensation point Θ_c (temperature at which the magnetic moments of the sublattices compensate each other) is of great importance to the theory of ferromagnetism. In a previous paper (ZhETF, 38, 1914, 1960), the authors already pointed out that $Li_2O \cdot 2.5Fe_2O_2 \cdot 2.5Cr_2O_3$ shows an extraordinary longitudinal galvanomagnetic effect (near Θ_c the sign of this effect changes from - to +). The authors describe the studies of the even galvanomagnetic effects (longitudinal and transverse) in ceramic $Li_2O \cdot 2.7\ Fe_2O_2 \cdot 2.3\ Cr_2O_3$ (A). (A) was first heated on air for 4 hours at 1000°C, subsequently it was sintered at 1200°C for three hours (on air), and then slowly cooled down. The gal-

Card 1/3

vanomagnetic effect was measured in a solenoid (up to 2000 oe) and between the poles of an electromagnet (up to 12,000 oe); the effect ($r = \Delta R/R$) was determined by comparison with the standard resistors. Magnetization I was determined in a solenoid by a ballistic method. r and I were measured in the range of from room temperature to 300°C. The temperature was measured by means of a copper-constantan thermocouple which was connected to a highly resistive potentiometer of the type ППТВ-1 (PPTV-1). The results are graphically illustrated. Fig. 1 shows the galvanomagnetic effects $r_{\perp}$ and $r_{\parallel}$ as well as I as temperature functions at H = 1550 oe and H = 1660 oe, respectively. The compensation point (incomplete compensation occurs) was at 98°C. Figs. 2 and 3 illustrate $r_{\parallel}(t)$ and $r_{\perp}(t)$ at high field strengths. The anomalies which become manifest in these curves can be explained by assuming that the sublattices of the ferrite concerned have "own" galvanomagnetic properties with different character. According to E.W. Gorter (Philips Res. Reports, 9, 295, 1954) (A) has two sublattices, the first one being formed mainly from Fe, Cr, and Li ions which occur in octahedral sites, the second one by Fe and Li ions in octahedral sites. Below Θ_c the octahedral

22127

Galvanomagnetic properties of ... S/056/61/040/003/007/031
B102/B202

sublattice is responsible of anomalies. The simple ferrite $Li_2O \cdot 5Fe_2O_3$ shows normal galvanomagnetic properties. A comparison of the effects $r_{\parallel}$ and $r_{\perp}$ showed the following: With $T < \Theta_c$, $r_{\perp} \gg r_{\parallel}$, and both are negative. In the range $T > \Theta_c$ $r_{\parallel}$ becomes positive, the point $r_{\parallel} = 0$ need not coincide with Θ_c. In the range of the Curie point, the negative maximum of the galvanomagnetic paraprocess is somewhat greater for $r_{\perp}$ than for $r_{\parallel}$. This is due to the fact that the difference between $r_{\perp}$ and $r_{\parallel}$ does not completely disappear at the Curie point. The experimental results prove that in (A) sublattices exist with different temperature dependence of spontaneous magnetisation. There are 5 figures and 3 references: 2 Soviet-bloc and 1 non-Soviet-bloc.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: October 11, 1960

Card 3/63

25182
S/056/61/040/006/003/031
B102/B214

24,7900

AUTHORS: Belov, K. P., Levitin, R.Z., Nikitin, S. A., Ped'ko, A. V.

TITLE: The magnetic and magneto-elastic properties of dysprosium and gadolinium

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 6, 1961, 1562 - 1569

TEXT: The interest that is being recently taken in the study of the magnetic properties of rare earths and their alloys is due to the following two causes: a) In some rare earth metals (Dy, Ho, Er, Tb, Tu) there occur complicated magnetic transformations from ferro magnetic to antiferromagnetic and then to the paramagnetic; b) In some rare earths there are uncompensated electron spins in a shell which is screened by outer 5s and 5p electrons. For this reason the direct exchange interaction between the 4f electrons is very difficult or even impossible. The authors have carried out measurements with the greatest possible accuracy on magnetization, magnetostriction λ, elastic modulus E, and the inner friction

Card 1/8

APPROVED FOR RELEASE: 06/06/2000 CIA-RDP86-00513R000204510002-7"

25182
S/056/61/040/006/003/031
B102/B214

The magnetic and magneto-elastic properties of ...

Q^{-1} of Dy and Gd and obtained them as functions of temperature. The present paper is concerned with the results of these experiments. The measurements were carried near the points Θ_1 and Θ_2 and in the region between them (Θ_1 is the temperature of the ferromagnetic - antiferromagnetic transition, and Θ_2 that of the antiferromagnetic paramagnetic transition). The results of the investigations are represented graphically. For Dy, Θ_1 was found to be 88°K and Θ_2 175°K. The character of the anomalies of E and Q^{-1} for Dy at Θ_2 is the same as in the antiferromagnetic $Cr_2\Theta_3$, i. e. Θ_2 is the Neel point. The behavior near Θ_1 is entirely different: The magnetic field has a strong effect on the Young's modulus E (Δ E effect) as well as on Q^{-1}, the changes of these quantities being irreversible.

Card 2/8

25182
S/056/61/040/006/003/031
B102/B214

The magnetic and magneto-elastic properties of ...

This means hystereses. These are shown for ΔE and Q^{-1} for 85° K in Figs. 2 and 3. All this signifies that Θ_1 is not a phase transition point of the second kind, and is in no way related to structural transformations. Fig. 4 shows the temperature dependence of Dy which shows particular peculiarities near Θ_1. Firstly, the magnetostriction at this point is unusually high (10^{-3} at 15,000 oe), and secondly, it is anisotropic. Moreover, there is for each temperature a critical value H_k at which a sudden rise of λ begins. Gadolinium whose ferromagnetism was discovered early has always been considered as a "normal" ferromagnetic. However, the authors have discovered that in weak fields there are anomalies in the temperature behavior of magnetization (Fig. 6), coercive force H_c (Fig. 7), and residual magnetization (Fig. 8). It may thus be concluded that a temperature exists for Gd (similar to the 217°C point for Ni and the 294°C point for Co) at which a temperature anomaly of μ and H_c exists. Contrary, however, to Ni and Co, Gd shows two singularities in the behavior of magnetic properties near the Curie point (Θ=290.5°K). The curvature of the curve show-

Card 3/9

25132
S/056/61/040/006/003/031
B102/B214

The magnetic and magneto-elastic properties of ...

ing the decrease of magnetization with temperature is very small and can be determined from the formula: $(\sigma_s/\sigma_0)^2 = \xi(1-T/\Theta)$. For Ni and Fe $\xi = 6 - 7$; for Gd: $\xi = 1.17$. Such a small ξ-value is characteristic of ferrite and some alloys (cf. Table). The existence of anomalous behavior of Gd (as compared to Ni and Fe) near Θ is due to the presence of an antiferromagnetic phase in this region of temperature, which, however, can be destroyed by weak fields. The authors thank Professor Ye. M. Savitskiy, V. F. Terekhova and I. V. Burov for preparing the Gd sample and A. S. Borovik-Romanov for discussions. There are 12 figures, 1 table, and 12 references: 4 Soviet-bloc and 8 non-Soviet-bloc. The most important references to English-language publications read as follows: J. Elliot et al. Phys. Rev. 94, 1143, 1954; D. Behrendt et al. Phys. Rev. 109, 1544, 1958.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

Card 4/4

28749
S/056/61/041/003/002/020
B125/B102

24,2200 (1068, 1147, 1164)

AUTHOR: Belov, K. P.

TITLE: The nature of low-temperature magnetic anomalies in ferrites possessing compensation points

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 3(9), 1961, 692 - 695

TEXT: The author shows that, at liquid-nitrogen and liquid-helium temperatures, a critical point occurs in the temperature dependences of the magnetic and non-magnetic properties (magnetic susceptibility, magnetostriction, coercive force, electric resistivity) of rare-earth ferrite garnets and of lithium chromite ferrite. The compensation point of $3\,Gd_2O_3 \cdot 5Fe_2O_3$ ferrite is studied. To find the $\sigma_s(T)$ curve of the iron-sublattice, it is necessary to eliminate the magnetic effect of the gadolinium sublattice, i.e. all Gd^{3+} ions must be replaced by non-magnetic ions (e. g. Y^{3+} or Lu^{3+}). The resulting ferrites $3Y_2O_3 \cdot 5Fe_2O_3$ or

Card 1/4

$3Lu_2O_3 \cdot 5Fe_2O_3$ show the normal Weiss temperature dependence of spontaneous magnetization. Their magnetic long-range order is destroyed only at $560^{o}K$, owing to the strong interaction in the iron sublattice. The temperature dependences of the spontaneous magnetization of the gadolinium sublattice and of some alloys (e. g. 30% Cu, 70% Ni) are not distinct. Probably, this is due to the fact that the long-range magnetic order in the gadolinium sublattice depends on the positive Gd^{3+} - Gd^{3+} exchange interaction in the sublattice c, and on the negative Gd^{3+} - Fe^{3+} exchange interaction. The long-range magnetic order undergoes a considerable change when the positive exchange interaction is "turned off" with rising temperature, but the negative exchange interaction prevents its complete destruction. All these facts lead to the condition under which the compensation point in ferrites is the most probable to occur. In the ferrite, one of the sublattices must exhibit a strong exchange interaction, and the curve $\sigma_s(T)$ must consequently show a Weiss character. The exchange interaction in the second sublattice must be "weak". The compensation point is found by subtracting curve 1 (with the smaller magnetic moment at $0^{o}K$) from curve 2 which corresponds to the sublattice with the greater magnetic moment at $0^{o}K$ (Fig.2). If the magnetic moment of the "weak" sublattice at $0^{o}K$ is smaller than that of the "strong" sublattice, $\sigma_{s}(T)$ of the ferrite will be anomal at low temperatures. Similar curves can be observed in yttrium ferrite when part of the Y^{3+} ions are substituted by Tb^{3+}, Gd^{3+} or other ions. Lithium chromite ferrite of the composition $Li_{0.5}Fe_{2.5-a}Cr_{a}O_{4}$ (for a = 1.25) for instance has two antiferromagnetically interacting sublattices, the first containing Fe^{3+}, Cr^{3+} and Li^{1+} ions (octahedral sites), and the second containing Fe^{3+} and Li^{1+} ions (tetrahedral sites). At low temperatures, the ferromagnetism of the ferrite depends on the octahedral sublattice. According to L. Neel (Ann. de Physique, 3, 137, 1948), the $\sigma_{s}(T)$ curve exhibiting the compensation point can also be found from the $\sigma_{sB}(T)$ and $\sigma_{sA}(T)$ curves of the octahedral and tetrahedral sublattices, respectively, which exhibit Weiss character. Ferrites with a compensation temperature must have a low-temperature point which corresponds to a considerable change of the magnetic

28749

The nature of low-temperature... S/056/61/041/003/002/020
B125/B102

long-range order in a sublattice with "weak" positive exchange interaction. According to A. V. Ped'ko (ZhETF, 41, 3, 700), the anomalies of the temperature dependence of the susceptibility of the para-processes, of the magnetostriction and of other phenomena are similar to the anomalies at the Curie point. A. N. Goryaga and Lin Chang-ta (ZhETF, 41, 3, 696) discussed anomalies in the temperature dependence of spontaneous magnetization, of the coercive force, of magnetic susceptibility, of the galvano-magnetic effect, and of the electric resistivity. There are 2 figures and 7 references: 4 Soviet and 4 non-Soviet. The two references to English-language publications read as follows: E. Lee, R. Birss, Proc. Phys. Soc., 76, 411, 1960; E. W. Gorter. Phil. Res. Rep., 9, 295, 1954.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: April 6, 1961

Card 4/5

44141

S/181/62/004/010/028/063
B108/B104

18.9500

AUTHORS: Belov, K. P., Svirina, Ye. P., and Malikova, O. A.

TITLE: The electrical conductivity of manganese ferrite single crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 10, 1962, 2829-2831

TEXT: The temperature dependence of the Hall emf, of the magnetization σ, and of the electrical conductivity $1/\rho$ of manganese ferrite single crystals was studied. The crystals were slightly out of the stoichiometric composition, either by a manganese or by an iron excess. The Hall emf $E = (R_oH + R_m\sigma)j$ increases rapidly with an excess of Mn. The magnetic Hall constant R_m rises linearly with increasing ρ. The classical Hall constant R_o is negative. The electron concentration calculated from it increases with increasing temperature according to an exponential law. The electron mobility calculated from R_o and ρ decreases considerably with increasing temperature in the case of manganese ferrite with excess Mn. In ferrite

Card 1/2

The electrical conductivity of... S/181/62/004/010/028/063
B108/B104

with excess Fe it decreases only a little. This shows that in the former case the phonons contribute most to the scattering of electrons (A. Miller. J. Appl. Phys., 31, no. 5, 261, 1960). There are 5 figures.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)

SUBMITTED: May 28, 1962

Card 2/2

38142

S/070/62/007/002/008/022
E132/E160

24.2200

AUTHORS: Belov, K.P., Zaytseva, M.A., Kadomtseva, A.M., Kvitka, S.S., and Ovchinnikova, T.L.

TITLE: The magnetic properties and structures of certain garnet systems

PERIODICAL: Kristallografiya, v.7, no.2, 1962, 242-246

TEXT: Garnet structures have been synthesized by the substitution in yttrium iron garnets of Fe and Y ions by Mn, Ge and Ti and their structures and magnetic properties have been studied. In the garnet of composition $Mn_{0.5}Y_{2.5}Fe_{4.5}Ge_{0.5}O_{12}$ an anomalous temperature dependence of the spontaneous magnetisation has been observed at low temperatures (of Neel's type M). It is established that the garnet of composition $MnY_2Fe_4GeO_{12}$ has a Curie point below 0 °C and that the curve of the temperature dependence of the spontaneous magnetisation tends asymptotically to zero. The curves are explained qualitatively. The cell size of the first-mentioned compound is 12.367 Å, and

Card 1/2

that of the second 12.347 as compared with 12.387 for the pure Y Fe garnet. In garnet there are three magnetic sub-lattices and on Neel's model M the curve observed for the first composition can be satisfactorily explained if the lattice having a weak inherent exchange interaction takes a different course from that of the other (iron) sublattices. The Ti-containing garnets $Mn_{0.5}Y_{2.5}Fe_{4.5}Ti_{0.5}O_{12}$ and $MnY_2Fe_4TiO_{12}$ were examined but showed no anomalies except that the second compound had a "tail" of residual magnetisation which persisted above the Curie point (506 °C) apparently connected with the appearance of another phase (traces of $Y_2Ti_2O_7$ were observed in the X-ray powder photograph). 4

There are 4 figures.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M.V. Lomonosova (Moscow State University imeni M.V. Lomonosov)

SUBMITTED: June 27, 1961

Card 2/2

S/126/62/013/001/001/018
E039/E535

AUTHORS: Belov, K.P. and Nikitin, S.A.

TITLE: The galvanomagnetic properties of terbium, dysprosium and holmium

PERIODICAL: Fizika metallov i metallovedeniye, v.13, no.1, 1962, 43-48

TEXT: Measurements of magnetic moment show that the rare earth metals have transition temperatures Θ_2 for antiferromagnetic-paramagnetic and Θ_1 for ferromagnetic-antiferromagnetic. Hence, the influence on electrical properties of the transition from a state of non-ordered spin to an ordered one can be studied on these metals. Values of Θ_1 and Θ_2, originally published by S. Legvold, F. Spedding et al., are:

Table 2

Element	Θ_1, °K	Θ_2, °K
Dy	85	178.5
Tb	219	229
Ho	20	133

Card 1/3

The galvanomagnetic properties ... S/126/62/013/001/001/018
E039/E535

Measurements of electrical and galvanomagnetic properties were made on samples of Dy, Tb and Ho (0.4 x 1 x 9 mm and 0.4 x 2.2 x 20 mm). Electrical resistance was measured over the temperature range 60-300°K using a potentiometric method, a constant current of 100 mA being passed through the sample. It is shown that there is a discontinuity in the resistance-temperature curves at Θ_2. The temperature dependence of the longitudinal and transverse galvanomagnetic effect was measured for Dy, Ho and Tb for magnetic fields up to 15000 Oe and it is shown that the galvanomagnetic effect passes through a marked negative maximum near Θ_2. In addition, in the case of Dy a second maximum is observed at Θ_1. The transition temperatures Θ_1 and Θ_2 for Tb are very close together, 219 and 229°K, respectively, so that only one maximum is obtained. Isotherms are plotted showing the change in longitudinal and transverse galvanomagnetic effect with intensity of magnetic field for a number of temperatures. It is shown that the temperature dependence of the slope of the isotherm $\Delta R/R\Delta H$ for Tb exhibits two maxima at 232°K and 224°K. This verifies the assumption that Tb possesses weak antiferromagnetic properties

Card 2/3

between 224 and 232°K. There are 9 figures.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet imeni M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)

SUBMITTED: May 31, 1961

33999

S/056/62/042/001/014/048
B104/B102

24.2200 (1147,1164,1482)

AUTHORS: Belov, K. P., Ped'ko, A. V.

TITLE: 'Helical" antiferromagnetism of gadolinium

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 1, 1962, 87-90

TEXT: The magnetic properties of polycrystalline toroidal specimens of gadolinium in magnetic fields between 0.28 and 2000 oe were investigated between 100 and 300°K. At 210°K, the specific magnetization drops sharply between 0.28 and 1.12 oe (Fig. 1). The curves have a normal Weiss shape only in strong fields (500-2000 oe). The magnetization isotherms between Θ_1 = 210°K and the Curie point Θ_2 = 290°K were examined. Like the other rare-earth metals (Dy, Tb, Ho, Er, and Tu), gadolinium exhibits two magnetic transitions at Θ_1 and Θ_2 and is antiferromagnetic between these temperatures. Antiferromagnetism vanishes already in weak fields. The magnetic properties in this temperature range can be attributed to a helical spin structure. Such structures form when

X

Card 1/2

33999

the exchange interaction between the atoms of a layer of the basal plane of the hexagonal Gd crystal is weak compared with the exchange interaction between the atoms of contiguous layers. Application of magnetic fields of 0-15 oe destroys this structure. There are 5 figures and 4 references: 1 Soviet and 3 non-Soviet. The three references to English-language publications read as follows: F. Spedding et al., Phys. Rev., 109, 1544, 1958; 94, 1143, 1954; 109, 1547, 1958; 112, 56, 1958; 100, 1595, 1955; M. Wilkinson, W. Koehler, E. Wollan, A. Cable. J. Appl. Phys., 32, 48, 49, 1961 (Suppl. to no. 3); U. Enz. J. Appl. Phys., 32, 22, 1961 (Suppl. to no. 3).

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: August 4, 1961

Fig. 1. Magnetization of Gd in weak and strong fields as a function of temperature.

Card 2/2

S/056/62/042/002/016/055
B102/B138

AUTHORS: Belov, K. P., Nikitin, S. A.

TITLE: Effect of helical magnetic structure on the magnetostriction of dysprosium

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 2, 1962, 403-407

TEXT: Dysprosium has two magnetic transformation temperatures: Θ_1 (85°K), at which the helical magnetic structure arises and Θ_2 (177°K), at which ferromagnetism of the basal planes vanishes, together with the helical magnetic structure. The lower temperature range has been studied previously (K. P. Belov et al. ZhETF, 40, 1562, 1961); it was found that below Θ_1, where the Dy crystal is ferromagnetic, and also between Θ_1 and Θ_2, the considerable anisotropy of magnetostriction is due to spontaneous magnetostriction. In continuation of these studies the range 120-190°K was here investigated. The magnetostriction observed on approaching Θ_2 will be caused by other kinds of spontaneous magnetostriction. The measurements were made with polycrystalline specimens and in magnetic
Card 1/3

fields in which the magnetic moments remained in the basal planes during magnetization. Magnetostriction was measured with a wire strain gage. The isotherms of transverse ($\lambda_{\perp}$) and longitudinal ($\lambda_{\parallel}$) magnetostriction between 0 and 15 koe were measured for several temperatures. It can be seen that for fields below critical, $\lambda_{\perp}$ is negative and $\lambda_{\parallel}$ positive. The temperature dependences of $\lambda_{\perp}$ and $\lambda_{\parallel}$ differ in shape, and their positions depend on whether H is stronger or weaker than H_{crit}. This is due to the fact that in this temperature range, besides magnetostriction corresponding to rotation of magnetic moments in the basal plane layers, there also exists a magnetostriction concomitant with destruction of the helical magnetic structure for $H = H_{crit}$. Around Θ_2 an intense paraprocess magnetostriction arises which is caused by exchange forces between atoms in adjacent basal planes. A. S. Borovik-Romanov is thanked for discussions. There are 5 figures and 6 references: 2 Soviet and 4 non-Soviet. The four references to English-language publications read as follows: D. Behrendt et al. Phys. Rev. 109, 1544, 1958. M. Wilkinson et al. J. Appl. Phys. 32, 49, 1961; suppl. to 3. U. Enz. J. Appl. Phys. 32, 22, 1961, suppl. to 3.

Effect of helical magnetic ...

S/056/62/042/002/016/055
B102/B138

J. Banister et al. Phys. Rev. 94, 1140, 1954.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: September 14, 1961

Fig. 1. Isotherm of $\lambda_{\perp}$

Fig. 2. Isotherm of $\lambda_{\parallel}$

Fig. 4. Temperature dependence of $\lambda_{\parallel}$ for 7500 oe (1) and 15 koe (2)

Fig. 5. Temperature dependence of $\lambda_{\perp}$ for 7500 oe (1) and 15 koe (2)

Card 3/~~6~~ 3

BELOV, K. P., CHICHERNIKOV, V. I., and VOL'KENSHTEYN, N. V.,

"Magnetic and electric properties of rare-earth metals and their alloys."

report presented at the Conf. on New Trends in the Study and Applications of Rare Earth Metals, Moscow, 18-20 Mar 63

BELOV, K. P., LEVITIN, R. S., NIKITIN, S. A., and PEDKO, A. V.,

"Magnetoelastic Properties of Rare Earth Ferromagnets"

report presented at the Symposium on Ferroelectricity and Ferromagnetism, Leningrad, 30 May-5 June 1963.

BELOV, K.P., doktor fiz.-matem.nauk; SHUVALOV, L.A., kand.fiz.-matem.nauk

Symposium on ferromagnetism and ferroelectricity at Leningrad.
Vest. AN SSSR 33 no.9:82-84 S '63. (MIRA 16:9)
(Dielectrics) (Ferromagnetism)

L 15518-63 EWT(1)/BDS/ES(s)-2 AFFTC/ASD/ESD-3/SSD Pt-4

ACCESSION NR: AP3005237 S/0056/63/045/002/0026/0028

AUTHORS: Belov, K. P.; Nikitin, S. A.; Ped'ko, A. V. 64

63

TITLE: Shift of the ferromagnetism-antiferromagnetism transition point in dysprosium under the effect of uniform pressure

SOURCE: Zhur, eksper. i. teoret. fiz., v. 45, no. 2, 1963, 26-28

TOPIC TAGS: ferromagnetism-antiferromagnetism transition, dysprosium, hydrostatic pressure

ABSTRACT: An attempt was made to observe the shift of the ferromagnetism-antiferromagnetism point of disprosium under the influence of a hydrostatic pressure of 1800 atmospheres. The observed shift in a 3100 Oe field was about 7° towards the lower temperatures and is ascribed to the influence of the change in the interatomic distances on the exchange interaction between the atoms in the basal plane of the dysprosium hexagonal lattice. The maximum of the coercive-force curve shifts by the same amount. An analogous behavior of gadolinium is pointed out, but the data available are not sufficient for a detailed interpretation. Orig. art. has 3 figures and 3 formulas.

Association: Moscow State University

Card 1/2

KARASIK, Vladimir Romanovich; BELOV, K.P., prof., red.; KOZLOV, V.D., red.; RYDNIK, V.I., red.

[Physics and technology of strong magnetic fields] Fizika i tekhnika sil'nykh magnitnykh polei. Moskva, Nauka, 1964. 347 p. (MIRA 17:10)

ACCESSION NR: AP4011744 S/0181/64/006/001/0101/0107

AUTHORS: Belov, K. P.; Iveronova, V. I.; Zaytseva, M. A.; Kadomtseva, A. M.; Katsnel'son, A. A.; Yatskul'yak, K.

TITLE: Magnetic and structural properties of lanthanum orthoferrite during partial replacement of Fe 3+ ions by other trivalent ions

SOURCE: Fizika tverdogo tela, v. 6, no. 1, 1964, 101-107

TOPIC TAGS: magnetic property, structural property, orthoferrite, lanthanum, lanthanum orthoferrite, Fe 3+, Al 3+, Sc 3+, Co 3+, thermoremanent magnetization, magnetization intensity, hysteresis loop, crystal lattice

ABSTRACT: In these studies the Fe^{+3} ion was replaced, in part, by Al^{+3}, Sc^{+3}, Cr^{+3}, and Co^{+3}. Thermoremanent magnetization of $LaFeO_3$ cannot be reduced to zero even in a field of 20 000 oersteds, but if Al^{+3} ions replace some of the Fe^{+3} ions ($LaFe_{0.9}Al_{0.1}O_3$), introduced by orthorhombic distortion of the crystal lattice, thermoremanent magnetization almost disappears, and the hysteresis loops become symmetrical. These changes may be explained by the finely dispersed character of the samples. The charge in magnetic properties on substitution of the indicated ions

Card 1/2

ACCESSION NR: AP4011744

is associated with change in degree of dispersion and with the orthorhombic distortion of the lattice. Along with these changes, an increase was observed in magnetization intensity. This is explained by the ordered distribution of Al^{+3} ions in the crystal lattice. Orig. art. has: 3 figures.

ASSOCIATION: Moskovskiy gosudarstvenny*y universitet im. M. V. Lomonosova (Moscow State University)

SUBMITTED: 10Jul63 DATE ACQ: 14Feb64 ENCL: 00

SUB CODE: PH NO REF SOV: 002 OTHER: 002

Card 2/2

ACCESSION NR: AP4034061 S/0126/64/017/004/0617/0619

AUTHORS: Belov, K. P.; Levitin, R. Z.; Malevskaya, L. A.; Sokolov, V. I.

TITLE: Anomalies of Young's modulus in rare ear[illegible] fe[illegible]omagnets

SOURCE: Fizika metallov i metallovedeniye, v. 17, no. 4, 1964, 617-619

TOPIC TAGS: rare earth, ferromagnet, Young modulus, dysprosium, erbium, holnium, thulium, helicoidal ferromagnetic structure, paramagnetism

ABSTRACT: Rare earth ferromagnets (Dy, Er, Ho, Tb, Tu, and possibly Gd) at certain temperature intervals possess antiferromagnetic helicoidal structures. To investigate the reasons for the formation of these structures, the Young's modulus was measured at various temperatures. A compound vibrator was used at a frequency of 150 kilocycles/sec, and the temperature was changed continuously from 4.2 to 78K by placing the specimen in a massive copper vessel which could be cooled down to a temperature near that of liquid helium. Further variation of temperature between 78 and 300K was obtained by using liquid nitrogen and an electric heater. The magnetization was measured by means of an oscillating magnetometer. The results showed three regions in which anomalous behavior of the Young's modulus could be observed: 1) a region around which a transition took place from antiferromagnetism

ACCESSION NR: AP4034061

to paramagnetism (here the value of the Young's modulus decreased); 2) a region corresponding to a transition from ferromagnetism to antiferromagnetism (here the Young's modulus fell significantly); 3) a region between these two temperatures which corresponded to the helicoidal antiferromagnetic structure (here the Young's modulus increased faster than in the paramagnetic region as the temperature was decreased). Orig. art. has: 2 figures.

ASSOCIATION: Moskovskiy gosuniversitet im. M. V. Lomonosova (Moscow State University)

SUBMITTED: 13Jul63 ENCL: 00

SUB CODE: SS, MM NO REF SOV: 004 OTHER: 003

Card 2/2

ACCESSION NR: AP4023400 S/0048/64/028/003/0519/0528

AUTHOR: Belov, K.P.; Levitin, R.Z.; Nikitin, S.A.; Ped'ko, A.V.

TITLE: Magnetoelastic properties of rare earth ferromagnetic materials /Report, Symposium on Ferromagnetism and Ferroelectricity held in Leningrad 30 May to 5 June 1963/

SOURCE: AN SSSR. Izvestiya. Seriya fizicheskaya, v.28, no.3, 1964, 519-528

TOPIC TAGS: magnetostriction, rare earth magnetostriction, magnetoelasticity, rare earth magnetoelasticity, rare earth exchange anisotropy, helical antiferromagnetism

ABSTRACT: The magnetostriction, the temperature dependence of the elastic moduli, and the effect of hydrostatic pressure on the magnetization, are discussed in some detail for a number of rare earths. The experimental data for the discussion are taken from a number of sources. These magnetoelastic properties are of interest because they involve a combination of exchange and magnetic interactions, and their behavior may shed some light on the complex magnetic properties of these materials. In the range of temperatures and fields in which the materials are ferromagnetic, the magnetostriction constants of Dy and Tb are large, and the two constants (for

Card 1/3

ACCESSION NR: AP4023400

the same material) are of opposite sign. The magnetostriction is due primarily to rotation of the magnetic moment in the basal plane against magnetic anisotropy forces. The magnetostrictive behavior of Gd is very complex and is not understood. In the range of temperatures and fields in which Dy exhibits helical antiferromagnetism its magnetostrictive behavior is complex. A simple theory of magnetostriction is developed, in which the magnetic anisotropy in the basal plane is neglected (presumably a reasonable approximation in the temperature range considered) and the exchange interactions between neighboring basal planes and between next-neighboring basal planes are assumed to be different linear functions of the strain in the hexagonal axis (i.e.; of the distance between the basal planes). This theory accounts qualitatively for the complex behavior observed. Unlike the behavior of magnetostriction in the iron group, the magnetostriction of Dy and Tb is anisotropic even very close to the Curie point. This indicates that the exchange interaction in these materials is anisotropic. The anisotropy of the exchange interaction is also indicated by the fact that the shear modulus of Dy has the same type of anomaly at the Curie point as has Young's modulus. The ferromagnetic-antiferromagnetic transition point of Dy is shifted to lower temperatures by the application of hydrostatic pressure. The transition of polycrystalline Gd at 210°C behaves similarly. After a short thermo-

Card 2/3

ACCESSION NR: AP4023400

dynamic discussion it is concluded from this that the exchange interaction between the basal planes (i.e., along the hexagonal axis) depends sharply on distance. This, and other properties of the exchange interaction revealed by magnetoelastic behavior, is not easy to understand on the basis of current theories, according to which the exchange interaction in these materials is indirect, via the conduction electrons and the $5s^2$ and $5p^6$ bands. Orig.art.has: 10 formulas and 6 figures.

ASSOCIATION: Moskovskiy gosudarstvenny*y universitet (Moscow State University)

SUBMITTED: 00 DATE ACQ: 10Apr64 ENCL: 00

SUB CODE: PH NR REF SOV: 007 OTHER: 014

Card 3/3

BELOV, K.P.; KADOMTSEVA, A.M.; LEVITIN, R.Z.

Magnetic susceptibility of orthoferrites of rare earth elements in strong magnetic fields. Zhur. eksp. i teor. fiz. 47 no.2:439-443 Ag '64. (MIRA 17:10)

1. Moskovskiy gosudarstvennyy universitet.

L 11953-65 EWT(m)/EWP(b) ESD(t) JD/JG

ACCESSION NR: AP4046399 S/0056/64/047/003/0860/0864

AUTHORS: Belov, K. P.; Burov, I. V.; Yergin, Yu. V.; Ped'ko, A. V.; Savitskiy, Ye. M.

TITLE: Anomalies of Galvanomagnetic phenomena in gadolinium 27 B

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 47, no. 3, 1964, 860-864

TOPIC TAGS: gadolinium, galvanomagnetic effect, magnetoresistance

ABSTRACT: To obtain more detailed data on the magnetic properties of gadolinium, the authors undertook measurements of the effect of a magnetic field on the electric resistance (even galvanomagnetic effect), as a function of field and temperature, for several polycrystalline samples and one single crystal of gadolinium. The measurements were made on cast, rolled, and drawn gadolinium 99.0--99.5% pure and annealed at 1200C. The transverse and longitudinal galvano-

Card 1/3

L 11953-65
ACCESSION NR: AP4046399

magnetic effects were found to have a complex temperature dependence much more complicated than observed by some of the authors (K. P. Belov and S. A. Nikitin, FMM v. 13, 43, 1962) in dysprosium or terbium. Two maxima of the negative galvanomagnetic effect were observed in the region of the Curie point, one corresponding to the Curie point itself (~290K) and due to intrinsic magnetization, and the other, higher and broader, located somewhat below the Curie point (~230--250K). A minimum of the negative galvanomagnetic effect is observed near 140--180K. At still lower temperatures, an additional maximum is observed below this temperature. In the single-crystal gadolinium a sharp difference was observed in the character of the galvanomagnetic effect curves parallel and perpendicular to the hexagonal axis, and this is interpreted as being due to a helicoidal ferromagnetic structure. Orig. art. has: 5 figures.

ASSOCIATION: Moskovskiy gosudarstvenny*y universitet (Moscow State University)

Card 2/3

L 11953-65

ACCESSION NR: AP4046399

SUBMITTED: 04Apr64 ENCL: 00

SUB CODE: SS, MM NR REF SOV: 005 OTHER: 006

Card 3/3

L 29293-65 EWT(l)/EPA(s)-2/EWT(m)/EWP(w)/EWA(d)/T/EWP(t)/EPA(bb)-2/EWP(b)
Pt-10 SSD/AFWL/AS(mp)-2/ESD(t) JD
ACCESSION NR: AP5001830 S/0056/64/047/006/2080/2084

AUTHOR: Belov, K. P.; Yergin, Yu. V.; Levitin, R. Z.; Ped'ko, A. V.

TITLE: Anisotropy of the magnetic properties of gadolinium near the Curie point

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 47, no. 6, 1964, 2080-2084

TOPIC TAGS: anisotropy, magnetization, gadolinium, single crystal, Curie point

ABSTRACT: To determine the influence of magnetic anisotropy on the magnetic phenomena occurring near the Curie points, the authors made detailed measurements of the magnetization curves of single-crystal gadolinium in the temperature interval 280--300K. The measurements were made with a Domenicali pendulum magnetometer by a null method in fields up to 15,000 Oe, on rods 5 mm long and 0.2 x 0.4 mm in cross section, cut from single-crystal gadolinium along the a and c axes. The temperature dependence of the magnetic anisotropy was calculated from the obtained magnetization curve. The Curie point was determined from these experiments with accuracy of 0.1°. The results have shown that the anomalous increase

Card 1/2

L 20293-65
ACCESSION NR: AP5001830

in the anisotropy constant on approaching the Curie point, and its strong dependence on the magnetic field, are due to the fact that the specific anisotropy energy of the crystal contains a component that depends on the field as a result of the influence of the paraprocess. A noticeable anisotropy at the Curie point was observed in the single-crystal gadolinium. It is noted in the conclusion that similar effects should be observed to an even greater degree in single-crystal Tb, Dy, Ho, Er, and Tu, in which the uniaxial anisotropy is very large. Orig. art. has: 4 figures and 6 formulas.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: 18 Jul64 ENCL: 00

SUB CODE: SS, EM NR REF SOV: 003 OTHER: 003

Card 2/2

BELOV, K.P., kand. tekhn. nauk

Lighting of passenger cars. Zhel. dor. transp. 46 no.7:94-95 Jl '64. (MIRA 17:8)

L 14050-(EWT(l)/EWT(m)/EWP(t)/EWP(b) IJP(c)/AFWL/SSD/ASD(d)/ESD(dp)/
ESD(gs)/ESD(t) JD/JG

ACCESSION NR: AP4043613 S/0056/64/047/002/0439/0443

AUTHOR: Belov, K. P.; Kadomtseva, A. M.; Levitin, R. Z. 8

TITLE: Investigation of the magnetic susceptibility of orthoferrites of rare earth elements in strong magnetic fields 21
27

SOURCE: Zh. eksper. i teor. fiz., v. 47, no. 8, 1964, 439-443

TOPIC TAGS: ferrite, magnetic susceptibility, rare earth element, lanthanum, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium

ABSTRACT: With an aim at a more thorough study of the magnetic properties of rare-earth orthoferrites, and especially establishing the contributions of iron and rare-earth ions to the susceptibility, the authors measured the field dependence of the magnetization of orthoferrites (general formula $MFeO_3$, where M -- rare earth metal ion) of La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, and Yb. Both

APPROVED FOR RELEASE: 06/06/2000 CIA-RDP86-00513R000204510002-7"

L 14050-65
ACCESSION NR: AP4043613

5

single-crystal and polycrystalline samples were investigated in pulsed fields up to 220 kOe. A ponderomotive measurement method was used. The tests show that the main contribution to the susceptibility of the orthoferrites is made by the rare-earth ions. Calculations of the molar susceptibilities of the orthoferrites from the experimental data have shown that at room temperature the magnetic moments of the rare-earth element ions are barely acted upon by the exchange fields of the iron sublattices, and that the magnetic moments of the rare-earth ions are not "frozen in" by the crystal lattice field, so that they can be regarded as free from the magnetic point of view. "In conclusion, we are deeply grateful to V. A. Timofeyeva for supplying the single-crystal orthoferrites, to M. A. Zaytseva and T. L. Ovchinnikova for preparing the polycrystalline orthoferrites and for a discussion of the results, and to Yu. F. Popov for help with the measurements." Orig. art. has: 3 figures and 1 formula.

Card 2/5

L 14050-65

ACCESSION NR: AP4043613

ASSOCIATION: Moskovskiy gosudarstvenny*y universitet (Moscow State University)

SUBMITTED: 06Mar64 ENCL: 02

SUB CODE: EM, SS NO REF SOV: 006 OTHER: 004

Card 3/5

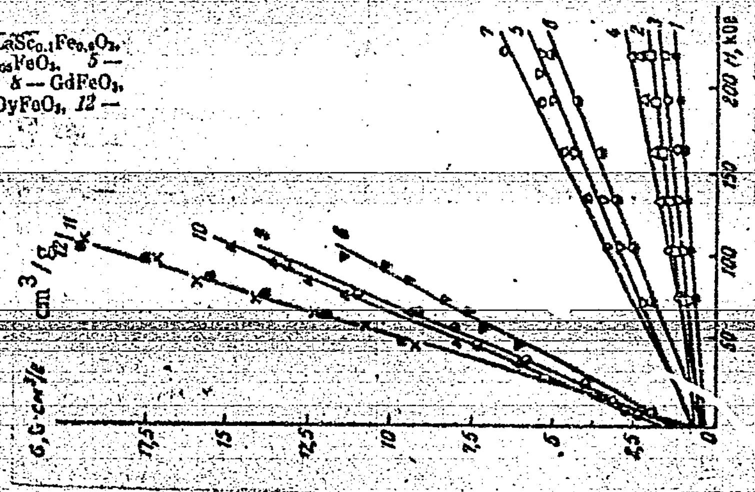
L 14050-65
ACCESSION NR: AP4043613

ENCLOSURE: 01

Fig. 1.

Dependence of specific magnetization on the magnetic field for the following polycrystalline orthoferrites:

1 — $LaFeO_3$, 2 — $LaSc_{0.1}Fe_{0.9}O_3$, 3 — $LaAl_{0.1}Fe_{0.9}O_3$, 4 — $La_{0.95}Gd_{0.05}FeO_3$, 5 — $PrFeO_3$, 6 — $NdFeO_3$, 7 — $YbFeO_3$, 8 — $GdFeO_3$, 9 — $TbFeO_3$, 10 — $ErFeO_3$, 11 — $DyFeO_3$, 12 — $HoFeO_3$



Card 4/5

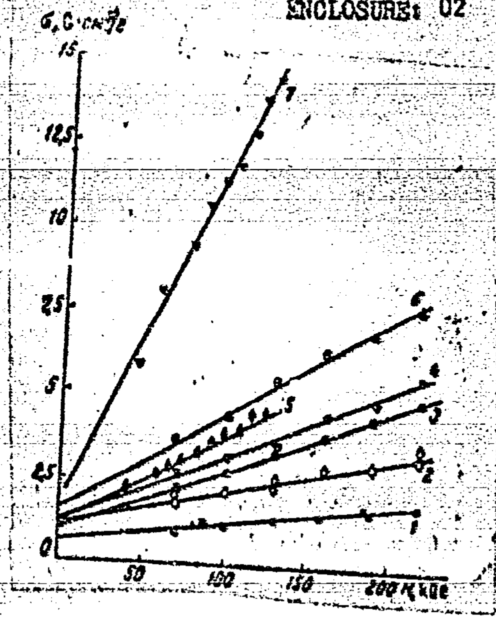
L 14050-65

ACCESSION NR: AP4043613

ENCLOSURE: 02

Fig. 2.
Dependence of the specific magnetization on the magnetic field for the following single crystal orthoferrites:

1 — $LaFeO_3$, 2 — $SmFeO_3$, 3 — $NdFeO_3$, 4 — $PrFeO_3$, 5 — $EuFeO_3$, 6 — $YbFeO_3$, 7 — $GdFeO_3$



Card 5/5

ACCESSION NR: AP4024574 S/0053/64/082/003/0449/0498

AUTHORS: Belov, K. P.; Levitin, R. Z., Nikitin, S. A.

TITLE: Ferromagnetism and antiferromagnetism of rare earth metals

SOURCE: Uspekhi fizicheskikh nauk, v. 82, no. 3, 1964, 449-498

TOPIC TAGS: ferromagnetism, antiferromagnetism, rare earth metal, yttrium subgroup, iron group, exchange interaction, electron shell

ABSTRACT: In view of the recent discovery that the rare earth metals of the yttrium subgroup have ferromagnetic properties different from those of ferromagnets of the iron group, and in view of the large amount of experimental data accumulated in recent years on these magnetic properties and the interest in helicoidal antiferromagnetism, the author describes and interprets systematically this material. It is shown that the rare earth ferromagnets have a more complicated magnetic behavior than those of the iron group. In view

ACCESSION NR: AP4024574

of this, a simple application of the theories originally developed for iron-group magnets cannot be directly applied to rare-earth ferromagnets and may lead to wrong results. It is concluded that the theory of exchange and magnetic interactions in rare-earth ferromagnets must be based on the fact that the magnetic 4f-electrons of the latter lie deep in the electron shells. The mechanism for the exchange interaction between the 4f electrons and the neighboring atoms, which must of necessity be indirect, should be the subject of further study. The section headings are: 1. Magnetic properties of rare-earth ferromagnets. 2. Neutron diffraction studies of the magnetic structure of rare-earth ferromagents. 3. Study of the helicoidal magnetic structure. 4. Nature of the magnetic phase transitions in rare-earth ferromagnets. 5. Antiferromagnetism of metals in the cerium subgroup. 6. Magnetoelastic properties of rare earth ferromagnets. 7. Electrical and galvanomagnetic properties of rare-earth alloys. Orig. art. has: 53 figures, 35 formulas, and 2 tables.

ACCESSION NR: AP4024574

ASSOCIATION: None

SUBMITTED: 00 DATE ACQ: 15Apr64 ENCL: 00

SUB CODE: EM, SS NR REF SOV: 029 OTHER: 124

Card 3/3

BELOV, K. P.

"On the magnetic properties of gadolinium torbium and their alloys with yttrium."

report submitted for Intl Conf on Magnetism, Nottingham, UK, 6-13 Sep 64.

Moscow State Univ.

BELOV, Konstantin Petrovich; BELYANCHIKOVA, Marianna Aleksandrovna; LEVITIN, Rudol'f Zinov'yevich; NIKITIN, Sergey Aleksandrovich; GUSEV, A.A., red.

[Rare-earth ferromagnetics and antiferromagnetics] Redkozemel'nye ferromagnetiki i antiferromagnetiki. Moskva, Nauka, 1965. 319 p. (MIRA 19:1)

L 38537-65 EWT(l)/EWT(m)/T/EWP(b)/EWA(d)/EWP(w)/EWP(t) Pad IJP(c) JW/JD/HW

ACCESSION NR: AP5005285 S/0181/65/007/002/0474/0476

AUTHOR: Belov, K. P.; Goryaga, A. N.; Volkova, N. V.

TITLE: Anomaly of electric resistivity in the region of the compensation temperature in the ferrite $NiFe_{1.26}V_{0.74}O_4$

SOURCE: Fizika tverdogo tela, v. 7, no. 2, 1965, 474-476

TOPIC TAGS: nickel ferrite, temperature dependence, electric resistivity, compensation temperature, activation energy, resistance anomaly

ABSTRACT: Continuing an earlier study of the temperature dependence of the electric resistivity of certain ferrites (ZhETF v. 38, 1914, 1960) with the special aim of determining the nature of the anomalies in the region of the compensation point, the authors made a thorough study of the electric resistivity (ρ) of the ferrite $NiFe_{1.26}V_{0.74}O_4$, which has a lower resistivity and a lower activation energy than the previously studied ferrites. The sample was prepared by a usual ceramic technology from the pure oxides NiO, Fe_2O_3, and V_2O_3 and annealed in vacuum at 1100C. The test results have shown that in the region of the temperature of com-