AUTHORS: Shur, Ya. S. and Zaykova, V. A. SOV/126-6-3-23/32

TITLE: On the Influence of Elastic Stresses on the Magnetic Structure of Silicon Iron Crystals (O vliyanii uprugikh napryazheniy na magnitnuyu strukturu kristallov kremnistogo zheleza)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 3, pp 545-555 (USSR)

ABSTRACT: The aim of the work described in this paper was to establish general relations governing the changes in the magnetic structure of silicon iron crystals under the effect of elastic stresses. By means of the method of powder patterns the changes were investigated in the magnetic structure of such crystals caused by elastic stretching of the crystal as a function of the magnitude of the tensile force, the type of the initial magnetic structure and the orientation of the stresses relative to the crystallographic directions in the crystal. The investigations were carried out on coarse crystal specimens of iron containing 3.5% Si, whereby the dimensions of the individual crystals varied between 0.5 and 5.0 mm. The specimens consisted of 30 mm long,

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4 mm wide, 0.1 to 0.2 mm thick strips with various crystallographic orientations of the surface. The surface treatment (mechanical and electrolytic polishing) and the preparation of the magnetic suspensions was the same as in earlier described work of Shur and Abel's (Ref 4). The powder patterns were observed by means of a microscope. The stretching of the specimens was effected by means of a specially designed instrument, a photo of which is reproduced in Fig.1. In this the specimen is fixed between the clamps of a spring dynamometer which is attached to the stand of a microscope; the stretching of the specimen was effected by means of an electric motor-driven screw which compressed the spring of the dynamometer. It was thus possible to obtain a continuous loading and unloading of the investigated specimens and to determine the load from the deflection of the dynamometer pointer. The applied loads did not cause plastic deformation of the specimens. The observation and photographing of the powder patterns were effected at magnifications of 180 to 300 times. Some of

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the thus produced photographs are reproduced in Figs.2-9. It was found that elastic stretching may bring about considerable changes in the magnetic structure of crystals of silicon iron; these changes depend on the magnitude of the stresses, the type of the initial magnetic structure and the orientation of the stresses relative to the crystallographic directions in the crystal. Changes in the structure may consist of displacement of the boundaries, changing the dimensions and cessation of additional areas and also of changes in the type of magnetic structure. The changes in the magnetic structure caused by tension in the elastic range may be irreversible. The obtained results can be explained qualitatively if it is assumed that, as a result of the elastic stresses, a redistribution takes place in the crystals of the sections where the boundary energy has a minimum value and in the direction of easy magnetisation, which is near to the direction of the tensile force, magnetisation will become still easier. In some cases the vector of spontaneous magnetisation may

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turn from the tetragonal axis of the crystal to the direction of the stretching. Students Yu.N.Dragashanskiy and Ye. D. Kuzmin participated in the experimental work. There are 9 figures and 6 references, 3 of which are Soviet, 3 English.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR (Institute of Metal Physics, Ural Branch of the Ac.Sc., USSR)

SUBMITTED: August 21, 1957

1. Silicon iron crystals--Magnetic properties 2. Electrolytic polishing --Applications 3. Silicon iron crystals--Stresses 4. Silicon iron crystals--Test results

SOV/126-6-3-24/32

AUTHORS: Shur, Ya. S. and Abel's, V. R.

TITLE: ~~Investigation~~ of the Processes of Magnetization in Silicon Iron Crystals (Issledovaniye protsessov namagnichivaniya v kristallakh kremnistogo zheleza)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol6, Nr 3, pp 556-563 (USSR)

ABSTRACT: In spite of the fact that during recent years a number of theoretical and experimental investigations have been made relating to the processes of magnetisation, the mechanism of these processes in real crystals has still not been clarified. Only the general conceptions appear to be established with a great degree of probability, according to which the magnetisation and remagnetisation of a ferromagnetic is effected by displacement of the boundaries between adjacent domains and rotation of the magnetisation vector of the individual domains. Usually the mechanism of the process of magnetisation itself, i.e. the mechanism of reconstruction of the magnetic structure as a result of the effect of the external magnetic field is not considered. Furthermore, as was shown in earlier work of the authors (Refs 1 and 2), only

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the simplified magnetic structure is considered, namely, the main domains. In a real ferromagnetic the magnetic structure may be very complicated; in addition to main domains, there are additional domains of various types which may have a considerable influence on the magnetisation process. For elucidating many properties of ferromagnetics it is necessary to have available reliable data on the changes of the magnetic structure under the effect of the magnetic field. At present observation of such a reconstruction can be effected by the powder pattern method and the authors of this paper used this method for studying the mechanism of the process of magnetisation of silicon iron crystals with the aim of establishing general relations governing the changes in the magnetic structure caused by a magnetic field. The investigations were carried out on 10 mm dia, 0.005 to 0.3 mm thick discs of coarse grain steel containing 3.5% Si. The preparation of the surface of the specimens and of the magnetic suspension was carried out by a method described in earlier work (Ref.1). Prior to observing the powder

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patterns, the specimens were demagnetised by means of an a.c. field. Following that, the powder patterns were observed during gradual increase of the magnetic field which was orientated parallel to the surface of the specimen. The magnetic field was generated by means of two solenoids located on both sides of the specimen on a single axis. The orientation of the crystals was determined by means of X-rays with an accuracy of up to 2°. The following designations were used for the tetragonal axes of the crystal: the nearest to the specimen surface was denoted by [100], the more distant one by [010] and the most distant one by [001]. Study of the changes of the powder patterns under the effect of the external field was effected on a large number of crystallites with various crystallographic orientations of their surface and various directions of the magnetic field in the plane of the investigated crystallite. As was shown in earlier work of the authors (Ref 2), the magnetic structure of relatively thin crystals of silicon iron can be of the type A, in which case the magnetisation

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vectors $\vec{I}_s$ of the main domains are orientated parallel to the direction [100] and the boundaries between the main domains are perpendicular to the surface of the specimen, and of the type B, in which case the orientation of the main domains is parallel to the direction of [010] or [001] and the magnetic flux between adjacent domains is closed through additional domains which cover the entire surface of the crystal. In the additional domains the I_s are in the direction perpendicular to the boundaries between these domains. If α[100] is larger than 0, then, in addition to the main domains in the case of a type A structure and the additional surface domains in the type B structure, other additional domains of various shapes will be present. Photos of the changes of the powder patterns caused by the effect of the magnetic field are reproduced in Figs.1-4 and in Fig.5 a sketch shows the changes in the type B magnetic structure in the case of magnetisation in the direction [100]. The obtained results have shown that under the influence of a magnetic field complicated

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changes may take place in the magnetic structure of crystals of silicon iron. Such changes depend on the field strength, the type of the initial magnetic structure and the orientation of the field relative to the crystallographic axes of the crystal. The changes in the structure may consist of boundary displacements, displacement in the orientation of the magnetisation of the field, displacements, changes in the dimensions and cessation of additional domains, and changes in the type of the magnetic structure. In weak magnetic fields there is a displacement of the boundaries between the main domains as well as displacement of the additional domains. In strong fields, in addition to processes of rotation, there are also processes of displacement of the boundaries between the domains, i.e. a reduction in the volume of the additional domains and a fragmentation of the surface domains in the type B structure. It can be assumed that the derived relations governing the change of the magnetic structure of silicon iron crystals caused by the effect of a magnetic field are generally

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for sheets of soft magnetic material, particularly for materials with a crystal lattice, such as the crystal lattice of iron, possessing a sufficiently large anisotropy constant.
There are 6 figures and 4 references, 3 of which are Soviet, 1 English.

ASSOCIATIONS: Institut fiziki metallov Ural'skogo filiala AN SSSR (Institute of Metal Physics, Ural Branch of the Ac.Sc., USSR) and
Vecherniy politekhnicheskiy institut v g. Komsomol'ske-na Amure (Evening Polytechnical Institute, Komsomol'sk on the Amur)

SUBMITTED: August 21, 1957

1. Silicon iron crystals--Magnetic properties 2. Magnetic susceptibility--Determination 3. Ferromagnetic materials--Properties 4. Magnetic fields--Effectiveness

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SOV/126-6-4-6/34

AUTHORS: Shur, Ya.S.,
Startseva, I.Ye.

TITLE: Change in the Magnetic Structure of Residually Magnetised Crystals of Silicon Iron in the Case of Demagnetisation with an Alternating Field. (Izmeneniye magnitnoy struktury ostatochno namagnichennykh kristallov kremnistogo zheleza pri razmagnichivanii peremennym polem)

PERIODICAL: Fizika metallov i metallovedeniye, 1958, Vol 6, Nr 4, pp 614-620 (USSR)

ABSTRACT: In earlier work of the authors, (Ref.1), relating to studying by means of powder patterns the magnetic structure of silicon iron crystals which are in the state of residual magnetisation, it was established that the magnetic structure of a residually magnetised crystal may consist of basic magnetic regions (the magnetisation vector I_s of these regions is orientated in the direction of easy magnetisation, which is near to the direction of the field of preliminary magnetisation of the crystal), reverse regions (with

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anti-parallel orientation of the $\vec{I_s}$ vector), supplementary closing regions of various types and also sub-regions which occur around defects. Thereby, the authors defined as "closing regions", regions which form around the surface of the crystal and reduce its total energy. It was also established that the type of the magnetic structure in the state of residual magnetisation depends on the crystallographic orientation of the surface of the specimen, on the orientation relative to the crystallographic axes of the crystal of the field which brought about the preliminary magnetisation and on the type of the magnetic structure of adjacent crystallites. It follows therefrom that the type of magnetic structure in the residually magnetised state can differ for differing crystals. Therefore, it can be anticipated that the change in the magnetic structure in the case of demagnetisation of

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residually magnetised crystallites will also differ, depending on the type of their magnetic structure in the original state of the residual magnetisation. The details of the process of demagnetisation can be established only on the basis of directly observed changes of the magnetic structure and, in order to establish these, experiments were carried out which are described in this paper. The experiments were carried out on polycrystalline specimens of silicon iron containing a large number of crystals with various crystallographic orientations of the surface. The linear dimensions of the individual crystallites were 0.5 to 2.0 mm. For excluding the demagnetising effect of the ends of the specimens, the investigations were carried out on rings of 40 mm outer diameter and 28 mm inner diameter with a thickness of 0.1 - 0.2 mm. Preparation of the surface of the specimens and of the magnetic suspension was carried out by means of methods

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described in earlier work (Ref.2). Observation of the powder patterns was carried out by means of an instrument, a photo of which is reproduced in Fig.1. The investigated specimen was placed in front of the objective lens of the microscope in a special attachment which was fixed to the stand of the microscope. The specimen could be turned about its axis and could also be displaced along its radius by means of screws. Preliminary magnetisation of the investigated specimen was effected by the field of a circular permanent magnet of 200 Oe; the demagnetisation was effected by a 50 cps magnetic field. The circular magnetic field was generated by passing a (d.c. or a.c.) current through a coil which can be taken apart and which surrounds the specimen. The amplitude of the a.c. field was made to vary continuously each time from the maximum value to zero by means of a special transformer with a mobile core. The powder patterns were photographed

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by means of a camera which was attached to the microscope in such a way that it was possible to follow the magnetic structure of the specimen whilst the exposures were being taken. Some of the obtained powder patterns are reproduced (Fig.2-5). On the basis of observation of the powder patterns in a large number of crystals with various crystallographic orientations, the following conclusions were arrived at:

1. The process of variation of the magnetic structure of a crystal under the effect of an a.c.field during transition from the residually magnetised into the demagnetised state takes place as follows: the supplementary surface regions become transformed into reverse regions; the reverse regions become extended and subsequent fragmentation of the reverse regions was observed; sub-regions never became transformed into reverse regions.

2. Supplementary regions and regions with reverse

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magnetisation, which occur in the crystal in the state of residual magnetisation, reduce the stability of its magnetic structure against the demagnetising effects. In presence of reverse regions the residually magnetised state is the most unstable; even in very weak magnetic fields a displacement of the inter-domain boundaries takes place. This phenomenon can easily be understood if it is taken into consideration that during displacement of the boundaries of reverse magnetisation regions no appreciable change in their areas takes place, whilst transformation of the supplementary regions into reverse regions is always linked with a considerable increase of the areas of the inter-domain boundaries.
3. In the case of repeated magnetisation with a d.c. field, the appearance of the magnetic structure in the state of residual magnetisation will differ each time in the same way as the reconstruction of the magnetic structure of a crystal in the case of repeated

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demagnetisation by an a.c. field of equal maximum amplitude.

4. In the case of polycrystalline specimens, the crystallographic orientation of adjacent grains will show an appreciable influence on the change of the magnetic structure of the individual crystallites.

There are 5 figures and 5 references of which 4 are Soviet and 1 English.

ASSOCIATION: Institut Fiziki Metallov, AN SSSR (Institute of Metal Physics, AS USSR)

SUBMITTED: 18th July 1957.

SOV/126-6-5-43/43

AUTHORS: Shur, Ya.S., and Glazer, A.A.

TITLE: Thermomagnetic Treatment and Ordering Processes (Termomagnitnaya obrabotka i protsessy uporyadocheniya) Part III. Investigation of the Effect of Thermomagnetic Treatment on the Magnitude of Electrical Resistance of Ordering Soft Magnetic Alloys (III. Issledovaniye vliyaniya termomagnitnoy obrabotki na velichinu elektrosoprotivleniya uporyadochivayushchikhsya myagkikh magnitnykh splavov)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 5, pp 958-960 (USSR)

ABSTRACT: 1. Earlier papers published by the authors (Refs 1,2) dealt with the effect of thermomagnetic treatment (t.m.t.) on ordering processes; it was shown that as a result of t.m.t., a new structural state may appear, which is different from the ordered and disordered states. These results were obtained by measurements of purely magnetic properties of certain alloys. To obtain a fuller picture of this new structural state, it was desirable to study also other physical properties, especially electrical resistance, which is a sensitive indication of the degree of ordering in alloys. The authors (Ref 2) showed that measurements of electrical resistance of ordering soft

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Thermomagnetic Treatment and Ordering Processes. Part III. Investigation of the Effect of Thermomagnetic Treatment on the Magnitude of Electrical Resistance of Ordering Soft Magnetic Alloys

magnetic alloys of various structures may answer the following two questions in connection with the new structural state: a) whether the superstructure of an ordered sample is disrupted by subsequent annealing in a magnetic field at a temperature lower than the critical temperature of ordering T_c ; b) whether the presence of a magnetic field during annealing of a disordered sample at a temperature lower than T_c affects the kinetics of ordering. The present paper deals with these two questions.

2. Electrical resistance of 78-Permalloy and Perminvar alloys, in the form of strips of 60 x 4 x 0.2 mm dimensions, was measured. Measurements were carried out by a compensation method using a low-resistance Dusselhorst potentiometer with a relative error of 0.08%. In addition to electrical resistance R_o , the authors measured the value of electrical resistance R_s in a magnetic field which produces saturation of the samples.

Thermomagnetic Treatment and Ordering Processes. Part III. Investigation of the Effect of Thermomagnetic Treatment on the Magnitude of Electrical Resistance of Ordering Soft Magnetic Alloys

The value of R_s, in contrast to R_o, does not depend on magnetic texture. Both these quantities were measured at 0 °C (in a thermostat) and -196 °C (in liquid nitrogen). The effect of t.m.t. could be judged from the change of the coercive force H_c (at 20 °C), from R_o and from

$$\frac{\Delta R}{R} = \frac{R_s - R_o}{R_o} .$$

3. To answer the first question, samples were first ordered by 96-hour annealing at 460 °C and then annealed for 5 hours at 450 °C in a magnetic field of 200 Oe. Then the samples were hardened in vacuum by heating to 700 °C. After each such treatment (ordering, annealing in a magnetic field, hardening), values of R_o, R_s and H_c were measured. The results obtained are given in Table 1:

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Treatment	Temperature	78-Permalloy: H_c, Oe, 20 °C	78-Permalloy: $R_o \cdot 10^5$ Ω	78-Permalloy: $R_s \cdot 10^5$ Ω	78-Permalloy: $\frac{\Delta R}{R}$, %	Perminvar: H_c, Oe, 20 °C	Perminvar: $R_o \cdot 10^5$ Ω	Perminvar: $R_s \cdot 10^5$ Ω	Perminvar: $\frac{\Delta R}{R}$, %
96-hr annealing at 460 °C (ordering)	0 °C	0.21	1832	1858	1.41	0.57	4782	4792	0.21
	-196 °C		1151	1192	3.56		3838	3849	0.29
5-hr annealing at 450 °C in a field of 200 Oe (t.m.t.)									
Hardening in vacuum from 700 °C (disordering)									

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Thermomagnetic Treatment and Ordering Processes. Part III. Investigation of the Effect of Thermomagnetic Treatment on the Magnitude of Electrical Resistance of Ordering Soft Magnetic Alloys

Table 1 shows that R_0 and R_s of ordered and disordered samples differ markedly both at 0 °C and at -196 °C. The authors' results obtained at -196 °C contradict the results of Kondorskiy and Ozhigov (Ref 4), who reported a decrease of electrical resistance on ordering. This difference may be due to the difference in the degree of order (short-range and long-range) of the samples prepared by the authors and the samples used by Kondorskiy and Ozhigov. After t.m.t., the values of H_c and $\Delta R/R$ of 78-Permalloy fell a little, which indicates appearance of a weak magnetic texture. The value of R_s, which is not related to magnetic texture, was not affected. After t.m.t. of Perminvar (Table 1), the value of $\Delta R/R$ approached 0 due to appearance of clear magnetic texture. Again, the value of R_s remained unchanged within the limits of experimental error. The authors conclude from these results that

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Thermomagnetic Treatment and Ordering Processes. Part III. Investigation of the Effect of Thermomagnetic Treatment on the Magnitude of Electrical Resistance of Ordering Soft Magnetic Alloys

superstructure is not destroyed by t.m.t. of ordered samples at temperatures below T_c. If the superstructure was affected, the value of R_s at 0 °C would have decreased and the value of R_s at -196 °C would have increased.

4. To answer the second question, a hardened sample was annealed for 5 hours at 450 °C with and without a 20 Oe magnetic field. The results of measurement of H_c, R_o and R_s after each treatment are given in Table 2: (Heading as per Table 1)

Hardening in vacuum from 700 °C (disordering)
Annealing for 5 hrs at 450 °C (partial ordering)
Annealing for 5 hrs at 450 °C and 200 Oe (t.m.t.)

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Thermomagnetic Treatment and Ordering Processes. Part III. Investigation of the Effect of Thermomagnetic Treatment on the Magnitude of Electrical Resistance of Ordering Soft Magnetic Alloys

Table 2 shows that t.m.t. of disordered samples of 78-Permalloy and Perminvar produces a clear magnetic texture - in both alloys the value of $\Delta R/R$ decreases considerably. The value of R_s is the same irrespective of whether the sample was annealed with or without a field. In both cases, the value of R_s at 0 °C fell and at -196 °C increased compared with the value of R_s of a hardened sample. This shows that annealing produces ordering of samples. The authors conclude that the kinetics of ordering of 78-Permalloy and Perminvar is not affected if the samples are in a magnetic field during annealing. If the kinetics of ordering were affected by the presence of a magnetic field, then the value of R_s after 5-hour annealing at 450 °C in a field would have been different from the values after a similar annealing without a field.

5. The authors finally conclude that the special structural state produced by t.m.t. involves such a small

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number of atoms that formation or retention of the ordered structure is not affected. This is a complete translation. There are 2 tables and 4 Soviet references.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Metal Physics of the Ac.Sc.USSR)

SUBMITTED: July 5, 1958

USCOMM-DC-60,661

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SOV-26-58-11/9/49

AUTHOR: Kuznetsov, V.Ye.

TITLE: Investigations of the Magnetic Structure of Ferromagnetics (Issledovaniya magnitnoy struktury ferromagnetikov). An All-Union Conference in Krasnoyarsk (Vsesoyuznoye soveshchaniye v Krasnoyarske).

PERIODICAL: Priroda, 1958, Nr 11, pp 53-55 (USSR)

ABSTRACT: In June 1958 an All-Union meeting on the magnetic structure of ferromagnetics was convoked by the Institut fiziki AN SSSR (Institute of Physics of the AS USSR) and the Komissiya po magnetizmu Otdeleniya fiziko-matematicheskikh nauk AN SSSR (Commission for Magnetism of the Department of Physico-Mathematical Sciences of AS USSR) in Krasnoyarsk. The meeting was attended by representatives of scientific institutions of many principal cities of the USSR. A total of 32 papers were read. Ya.S. Shur of the Institut fiziki metallov AN SSSR (Institute of the Physics of Metals, AS USSR) in Sverdlovsk summarized the magnetic structure of ferromagnetics. G.V. Spivak of the Moskovskiy gosudarstvennyy universitet (Moscow State University) told of present and future electron-optical methods of study of the domain structure of ferromagnetics. L.V. Kirenskiy and M.K. Savchenko of the Institute of Physics of the AS USSR in Krasnoyarsk presented new data on the spatial distribution of the domain structure in samples of transformer iron. A.I.

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Investigations of the Magnetic Structure of Ferromagnetics

Sudovtsev and Ye.Ye. Semenenko of the Fiziko-technicheskiy institut AN USSR (Physico-Technical Institute of AS UkrSSR) in Khar'kov read a paper on the influence of the domain structure on the electrical conductivity of very pure iron. G.V. Spivak, V.Ye. Yurasova and Ye.I. Shishkina of Moscow University presented an original method of exposure of magnetic heterogeneity in metal. T.I. Prasova of the Verkh-Isetskiy metallurgicheskiy zavod (Verkh-Isetskiy Metallurgical Plant) told of experimental work carried out in cooperation with V.V. Druzhinin on the application of the method of powder patterns to the study of the magnetic properties of transformer steel. G.P. D'yakov of Moscow University spoke on the calculation of the domain structure in the theory of magnetization and magnetostriction of monocrystals. L.V. Kirpenskiy and I.F. Degtyarev of Krasnoyarsk read a paper on the temperature dependence of the domain structure of crystals of ferrosilicon. V.A. Zaykova and Ya.S. Shur reported on the results of a study of the influence of elastic stresses on the magnetic structure of the crystals of ferrosilicon. V.V. Veter of the Institute of Physics of the AS USSR in Krasnoyarsk reported on his original work conducted together

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Investigations of the Magnetic Structure of Ferromagnetics

with L.V. Kirenskiy on the determination of the width of the domain boundary; the method had been suggested by G.S. Krinchik. I.M. Puzey of the Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii, Moskva (Central Scientific Research Institute of Iron Metallurgy, Moscow) communicated the results of studies of the dynamics of the domain structure in a frequency range of up to several mhz. A.I. Drokin, D.A. Laptey, and R.P. Smolin (Krasnoyarsk) presented results of their studies of the temperature magnetic hysteresis on the points of the hysteresis loop. Nickel and iron-nickel alloy samples had been studied for this purpose. I.Ye. Startseva and Ya.S. Shur read a study of the structure of the residual magnetized ferromagnetic by aid of the method of powder patterns, and the change of this structure under the influence of a changing magnetic field. The papers of L.V. Kirenskiy, A.I. Drokin and V.S. Cherkashin dealt with the results of the influence of ultrasonic waves on the magnetic properties of ferromagnetics at various temperatures. Several papers were devoted to further investigations of the

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Investigations of the Magnetic Structure of Ferromagnetics

Barkhausen effect, the concept of which has been considerably extended by such Soviet researchers as R.V. Telesnin, Ye.P. Dzaganiya, V.F. Ivlev and others. Several papers dealt with transitional magnetic structure and temperature changes. The Physical Institute of the AS USSR in Krasnoyarsk, in 1957 opened the Stolby Game Reservation. The construction site of the Krasnoyarsk Hydroelectric Power Station was visited by the scientists.

1. Magnetostriction--Properties

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SOV/58-59-4-8357

Translation from: Referativnyy Zhurnal Fizika, 1959, Nr 4, p 143 (USSR)

AUTHOR: Shur, Ya.S.

TITLE: On the Magnetic Structure of High-Coercive Ferromagnetics Z/

PERIODICAL: Tr. In-ta fiz. metallov. Ural'skiy fil. AS USSR, 1958, Nr 20, pp 111-124

ABSTRACT: The article is a review of studies carried out by the Institute of the Physics of Metals of the Ural branch of the AS USSR. The bibliography contains 28 titles.

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SOV/58-59-5-10798

Translation from: Referativnyy Zhurnal Fizika, 1959, Nr 5, p 128 (USSR)

AUTHORS: Startseva, I.Ye., Shur, Ya.S.

TITLE: Magnetic Structure 21 of Iron Silicide Crystals 21 in a State of Residual Magnetization

PERIODICAL: Tr. in-ta fiz. metallov. Ural'skiy fil. AS USSR, 1958, Nr 20, pp 125 - 130

ABSTRACT: Using the powder figure method, the authors studied the magnetic structure of individual crystallites of polycrystalline iron silicide samples in a state of residual magnetization. The authors discovered that in each crystallite, in addition to the "basic" magnetic domains (magnetized in the directions of easy magnetization that are closest to the direction of the field by which the sample was first magnetized), there generally exist "reverse" and "supplementary" magnetic domains of various forms. In the "reverse" domains the spontaneous magnetization vectors are oriented antiparallel and in the "supplementary" domains either antiparallel or at an angle of 90° relative to the magnetization of the "basic" domains. The form of magnetic structure in a state of

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SOV/58-59-10-22821

Translation from: Referativnyy Zhurnal, Fizika, 1959, Nr 10, p 145 (USSR)

AUTHORS: Shur, Ya.S., Luzhinskaya, M.G., Vlasov, K.B., Shiryayeva, O.I., Zaykova, V.A.

TITLE: On the Relation Between the Magnetic Properties and Sensitivity of Magnetostrictive Receivers

PERIODICAL: Tr. In-ta fiz. metallov. Ural'skiy fil. AN SSSR, 1958, Nr 20, pp 131-140

ABSTRACT: The authors made an experimental study of the relation between the sensitivity of magnetostrictive receivers and the magnetic characteristics of a number of materials out of which they were produced. For this study soft magnetic materials were used that possess very dissimilar magnetic and magnetostrictive properties. It is demonstrated that for every receiver the greatest magnitude of sensitivity is attained at those values of the magnetizing field and that magnitude of induction, at which the greatest value of the product $\mu_{\sim} \cdot (\partial\lambda/\partial B)$ is obtained for the given material. The sensitivity of receivers made of different kinds of materials, measured at optimum polarization, is proportional to the

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On the Relation Between the Magnetic Properties and Sensitivity of Magnetostrictive Receivers

magnitudes $\mu_{\sim} \cdot (B_{opt}) (\partial \lambda / \partial B) (B_{opt})$, $\mu_{\sim} \cdot (B_{opt}) (\lambda_s / I_s)$, or $\mu_o (\lambda_s / I_s)$ obtained on these materials. It follows that if the static magnetic characteristics μ_o, λ_s, and I_s of the materials are known, then, using the correlation $e_{max} \sim \mu_o (\lambda_s / I_s)$, it is possible to make an approximate comparative estimate of the magnitude of sensitivity of magnetostrictive receivers produced from these materials. Cf abstract 22801.

V.A. Zaykova

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SOV/48-22-10-3/23

AUTHOR: Shur, Ya. S.

TITLE: Magnetic Structure and Processes of Technical Magnetization in Highly Coercive Ferromagnetic Materials (Magnitnaya struktura i protsessy tekhnicheskogo namagnichivaniya v vysokokoertsitivnykh ferromagnetikakh)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1177 - 1180 (USSR)

ABSTRACT: At the Institut fiziki metallov (Institute of Metal Physics) already for several years investigations on the structure of highly coercive ferromagnetic materials have been carried out. In the present paper some basic results of these investigations are presented. It has been found that the magnetic properties of ferromagnetic materials change with varying magnetic structure according to a law. The magnetic structure becomes simplified if the size of the ferromagnetic body decreases; the processes of technical magnetizing are then rendered more difficult. In small particles of ferromagnetic materials the highly coercive state can occur only when a transition- or a one-domain structure exists. The dimensions of the particles occurring in these magnetic

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Magnetic Structure and Processes of Technical Magnetization in Highly Coercive Ferromagnetic Materials

structures depend on the physical properties of the ferromagnetic material and to a considerable degree are determined by its magnetic anisotropy. These conceptions permit only a qualitative judgement on the structure of highly coercive alloys. Many details of this structure still remained unexplained. A further thorough investigation of the magnetic structure of this class of ferromagnetic materials is of great importance for the whole problem of highly coercive alloys. A detailed survey on this problem is published in "Trudy instituta fiziki metallov" (Ref 15). There are 15 references, 14 of which are Soviet.

ASSOCIATION: Institut fiziki metallov Akademii nauk SSSR (Institute of Metal Physics, AS USSR)

Card 2/2

SOV/48-22-10-5/23

AUTHORS: Zaykova, V. A., Shur, Ya. S.

TITLE: The Change of the Magnetic Structure of Iron Silicate Crystals Under the Action of Elastic Strain (Izmeneniye magnitnoy struktury kristallov kremnistogo zheleza pod deystviyem uprugikh napryazheniy)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1185 - 1189 (USSR)

ABSTRACT: In the present paper the authors investigated the change of the magnetic structure under the action of elastic tension-stresses. They intended to find general rules governing the change of the magnetic structure of ferromagnetic crystals in the case of one-sided elastic stress. The investigations resulted the following: Under the influence of an elastic stress considerable changes in the magnetic structure of iron silicate crystals take place. These changes are represented by the shift of the boundaries, the change of the supplementing and boundary domains, and the change of the type of the magnetic structure. They depend on the strain value, on the nature of the original magnetic structure, and on the orientation of the strain with respect

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The Change of the Magnetic Structure of Iron Silicate Crystals Under the Action of Elastic Strain

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to the crystallographic axes. The change of the magnetic structure of the crystal with varying strain is irreversible. Qualitatively the results may be explained as follows: It is assumed that under the influence of elastic strain an orientation of $\vec{I}_s$ into the direction of the strain takes place; the domains with minimum values of the boundary energy becomes displaced in the crystal; the tetragonal axis which is nearest to the orientation of the strain becomes the orientation of the weak magnetization. It may be assumed that the change of the magnetic structure under the action of elastic strains will exhibit qualitatively the same character also in other weakly magnetic materials. This is especially true of triaxial ferromagnetic materials. There are 2 figures and 5 references, 3 of which are Soviet.

ASSOCIATION: Institut fiziki metallov Akademii nauk SSSR (Institute of Metal Physics, AS USSR)

Card 2/2

SOV/48-22-10-6/23

AUTHORS: Startseva, I. Ye., Shur, Ya. S.

TITLE: The Magnetic Structure of a Ferromagnetic Substance With Remanent Magnetization and Its Change When Demagnetized by an Alternating Field (Magnitnaya struktura ostatochno namagnichennogo ferromagnetika i yeye izmeneniye pri razmagnichivanii peremennym polem)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1189 - 1193 (USSR)

ABSTRACT: In previous papers (Refs 1 and 2) assumptions concerning some particular features of the magnetic structure of a ferromagnetic material with remanence ($\vec{I}_r$) and their influence on the stability of remanence was made. In the present paper these assumptions are checked by means of a direct observation of the structure in the case of presence of a remanent magnetization as well as in the case of its annihilation by an alternating magnetic field. Because of observations of powder patterns on the surface of single crystal grains of the polycrystalline samples the following conclusions could be deduced: In a state of remanence in crystals apart from the magnetic ground domains also inverse

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The Magnetic Structure of a Ferromagnetic Substance With Remanent Magnetization and Its Change When Demagnetized by an Alternating Field

(obratnyye) and supplementary (dopolnitel'nyye) domains of various kinds exist, among them also sub-domains. The existence of these domains leads to a decrease of the remanence which is greater as compared to the theoretical value. In the state of remanence the nature of the magnetic structure depends on the crystallographic orientation of the crystal surface and on the orientation of the magnetizing field with respect to the crystallographic axes. Supplementary and inverted domains decrease the resistance of the magnetic structure to the demagnetizing influences. Sub-domains usually do not change into inverted domains. Changes in the magnetic structure of a crystal with remanence at a demagnetization take place in the following way: Some supplementary surface-domains change into inverted domains by growing. These inverted domains expand with the increase of the amplitude of the alternating field. In the case of even stronger alternating fields sometimes a disintegration of the inverted domains can be observed. In polycrystals the nature of the magnetic structure of single crystal grains

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The Magnetic Structure of a Ferromagnetic Substance With Remanent Magnetization and Its Change When Demagnetized by an Alternating Field

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with remanence as well as the change of the structure at a demagnetization is considerably influenced by the crystallographic orientation of neighboring grains. There are 4 figures and 8 references, 6 of which are Soviet.

ASSOCIATION: Institut fiziki metallov Akademii nauk SSSR (Institute of Metal Physics, AS USSR)

Card 3/3

SOV/48-22-10-9/23

AUTHORS: Glazer, A. A., Shur, Ya. S.

TITLE: On the Nature of the Effect of Thermomagnetic Treatment on Magnetically Soft Ferromagnetic Materials (O prirode effekta termomagnitnoy obrabotki v magnitnomyagkikh ferromagnetikakh)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1205 - 1211 (USSR)

ABSTRACT: No conclusive experimental data have hitherto been presented indicating a connection between the effect of the thermomagnetic treatment and the process of coordination. In the present work the authors examined the problem, whether such a connection exists. The temperature range in which the thermomagnetic treatment is effective was determined. The influence of the thermomagnetic treatment upon the temperature dependence of the saturation magnetization was investigated. The kinetics of thermomagnetic treatment of coordinated and non-coordinated alloys as well as the kinetics of coordination of thermomagnetically treated alloys were examined. The investigations showed that the long-range order does not play any decisive role in the mechanism of the thermomagnetic treatment. This obviously proceeds

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firstly from the fact that the thermomagnetic treatment is effective also at temperatures higher than the critical temperature, and secondly that after the thermomagnetic treatment the saturation magnetization remains the same as in the disordered state. The state appearing after the thermomagnetic treatment is not the same as in the case of a common disordered distribution of the atoms. The kinetics of coordination is different in disordered and in thermomagnetically treated samples. The state occurring due to a thermomagnetic treatment differs from the coordinated as well as from the disordered state and leads to a magnetic uniaxiality. Apparently it is a particular structural state in the formation of which only a small number of atoms are participating. As this state is destroyed if coordination occurs due to the action of electrostatic forces it may be assumed that this structure is formed under the action of magnetic forces. Such a structure was predicted by Neel (Ref 4). There are 4 figures, 1 table, and 6 references, 1 of which is Soviet.

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On the Nature of the Effect of Thermomagnetic Treatment on Magnetically Soft Ferromagnetic Materials

ASSOCIATION: Institut fiziki metallov Akademii nauk SSSR (Institute of Metal Physics, AS USSR)

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SOV/48-22-10-18/23

AUTHORS: Shur, Ya. S., Luzhinskaya, M. G., Vlasov, K. B., Shiryayeva, O. I., Zaykova, V. A.

TITLE: On the Dependence of the Sensitivity of Magnetostrictive Receivers on Their Magnetostrictive Characteristics (O zavisimosti chuvstvitel'nosti magnitostriktsionnykh priyemnikov ot ikh magnitnykh kharakteristik)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1259 - 1262 (USSR)

ABSTRACT: According to theoretical calculations (Refs 1 - 3) the sensitivity of the magnetostrictive receiver can be related to the magnetic characteristics of the material of the receiver as follows:

$$e \sim \mu_{\sim} \frac{\partial\lambda}{\partial B} \quad (1)$$

$$e_{max} \sim \mu_{\sim} (B_{opt.}) \frac{\lambda_s}{I_s} \quad (2)$$

$$e_{max} \sim \mu_0 \frac{\lambda_s}{I_s} \quad (3)$$

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On the Dependence of the Sensitivity of Magnetostrictive Receivers on Their Magnetostrictive Characteristics

The symbols denote: e - sensitivity, $\mu_{\sim}$- apparent permeability, λ- magnetostriction, B - induction, λ_s - saturation magnetostriction, I_s - saturation magnetization, μ_o- initial permeability, e_{max} - maximum sensitivity of the receiver at a certain optimum value of the induction of the polarization B_{opt}. In the present paper the above-mentioned theoretical relations and their possible application in the selection of the material for magnetostrictive receivers were checked by experiment. Materials with widely differing magnetic properties were investigated. The measurements showed that after different treatment the alloys exhibited widely differing magnetic properties and sensitivities. From experimental data can be seen that in the case of a modification of the magnetic state of the concerned receiver its sensitivity varies according to formula (1). The relations (2) and (3), which relate the maximum values of the receiver sensitivity of various alloys, are satisfied less exactingly. One of the reasons for this disagreement might be errors in the experimental determination of various characteristics.

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On the Dependence of the Sensitivity of Magnetostrictive Receivers on Their Magnetostrictive Characteristics

The results show that when formula (3) is employed an approximate comparative estimation of the sensitivity of the material can be given if the values of μ_0, λ_s, and I_s are known. Detailed results of this work are published in reference 3. There are 3 figures and 3 references, 1 of which is Soviet.

ASSOCIATION: Institut fiziki metallov Akademii nauk SSSR (Institute of Metal Physics, AS USSR)

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SOV/48-22-10-20/23

AUTHORS: Shtol'ts, Ye. V., Shur, Ya. S., Kandaurova, G. S.

TITLE: On the Anisotropy of the Coercive Force in Magnetically Anisotropic Samples of Fine Powder (Ob anizotropii koertsitivnoy sily v magnitnoanizotropnykh obraztsakh iz tonkikh poroshkov)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1269 - 1272 (USSR)

ABSTRACT: In the present paper the authors give a report on measurements of the coercive force of uniaxial magnetic powder produced from the following substances: Cobalt, Mn-Bi-alloy, magnetite, and iron-γ-oxide. The angular dependence of the coercive force of various powder samples is shown in figure 1. A comparison of the curves shows that in textured samples made of magnetically uniaxial powders the angular dependences of H_c may exhibit a different character. The process of the technical magnetization in directions close to the axis of texture differs from the process of irreversible rotation. Probably this is caused by the fact

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that the one-domain structure in the particles has not yet completely been reached. The investigation of other rules governing the magnetic properties of fine powders results in the assumption that these particles exhibit a particular domain structure (Ref 4): In one particle only one basic domain and several closing domains exist. As a consequence of this the formation, the growth, and the diminuition of the closing domains plays a decisive role in the process of technical magnetization. The assumption of the existence of such a domain structure is confirmed by observations of powder patterns (Ref 5). In the case of a poly-domain structure the coercive force varies inversely as $\cos\varphi$ (Ref 6). Therefore the coercive force increases with increasing angle φ. A complicated dependence of $H_c(\varphi)$ exhibiting a maximum at a certain value of φ which varies between $\varphi = 0$ and $\varphi = 90^{\circ}$ may be expected. Such a regularity was observed in samples of cobalt, magnetite, and iron-γ-oxide powder. In this case the structure apparently approximates the poly-domain structure. The magnitude of H_c of these powders,

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however, is considerably higher than that of the respective massive substances. In the examined substances a change of the anisotropic character was not observed when the dimensions of the particles were modified. A change in the anisotropy of H_c together with the diminution of the particles was found in the investigation of magnetically anisotropic samples consisting of powder of the "low-coercive" Mn-Bi alloy. The dependence of H_c (φ) found in this instance is given in figure 2. In powder of the low-coercive Mn-Bi alloys the diminution of the particles leads to a change in their magnetic structure which can be determined from the shape of the angular dependence of the coercive force. The observation results and their analysis show that in magnetically anisotropic ferromagnetics the data on the anisotropy of the coercive force besides other characteristics may give certain indications concerning the magnetic structure. There are 2 figures and 7 references, 5 of which are Soviet.

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On the Anisotropy of the Coercive Force in Magnetically Anisotropic Samples of Fine Powder

ASSOCIATION: Institut fiziki metallov Akademii nauk SSSR (Institute of Metal Physics, AS USSR) Fiziko-matematicheskiy fakul'tet Ural'skogo gos. universiteta (Physics and Mathematics Dept. at the Ural State University)

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SOV/48-22-10-21/23

AUTHORS: Baranova, N. A., Shur, Ya. S.

TITLE: The Question of the Temperature Dependence of Magnetic Properties of Highly Coercive Alloys (K voprosu o temperaturnoy zavisimosti magnitnykh svoystv vysokokoertsitivnykh splavov)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1272 - 1275 (USSR)

ABSTRACT: The present paper examines the course of temperature for the fundamental magnetic characteristics of magnetically anisotropic, highly coercive Alnico and Vicalloy alloys. Alnico - 51% Fe, 24% Co, 14% Ni, 8% Al, 3% Cu; Vicalloy - 35% Fe, 52% Co, 13% V. As is known, Vicalloy, in a highly coercive state, consists of 2 phases: the ferromagnetic α-phase and the paramagnetic γ-phase. Due to the fact that one phase only is ferromagnetic, the temperature dependence of the saturation magnetization of Vicalloy shows no peculiarities whatsoever. In the Alnico alloy, which is also of a two-phase composition in a highly coercive state, both phases are ferromagnetic. But they differ in the value

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The Question of the Temperature Dependence of Magnetic Properties of Highly Coercive Alloys

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of the saturation magnetization I'_s and have different Curie points. At an increase of temperature, the value of I'_s becomes smaller for each phase. There are 2 causes exerting influence upon the value of the coercive force in the Alnico alloy: a reduction of the interaction of the one-domain structures leads to an increase of the coercive force with temperature; the dependence of H_c on I_s causes a reduction of H_c with temperature. Consequently, a maximum can be observed on the curve $H_c(T)$ of the Alnico alloy. In the Vicalloy alloy, which has just one ferromagnetic phase, the coercive force decreases with temperature only. This is to be explained by the reduction of the saturation magnetization of the alloy at an increase of temperature. There are 4 figures and 4 references, 3 of which are Soviet.

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The Question of the Temperature Dependence of Magnetic Properties of Highly Coercive Alloys

ASSOCIATION: Institut fiziki metallov Akademii nauk SSSR (Institute of Metal Physics, AS USSR)

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67684
SOV/126-8-4-5/22

18.1142

AUTHORS: Luzhinskaya, M.G., Shur, Ya.S., and Yagovkina, N.N.

TITLE: Influence of Combined Heat and Mechanical Treatment in which Stresses are Produced by Means of Torsion of the Specimen, on the Magnetic Properties of the Vickalloy

PERIODICAL: Fizika metallov i metallovedeniye, Vol 8, Nr 4, 1959, pp 531-534 (USSR)

ABSTRACT: The authors have previously shown (Refs 1, 2) that by applying tension during the heat treatment of Fe-Co-V Vickalloy-type high-coercivity alloys, the coercive force, remanence and maximum magnetic energy in the direction of tension could be increased. It could not be found, however, which of the various possible factors produced the coercive-force increase. To settle this question the authors have now studied the influence of a different type of stress, torsional, applied during heat treatment, on the magnetic properties. The alloy composition (%) was 12 V, 52 Co, remainder Fe, specimens being in the form of wire 0.6 mm in diameter and about 100 mm long. During tempering one end was held stationary, the other was attached to the axis of a

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Influence of Combined Heat and Mechanical Treatment in which Stresses are Produced by means of Torsion of the Specimen, on the Magnetic Properties of the Vickalloy

pulley round which passed a thread holding a weight: the arrangement gave a constant torsion moment, the weight being chosen to keep the specimen twisted through the required angle. Magnetization curves and hysteresis loops were obtained by the ballistic method. Fig 1 (tempering at 600 °C for 30 min) shows that with increasing angle of twist the coercive force first rises and then falls; the remanence value only falls; the value of the magnetization at 2000 oersted (close to saturation) remains constant at low angles but falls at higher angles. Similar results were obtained with tempering temperatures of 500, 550 and 620 °C. Fig 2 shows changes in the same magnetic properties for tensile stressing of a 1 mm diameter specimen of the same composition during tempering at 575 °C for 20 minutes. The effect of tension is qualitatively similar to those of torsion on coercive force and saturation magnetization, but with tension the remanence first increases slightly before falling as the stress rises further. The authors

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Influence of Combined Heat and Mechanical Treatment in which Stresses are Produced by means of Torsion of the Specimen, on the Magnetic Properties of the Vickalloy

propose a single explanation for the effects of both types of stress (Ref 1).
There are 2 figures and 3 Soviet references.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Physics of Metals, Ac. Sc. USSR)

SUBMITTED: March 23, 1959

Card 3/3

67753

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SOV/126-8-5-5/29

AUTHORS: Shur, Ya.S., Shtol'ts, Ye.V., Kandaurova, G.S., and Redneva, L.V.

TITLE: The Temperature Dependence of Magnetic Properties of MnBi Alloy Powder Samples with Magnetic Texture

PERIODICAL: Fizika metallov i metallovedeniye, Vol 8, 1959, Nr 5, pp 678-684 (USSR)

ABSTRACT: The authors studied the temperature dependence of magnetic properties of samples made of the MnBi alloy powder. This alloy has a very high magnetic anisotropy constant K at room temperature (Ref 4) and a high value of the critical particle size, d_{cr} (below this size the powder particles exist in monodomain state only). On lowering of temperature the value of K falls sharply and this is accompanied by a sharp fall of the critical particle size d_{cr}, which is a function of K. It follows that on lowering of temperature the magnetic structure of MnBi alloy powders will be altered (a polydomain-monodomain transition will occur) and this change of structure will affect some magnetic properties. Consequently we can make some deductions about the structure of this magnetically uniaxial material from

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The Temperature Dependence of Magnetic Properties of MnBi Alloy Powder Samples with Magnetic Texture

the temperature dependence of its magnetic properties. The alloy was produced by heating powders of Mn and Bi together at 300 °C and its coercive force was of the order of 1000 Oe. The alloy was powdered mechanically and several fractions of the powder with particle size from 2 to 20 μ were obtained. Samples were made from each fraction by mixing the powder with a binder and by placing this mixture in a disk-like form and allowing it to set between two poles of an electromagnet. In this way magnetically textured samples were obtained whose texture axis lay along the direction of the electromagnet field. Magnetic properties were measured between 20 and -150 °C using a ballistic throw method. Samples were demagnetized at the temperature at which a particular set of measurements were carried out by a suitable constant magnetic field in the reverse direction. The angular dependences of the coercive force and residual magnetization were obtained, magnetization curves were recorded and dependence of the residual magnetization (for partial magnetization cycles) on the magnitude of

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The Temperature Dependence of Magnetic Properties of MnBi Alloy Powder Samples with Magnetic Texture

the maximum field used to magnetize the sample were found. The main results are given in Figs 1-4. Fig 1 shows the angular dependence of the coercive force of a sample made from powder with 6 μ particle size at temperatures of +20, -40, -65, -90 and -150 °C (curves 1-5 respectively). The abscissa represents φ which is the angle between the texture axis and the direction of the magnetic field used in measurements. The ordinate represents the ratio of the coercive force H_c measured in the direction of φ and the coercive force, H_c^o, along the texture axis (φ = 0°). Fig 2 shows the angular dependence of the relative coercive force, H_c/H_c^o, of samples made of powders with particle sizes of 20, 6, 3 and 2 μ (curves 1-4 respectively); all the results in Fig 2 were obtained at -65 °C. Fig 3 shows the temperature dependence of the relative residual magnetization (defined as the ratio of the residual magnetization I_r to the saturation magnetization I_s) along the texture axis of samples made of

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The Temperature Dependence of Magnetic Properties of MnBi Alloy Powder Samples with Magnetic Texture

powders with 30 and 3 μ particle size (curves 1 and 2 respectively). Fig 4a shows the 20 °C dependence of the relative magnetization I/I_s (curve 1) and the relative residual magnetization I_r/I_s (curve 2) on the magnetic field intensity along the texture axis (The results of Figs 4a, 4b and 4B all refer to a sample made of powder with 6 μ particle size). Figs 4b and 4B give the same dependences at -37 °C and at -60 °C. The authors draw the following conclusions from their results. 1) On lowering of temperature the curves representing the angular dependence of the coercive force depart more and more from the theoretical curve $H_c(\psi)$ for a monodomain sample. This is due to a decrease of the anisotropy constant and consequent lowering of the magnitude of d_{cr} as a result of which the magnetic structure of powder particles changes gradually from monodomain to polydomain type. 2) At room temperature, when the anisotropy constant K and the critical particle size d_{cr} are large, the residual magnetization produced by partial magnetization

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cycles is close to the maximum magnetization of a complete cycle and the maximum residual magnetization is reached in the saturation field, i.e. the magnetic structure is practically monodomain. On lowering of temperature the values of K and d_{cr} decrease and the maximum residual magnetization remains close to the saturation magnetization but is reached in fields larger than the saturation field (transition structure). At low temperatures, i.e. when K and d_{cr} are low, the residual magnetization is small and is reached in fields lower than the saturation field (polydomain structure).

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There are 4 figures and 5 references, of which 3 are Soviet, 1 is English and 1 is French.

ASSOCIATION: Institut fiziki metallov, AN SSSR (Institute of Physics of Metals, Academy of Sciences USSR)

SUBMITTED: July 18, 1959

6775-

SOV/126-8-5-6/29

AUTHORS: Zhur, Ya.S., Shtol'ts, Ye.V. and Glazer, A.A.

TITLE: Change in the Domain Structure of Magnetically Uniaxial Ferromagnetics in a Magnetic Field

PERIODICAL: Fizika metallov i metallovedeniye, Vol 8, 1959, Nr 5, pp 685-688 (USSR)

ABSTRACT: Powder patterns, representing domain structure, were obtained for an MnBi crystal whose hexagonal axis (easy magnetization axis) practically coincides with the sample surface. In the absence of an external field the whole crystal is seen to consist of domains, whose boundaries appear as black lines due to powder deposits (Fig 1a); these boundaries separate regions with antiparallel orientation of magnetization Is. When a magnetic field is applied at right angles to Is and gradually increased to 600 Oe (Fig 1b) the powder deposits at some domain boundaries become broader and thinner at others. A further increase of the applied field to 3000 Oe (Fig 1B) produces complete disappearance of those boundaries which were gradually becoming thinner and thinner. Such a change in the domain structure contradicts the accepted theories, indicating that the

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A Change in the Domain Structure of Magnetically Uniaxial Ferromagnetics in a Magnetic Field

results obtained by the powder-pattern technique in strong fields are open to question. For this reason the authors studied domain structure of MnBi in two ways: using the powder-pattern technique and the magneto-optical polar Kerr effect (Ref 3). The latter technique showed the domain surfaces rather than the domain boundaries. The Kerr effect results are shown in Fig 2. Fig 2a represents the domain structure in zero external field; the boundaries between the dark and light regions coincide exactly with the boundaries found by the powder-pattern technique (Fig 1a). The Kerr effect shows (Fig 2b) that application of a 3000 Oe field at right angles to the domain boundaries does not affect the initial domain structure. Both methods of domain-structure study can be used simultaneously: domains are revealed by the Kerr effect in a polarizing microscope and the same microscope is used to observe simultaneously the magnetic powder patterns. The results (Fig 3) show clearly that in strong fields the powder-pattern technique fails to show the true domain structure in

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A Change in the Domain Structure of Magnetically Uniaxial Ferromagnetics in a Magnetic Field

magnetically uniaxial crystals when the latter are subjected to magnetic fields at right angles to the easy magnetization axis. One possible reason for this effect may be an interaction between the external magnetic field and the ferromagnetic particles used in the powder-pattern technique (Ref 2). It is also possible that the effect is due to some complex processes occurring at the domain boundaries themselves. Using the Kerr effect the authors found that when fields of increasing intensity are applied at right angles to the easy-magnetization axis the domains are gradually distorted, are split into smaller parts and finally disappear on approach to saturation. The authors conclude that the magnetization process in a magnetically uniaxial ferromagnetic in field. at right angles to the easy magnetization axis involves rotation of the magnetization vectors in each domain in such a way as to reach alignment with the field direction.

There are 3 figures and 3 references, of which 2 are English and 1 mixed (English and Russian).

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A Change in the Domain Structure of Magnetically Uniaxial Ferromagnetics in a Magnetic Field

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ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Physics of Metals, Academy of Sciences, USSR)

SUBMITTED: August 21, 1959

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SHUR, Ya. S.

PHASE I BOOK EXPLOITATION SOV/4893

Vsesoyuznoye soveshchaniye po fizike, fiziko-khimicheskim svoystvam ferritov i fizicheskim osnovam ikh primeneniya. 3d, Minsk, 1959

Ferrity; fizicheskiye i fiziko-khimicheskiye svoystva. Doklady (Ferrites; Physical and Physicochemical Properties. Reports) Minsk, Izd-vo AN BSSR, 1960. 655 p. Errata slip inserted. 4,000 copies printed.

Sponsoring Agencies: Nauchnyy sovet po magnetizmu AN SSSR. Otdel fiziki tverdogo tela i poluprovodnikov AN BSSR.

Editorial Board: Resp. Ed.: N. N. Sirota, Academician of the Academy of Sciences BSSR; K. P. Belov, Professor; Ye. I. Kondorskiy, Professor; K. M. Polivanov; Professor; R. V. Telesnin, Professor; G. A. Smolenskiy, Professor; N. N. Shol'ts, Candidate of Physical and Mathematical Sciences; E. M. Smolyarenko; and L. A. Bashkirov; Ed. of Publishing House: S. Kholyavskiy; Tech. Ed.: I. Volokhanovich.

PURPOSE: This book is intended for physicists, physical chemists, radio electronics engineers, and technical personnel engaged in the production and use of ferromagnetic materials. It may also be used by students in advanced courses in radio electronics, physics, and physical chemistry.

COVERAGE: The book contains reports presented at the Third All-Union Conference on Ferrites held in Minsk, Belorussian SSR. The reports deal with magnetic transformations, electrical and galvanomagnetic properties of ferrites, studies of the growth of ferrite single crystals, problems in the chemical and physicochemical analysis of ferrites, studies of ferrites having rectangular hysteresis loops and multicomponent ferrite systems exhibiting spontaneous rectangularity, problems in magnetic attraction, highly coercive ferrites, magnetic spectroscopy, ferromagnetic resonance, magneto-optics, physical principles of using ferrite components in electrical circuits, anisotropy of electrical and magnetic properties, etc. The Committee on Magnetism, AS USSR (S. V. Vonsovskiy, Chairman) organized the conference. References accompany individual articles.

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Ferrites (Cont.)

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SHUR, Ya. S.

SOV/5526

PHASE I BOOK EXPLOITATION

Vsesoyuznoye soveshchaniye po magnitnoy strukture ferromagnetikov, Krasnoyarsk, 1958.

Magnitnaya struktura ferromagnetikov; materialy Vsesoyuznogo soveshchaniya, 10 - 16 iyunya 1958 g., Krasnoyarsk (Magnetic Structure of Ferromagnetic Substances; Materials of the All-Union Conference on the Magnetic Structure of Ferromagnetic Substances, Held in Krasnoyarsk 10 - 16 June, 1958) Novosibirsk, Izd-vo Sibirskogo otd. AN SSSR, 1960. 249 p. Errata slip inserted. 1,500 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Institut fiziki Sibirskogo otdeleniya. Komissiya po magnetizmu pri Institute fiziki metallov OFMN.

Resp. Ed.: L. V. Kirenskiy, Doctor of Physical and Mathematical Sciences; Ed.: R. L. Dudnik; Tech. Ed.: A. F. Mazurova.

PURPOSE: This collection of articles is intended for researchers in ferromagnetism and for metal scientists.

Card 1/11

SOV/5526

Magnetic Structure (Cont.)

COVERAGE: The collection contains 38 scientific articles presented at the All-Union Conference on the Magnetic Structure of Ferromagnetic Substances, held in Krasnoyarsk in June 1958. The material contains data on the magnetic structure of ferromagnetic materials and on the dynamics of the structure in relation to magnetic field changes, elastic stresses, and temperature. According to the Foreword the study of ferromagnetic materials had a successful beginning in the Soviet Union in the 1930's, was subsequently discontinued for many years, and was resumed in the 1950's. No personalities are mentioned. References accompany individual articles.

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APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001550220015-0"

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Magnetic Structure (Cont.)

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Magnetic Structure (Cont.)

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SOV/5526

S/046/60/006/01/26/033
B008/B011

AUTHORS: Sokolov, A. D., Shur, Ya. S.

TITLE: On the Relationship Between Magnetic Properties and Sensitivity of Nickel - Zinc - Ferrite Magnetostriction Receivers

PERIODICAL: Akusticheskiy zhurnal, 1960, Vol. 6, No. 1, pp. 131-133

TEXT: The relation $e_{max} \sim \mu_o \frac{\lambda_s}{I_s}$ used for the estimation of sensitivity was experimentally checked on ferrite receivers. e_{max} - peak value of the electromotive force which is induced in the receiver winding under a given sound pressure and with an optimum magnetization; μ_o - initial magnetic permeability of the receiver material; λ_s - saturation magnetostriction; I_s - saturation magnetization. Measurements were made on samples in the form of ferrite rings and bars of various composition (Table). The measurement results are shown in the table and in the figure. The figure shows that the relation mention is almost linear. The deviations may have been

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On the Relationship Between Magnetic Properties and Sensitivity of Nickel - Zinc - Ferrite Magnetostriction Receivers

S/046/60/006/01/26/033
B008/B011

partly caused by the fact that the receivers had not exactly the same geometrical dimensions. Moreover, measurements of the magnetic characteristics of the material were inaccurate. The results obtained confirm the accuracy of the relation for nickel- and nickel-zinc ferrites. Hence it is possible, on the strength of static magnetic characteristics, to undertake a comparative estimation of the sensitivity of nickel-zinc-ferrite receivers. There are 1 figure, 1 table, and 5 references: 4 Soviet and 1 English.

ASSOCIATION: Institut fiziki metallov AN SSSR, Sverdlovsk (Institute of Metal Physics AS USSR, Sverdlovsk)

SUBMITTED: November 10, 1958

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Card 2/2

86033

S/126/60/009/02/024/033
E073/E335

18.1141

AUTHORS: Luzhinskaya, M.G., Fremderman, L.O. and Shur, Ya.S.

TITLE: On the Dependence of the Effect of Thermomagnetic Treatment on the Initial Properties of Permalloy 18

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol 9, Nr 2, pp 300 - 302 (USSR)

ABSTRACT: In earlier work (Ref 7) A.A. Lukshin and one of the authors studied the dependence of the effect of thermomagnetic treatment on the initial characteristics of ferromagnetic alloys for the case that differences in the initial properties are due to differing purities of the material or variations in its chemical composition. The work described in this paper is devoted to the study of the relation between the effect of thermomagnetic treatment and the degree of perfection of the crystal lattice, in cases in which there is no change in the chemical composition of the material. The investigations were effected on a 66 permalloy (66% Ni, rest Fe), a material which is highly sensitive to thermomagnetic treatment. The differing degrees of distortions of the crystal lattice were obtained by

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On the Dependence of the Effect of Thermomagnetic Treatment on the Initial Properties of Permalloy

cold drawing followed by heat treatment. Depending on the degree of preliminary deformation relaxation, partial or full recrystallization will take place, which leads to obtaining greatly differing magnetic properties (Ref 8). Specimens 150 x 5 x 0.1 mm were cut from cold-rolled strip, annealed in vacuo at 950 °C for one hour and drawn to gain residual elongations between 0 and 10%. Following that, all the specimens and also some in the as cold-rolled state were heated to 800 °C for two hours and then cooled with a speed of 100 °C/h. The H_c values for the specimen in this initial state are given in the fourth column of the table, p 301. These specimens were then subjected to thermomagnetic treatment consisting of heating to 700 °C and holding at that temperature for 30 min and cooling at the speed of 100 °C/h in a magnetic field of a potential of 300 Oe; the H_c values obtained after this thermomagnetic treatment are entered in the

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On the Dependence of the Effect of Thermomagnetic Treatment on the Initial Properties of Permalloy

fifth column of the table. After this treatment the specimens were again held at 700 °C for 30 min and cooled at a speed of 100 °C/h without the magnetic field; the resulting H_c values are entered in the sixth column of the table and it can be seen that the values are in good agreement with those obtained for specimens in the initial state (column 4), which shows that the change in the coercive force gained by the thermomagnetic treatment was due solely to the effect of the magnetic field. In the last column of the table, the ratios of the H_c values, after cooling in the absence of the magnetic field, to those obtained after cooling in the presence of the magnetic field are given; the lower the H_c values in the initial state the greater was the effect of the thermomagnetic treatment. The obtained results lead to the conclusion that the effect of the thermomagnetic treatment depends on the state of the crystal lattice of a given alloy, the degree of perfection of which is associated

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On the Dependence of the Effect of Thermomagnetic Treatment on the Initial Properties of Permalloy

with the conditions of preliminary heat treatment; the more perfect the crystal lattice of a material, the greater will be the influence of thermomagnetic treatment on its magnetic properties. It is likely that the process of ordering progresses to a greater extent in non-deformed material and becomes the less pronounced the greater the degree of deformation of the material. It is also possible that the magnetic texture which is produced by thermo-magnetic treatment manifests itself differently, depending on the background of the lattice distortions, particularly depending on the differing background of non-uniform stresses which create sections which are locally uniaxial from the magnetic point of view.
There are 1 table and 8 references, 1 of which is French, 2 English and 5 Soviet.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Metal Physics of the Ac.Sc., USSR)

SUBMITTED: September 26, 1959

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69702
S/126/60/009/03/028/033
E032/E414

18.1141

AUTHORS: Glazer, A.A., Magat, L.M. and Shur, Ya.S.

TITLE: Thermomagnetic Treatment and Ordering Processes. IV. A Study of the Effect of Thermomagnetic Treatment on the Crystal Lattice Parameter in the Case of Ordering Soft Magnetic Alloys

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol 9, Nr 3, pp 467-469 (USSR)

ABSTRACT: It has been shown experimentally that thermomagnetic treatment (cooling in a magnetic field) in the case of soft magnetic materials, which leads to the appearance in the ferromagnetic of single axis magnetism, is effective only in ordering alloys. In the present work, a study was made of the crystal lattice parameter in the case of 78-permalloy (78% Ni, 22% Fe) and perminvar (34% Fe, 29% Co, 34% Ni, 3% Mo). The specimens were in the form of strips 60 x 4 x 0.2 mm. The magnetic and electrical properties of the specimens were reported earlier (Ref 1,2). The lattice parameter was determined for specimens in different structural states namely, disordered, ordered, after thermomagnetic treatment, and

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Thermomagnetic Treatment and Ordering Processes. IV. A Study of the Effect of Thermomagnetic Treatment on the Crystal Lattice Parameter in the Case of Ordering Soft Magnetic Alloys

after annealing in the absence of the field. The disordered specimens were obtained by quenching from 700° and the ordered by 100-hour annealing at 450°. Thermomagnetic treatment consisted in the cooling of the specimens from 700 to 300° in a field of 200 oersted. The lattice parameter was determined by X-ray diffraction methods. The results obtained are summarized in a table on p 469 for 78-permalloy and perminvar specimens after the following heat treatments: quenching from 700°C (disordered), annealing at 450°C for 100 hours (ordered), cooling from 700°C at the rate of 200°C/hr in a magnetic field, cooling from 700°C at the rate of 200°C/hr with the field on. The following values are given: H_c, Oe (2nd and 5th columns); $\lambda_s \cdot 10^6$ (3rd and 6th columns) and the lattice parameter at 20°C in Å (4th and 7th columns). As can be seen from this table, the thermomagnetic treatment has very little effect on the lattice parameter. This indicates that the structural

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Thermomagnetic Treatment and Ordering Processes. IV. A Study of the Effect of Thermomagnetic Treatment on the Crystal Lattice Parameter in the Case of Ordering Soft Magnetic Alloys

changes which take place on annealing in a field, appear to confirm the hypothesis that only a small proportion of atoms take part in the setting up of the single axis magnetism which is produced as a result of thermomagnetic treatment. The usual ordering process does not play an important part in the mechanism of thermomagnetic treatment. There are 1 table and 4 references, 3 of which are Soviet and 1 English.

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ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Physics of Metals AS USSR)

SUBMITTED: July 15, 1959

Card 3/3

Shur, YA.S.

81901

18.8100
18.1275

S/126/60/010/01/003/019
E073/E335

AUTHOR: Kandaurova, G.S.. and Shur, Ya.S.

TITLE: Certain Magnetic Properties of Manganese - Bismuth Alloy Powders

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol.10, No.1, pp 37 - 41

TEXT: In earlier published work (Refs. 1 and 2) the authors detected a number of features in manganese-bismuth alloy powders which could be explained on the assumption that such powders possess a particular type of magnetic structure, a transient structure. Later on, this structure was detected experimentally by means of the powder-pattern method (Ref.3). The properties of the artificially textured powders were determined not only by the magnetic structure of the ferromagnetic particles but also by the presence of a magnetic structure, i.e. by the parallel orientation of the axes of easy magnetization of the individual particles. The authors considered it of interest to make a special study of the magnetic properties of isotropic (pseudo-crystalline) specimens from manganese-bismuth powders of various degrees of dispersion. It can be assumed in such a case that

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Certain Magnetic Properties of Manganese - Bismuth Alloy Powders

the magnetic properties of specimens are determined solely by the magnetic structure of the alloy. In the experiments, a magnetically uniaxial highly coercive MnBi alloy (H_c ≈ 1000 Oe) was studied. The grain size varied between 720 and 6 μ and the coercive force varied correspondingly between 1350 and 7000 Oe. The specimens were produced from powders of certain grain sizes which were carefully mixed with a binder and the mixture was poured into a mould 15 mm dia., 2 mm high. After hardening of the binder, disc-shaped specimens were obtained which consisted of randomly orientated MnBi particles interspaced with nonferromagnetic interlayers. The concentration of the MnBi powder in the specimens did not exceed 15% in volume. This quantity was sufficient for measuring the magnetic properties by means of a ballistic method but the concentration was low enough to disregard the magnetic interaction between the individual particles. Before the actual measurements the specimens were demagnetized by using three differing methods. The results of the measurements are

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Certain Magnetic Properties of Manganese - Bismuth Alloy Powders

plotted in Figs. 1-4. These show that the properties of the specimens were similar to those observed earlier in investigating magnetically anisotropic pseudo-single crystals of powder specimens and are due to the existence in the fine particles of a particular magnetic structure which is intermediate between multi- and single-domain magnetic structures.
There are 4 figures and 7 Soviet references.

ASSOCIATION: Ural'skiy gosudarstvennyy universitet im. A.M. Gor'kogo (Ural State University im. A.M. Gor'kiy)

SUBMITTED: February 8, 1960

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Card 3/3

87897

S/126/60/010/003/003/009/XX
E201/E391

9.4300 (1143, 1155 only)
18 1142

AUTHORS: Zaykova, V.A. and Shur, Ya.S.

TITLE: Causes of Rise of the Coercive Force on Reduction of Thickness of Ferromagnetic Sheets

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol. 10, No. 3, pp. 350 - 358

TEXT: It is known (Refs. 1-6) that in sufficiently thin sheets of soft magnetic materials the coercive force H_c depends markedly on the sample thickness d: the thinner the sample, the higher H_c. The present authors studied the dependence of the coercive force on the sheet thickness using monocrystals and polycrystals of silicon iron (3.5% Si) and of permalloy-78. The sample thickness was reduced by electrolytic etching or by cold rolling with subsequent high-temperature annealing in vacuum. The coercive force was measured with a sensitive astatic magnetometer. The authors determined also the temperature dependence of the coercive force of silicon iron polycrystals. Powder-pattern method was used to study the

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Causes of Rise of the Coercive Force on Reduction of Thickness of Ferromagnetic Sheets

domain structure and its changes on reduction of sample thickness in silicon iron monocrystals. Some of the results are given in Figs. 2-8 (Fig. 1 shows schematically magnetic "charge" distribution in ferromagnetic crystals). Figs. 2-5 give the $H_c = f(d)$ dependences for permalloy-78 (Fig. 2) and silicon iron monocrystals (Figs. 3-4 and Curves 1 and 2 in Fig. 5), and polycrystals (Fig. 5, Curve 3). The domain structure of silicon iron monocrystals is shown in Figs. 6 and 7; in Fig. 7 the four photomicrographs represent changes in the domain structure on gradual reduction of the sample thickness from 0.18-0.2 mm (Fig. 7a) to 0.005-0.003 mm (Fig. 7d). Fig. 8 gives the temperature dependence (-200 to 500 °C) of H_c for silicon iron samples of various thicknesses. It was concluded that the rise of the coercive force with decrease of the thickness of magnetically soft ferromagnetic sheets was due to an increase of the magnetic leakage fields at the

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STARTSEVA, I.Ye.; SHUR, Ya.S.

Characteristics of the domain structure of magnesium-manganese ferrites with a rectangular hysteresia loop. Fiz. met. i metalloved. 11 no. 1:158-160 Ja '60. (MIRA 14:2)

1. Institut fiziki metallov AN SSSR.
(Ferrates--Magnetic properties)
(Magnesium-manganese alloys--Metallography)

SHUR, Ya.S.; SHTOL'TS, Ye.V.; MARGOLINA, V.I.

Magnetic structure of small monocrystalline particles of Mn-Bi alloy. Zhur. eksp. i teor. fiz. 38 no.1:46-50 Jan '60. (MIRA 14:9)

1. Institut fiziki metallov Akademii nauk SSSR.
(Manganese-bismuth alloys--Magnetic properties)

KANDAUROVA, G.S.; SHUR, Ya.S.; MASLENNIKOVA, F.V.

Dependence of the magnetic structure of a cobalt crystal on its size. Zhur. eksp. i teor. fiz. 38 no.1:60-63 Jan '60. (MIRA 14:9)

1. Ural'skiy gosudarstvennyy universitet.
(Cobalt crystals--Magnetic properties)

84962

S/056/60/039/003/048/058/XX
B006/B070

24.7600 (1043,1137,1160)

AUTHORS: Shur, Ya. S., Startseva, I. Ye.

TITLE: Temperature Hysteresis of the Domain Structure of Ferrosilicon Crystals

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 3(9), pp. 566 - 573

TEXT: The aim of the authors was to study the general rules governing the temperature hysteresis of the domain structure of ferrosilicon crystals. The magnetic structure was observed by the method of powder patterns. Single and polycrystals with 3.5% Si were studied; they were in the form of disks 15 mm large and 0.3 - 0.7 mm thick. All the samples were annealed at 1,250°C before they were ground and polished. The effect of cyclic temperature changes on the magnetic structure was investigated. For this, the samples were heated from room temperature to different temperatures (up to 550°C), and cooled again to the initial temperature. The samples were heated by a special instrument which was placed in a vacuum chamber (Fig.1). This instrument as well as the

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Temperature Hysteresis of the Domain Structure of Ferrosilicon Crystals

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experimental method are described in the introduction. The maximum strength of the magnetic field was 600 oe. Photographs of the domain structure were taken for one and the same sample a) after the first magnetization, b) after heating and cooling, and c) after the second magnetization. It could be established that no significant change in the domain structure took place when the sample was heated from 20° to 200°C and cooled again to 20°C. A hysteresis is first observed on heating to 400 - 550°C. Figs. 2, 4, 5, and 6 show powder patterns which illustrate the transformation of the domain structure in one cycle. Figs. 6 and 7 show a schematic representation of the structure of the types B and A. The investigations showed that a significant irreversible transformation of the magnetic structure in mono- and polycrystalline samples takes place in a cycle between 20° and 400 - 550°C. This change in the structure shows itself in the following way: The dimensions, the form, and the number of closure domains are changed, and the boundaries between the principal regions are displaced. Finally, the results are discussed and theoretically interpreted. L. D. Landau, Ye. M. Lifshits, L. V. Kirenskiy, and I. F. Degtyarev are mentioned. There are 7 figures and 8 references: 6 Soviet and 2 US.

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88432

S/056/60/039/006/021/063
B006/B056

24.7900 (1147, 1158, 1160)

AUTHORS: Shur, Ya. S., Shiryayeva, O. I.

TITLE: Ferromagnetic Resonance in Silicon Iron Crystals and Its Relation to the Domain Structure

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 6(12), pp. 1596 - 1601

TEXT: It was the purpose of the experimental investigations described here to determine the interrelation between the course of the ferromagnetic resonance absorption curves and the nature of the domain structure of silicon iron single crystals (3.5% Si). Silicon iron was chosen because it has a relatively small anisotropy constant, and because its magnetic structure is well known. 15 single crystal disks of various diameters (4 - 15 mm) and thicknesses (0.07 - 0.2 mm), which were cut parallel to the planes (001) and (011) were investigated. The specimens were electrolytically polished after a heat treatment (1100°C) in vacuo. The ferromagnetic resonance absorption was investigated at 9370 Mc/sec. The domain structure was investigated by the powder pattern method. A

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88432

Ferromagnetic Resonance in Silicon Iron Crystals and Its Relation to the Domain Structure

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B006/B056

comparison between the resonance absorption curves and the domain structures showed that besides the resonance peak observed in strong saturating fields, a second peak may occur in weaker fields if the crystal has a multidomain structure and if the highfrequency field is parallel to the domain boundaries. This proves the theoretical rules given in Refs. 4,5. This phenomenon may be used for a more exact investigation of the domain structure of ferromagnetics, especially in such cases in which the known methods of direct observation are not applicable. There are 4 figures and 7 references: 2 Soviet and 5 US.

ASSOCIATION: Institut fiziki metallov Akademii nauk SSSR (Institute of Metal Physics of the Academy of Sciences USSR)

SUBMITTED: July 19, 1960

Text to Fig.1: Absorption curves for a crystal disk cut parallel to the (011) plane; $\vec{H}$ parallel to the axes [110], [111] or [100].
Text to Fig.2: Absorption curves for a crystal disk cut parallel to the (001) plane; $\vec{H}$ parallel to the axes [100] or [110].

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ALIKHANOV, R. A., Institute for Physical Problems imeni S. I. Vavilov, Academy of Sciences USSR, Moscow - "Neutronographic study of $NiCO_3$" (Section J-2)

BELOV, N. V., Associate Director, Institute of Crystallography, Academy of Sciences USSR, Moscow - "Magnetic (ferromagnetic) space group symmetry" (C-6)

BELOV, N. V., NERONOVA, N. N., Both Institute of Crystallography, Academy of Sciences USSR, Moscow, DONNAY, J. D. H., Johns Hopkins University, Baltimore, Md., and DONNAY, G. H., Geophysical Laboratory, Carnegie Institution, Washington, D. C. - "Tables of magnetic space groups, II. Special positions" (C-6)

BOROVIK-ROMANOV, A. S., Institute for Physical Problems imeni S. I. Vavilov, Academy of Sciences USSR - "Antiferromagnetic resonance in carbonated of transition elements" [sic] (M-16)

BOROVIK-ROMANOV, A. S., ALIKSANYAN, G. G., RUDASHEVSKIY, G. Ye. - "Piezomagnetic effect in antiferromagnets" (M-18)

KONDORSKIY, Ye. I., Head, Magnetism Laboratory, Moscow State University - (1) "The electrical and galvanomagnetic properties of thin films at very low temperatures" (M-5); (2) "On the connection between the spontaneous magnetization of current carriers and the Nernst-effect in ferromagnetic metals" (M-4); "The exchange interaction and magneto-effects in ferrites [illegible]" (M-15)

USSR (cont.)

LOBACHEV, B., and VAYNSHTEYN, B., Institute of Crystallography, Moscow - "Electron diffraction study of thiourea $CO(NH_2)_2$"

LYASHENKO, B. G., Central Scientific Research Institute of Metallurgy, Moscow - "The problem of the influence of spontaneous magnetization on crystal structure and phase state of alloys" (M-8)

LYASHENKO, B. G., LIVITIN, D. F., PUZEY, I.M., ABOV, Yu G. Central Scientific Research Institute of Metallurgy, Moscow - "Neutron diffraction investigation of order-disorder in the alloys 'Ferrum-nickel and ferrum-cobalt'" (J-1)

OZEROV, R. P., KOGAN, V. S., ZHDANOV, G. S., Scientific Research Physico-Chemical Institute imeni L. Ya. Karpov, Moscow - "Neutron diffraction study of the structure of solid hydrogen and deuterium" (C-8)

PINSKER, Z. G., Institute of Crystallography, Academy of Sciences USSR, Moscow - "Results and progresses of electron diffraction analysis" (C-11)

PUZEY, I. M., Scientific Research Institute of Metallurgy, Moscow - "Magnetic anistropy in monocrystals of Ni-Fe-Co alloys" (M-9)

SHUR, Yakov S., Scientific Research Institute of Metallurgy, Moscow - "Some problems of the physics of high coercive materials" (M-17)

SMOLENSKIY, G. A., Institute of Semiconductors, Leningrad - "Some investigations of non-metallic ferro and antiferromagnetics" (M-13)

VAYNSHTEYN, B. K., Institute of Crystallography, Academy of Sciences USSR - "Development of electron diffraction method" (C-11)

YAMZIN, I. I., BELOV, N. V., NOZIK, Y. Z., Institute of Crystallography, Moscow - "Atomic and magnetic structures of magnese ferrite" (J-2)

VONSOVSKIY, S. V., Institute of the Physics of Metals, Academy of Sciences USSR, Sverdlovsk. A member of the IUPAP Commission on Magnetism. See paragraph 1 of Comment for a complete listing of members of the Commission. "Some investigations of Soviet physics on the theory of ferromagnetism for the last years" (Invited paper. Section M-11)

paper to be submitted for the IUPAP Intl. Conference on Magnetism and Crystallography, Kyoto, Japan, 25-30 Sep 1961

22959

S/126/61/011/005/004/015
E073/E535

24,2200(1068,1147,1164)

AUTHORS: Sokolov, A. D. and Shur, Ya. S.

TITLE: Influence of Small Additions of Cobalt on the Hysteresis Loop of Nickel-Zinc Ferrites

PERIODICAL: Fizika metallov i metallovedeniye, 1961, Vol.11, No.5, pp.681-685

TEXT: Various authors have observed that for some magnetically soft ferrites the hysteresis loop is rectangular if remagnetization is by means of weak fields. The physical nature of this phenomenon has so far not been clarified. The influence of slight additions of cobalt was investigated. Nickel-zinc ferrite specimens of four differing compositions with and without cobalt additions were tested. The CoO additions were 0.5, 1, 2 and 3%; differences in the nickel and zinc contents were slight. The specimens were in the shape of rings 37 mm external, 30 mm internal diameter with a height of 1½ mm. From the same materials bar specimens 4.3 x 4.3 mm² and 60 mm long were produced. On the ring specimens the magnetization curves and the hysteresis loops were determined by means of a ballistic

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Influence of Small Additions of ... S/126/61/011/005/004/015
E073/E535

method and in addition, the dynamic hysteresis loops at 50 c.p.s. were measured on some of the specimens by means of an electron-beam ferrometer. The saturation magnetization was determined on the bar specimens. The obtained results indicate that specimens with slight additions of CoO showed maximum values of B_r/B, which were higher than those obtained for specimens without CoO but otherwise of equal compositions. (B_r - residual induction, B - maximum induction). The most rectangular hysteresis loop was obtained for nickel-zinc ferrites with 1 to 2% CoO; specimens of equal composition containing 0.5% CoO had somewhat lower B_r/B values and specimens with 3% CoO additions had still lower B_r/B values. The highest B_r/B values (90 to 92%) were obtained for nickel-zinc ferrites with 1 to 2% CoO; the coercive force of the respective specimens was H_c = 1.1-1.3 Oe and for $H = 5H_c$, B was of the order of 3700-3800 gauss. Slight changes in the NiO and ZnO contents, without any change in the CoO content, led to a drop in the ratio B_r/B and the coercive force (B_r/B = 88.5%, H_c = 0.8 Oe). Some of the specimens were subjected to thermo-magnetic treatment in longitudinal and transverse magnetic fields (at 620°C with slow cooling to room temperature in the magnetic

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field, at a rate below 50°C/hour). The applied magnetic field was of 20 Oe. This treatment did not bring about any change in the magnetic properties. The results obtained in measuring the dynamic hysteresis loops were in full agreement with the results obtained under static conditions. Thus, the experiments show that as a result of additions of 1-2% CoO to some nickel-zinc ferrites, the hysteresis loops will become "spontaneously" rectangular. There are 5 figures, 1 table and 6 references: all non-Soviet. The references to English-language publications read as follows: Littmann, M.F. Electronic Engineering, 1952, 71, 792; Brown, O.R., Allers-Schoenberg, E. Electronics, 1953, 26, 146.

ASSOCIATION: Institut fiziki metallov AN SSSR
(Institute of Physics of Metals AS USSR)

SUBMITTED: December 20, 1960

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001550220015-0"

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TITLE: Specific features of the magnetic structure of Vicalloy [V-Co-Fe alloy]

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TEXT: In continuation of their earlier work (Ref. 1: FMM, 1957, 4, 54; Ref. 2: Izv.AN SSSR, ser. fiz., 1956, 21, 1275 and Ref. 3: FMM, 1957, 4, 239), the present authors studied the effect of elastic stresses on the magnetic properties of Fe-8V-52Co and Fe-12V-52Co alloys, tested under conditions intermediate between magnetically soft and magnetically hard states, attained by annealing wire specimens, cold-drawn to 91% (the 12% V alloy) and 94% (the 8% V alloy) reduction at temperatures between 350 and 600 °C. The effect of such treatment on the magnetic properties of the alloys studied is demonstrated in Fig. 1, where the coercive force (H_c, Oe, lefthand scale) and residual induction ($4\pi I$, gauss, righthand scale) are plotted against the annealing temperature (°C),

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the continuous and broken curves relating, respectively, to alloys with 12 and 8% V. The effect of elastic stresses on the magnetic properties of the 12% V alloy is demonstrated in Fig. 2, where H_c (lefthand scale, lower set of curves) and $4\pi I$ (righthand scale, upper set of curves) are plotted against the applied stress (σ, kg/mm^2), Curves 1 relating to cold-worked specimens, Curves 2 - 5 to specimens annealed for 30 min at 350, 400, 450 and 500 °C, respectively. In the discussion of the results obtained the authors refer to an earlier work (Ref. 1) concerned with the effect of elastic stresses on cold-worked unannealed material. It was concluded then that the variation of H_c due to tensile elastic stresses was associated with the variation of the magnetic texture in an alloy with multidomain structure. In the case of magnetically-hard specimens (i.e. those annealed at 600 °C), the elastic tensile stresses also brought about the formation of a magnetic texture but the resultant increase in H_c could be attributed

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only to the existence of a single domain structure. The results of the present investigation indicate that in the case of Vicalloy specimens, annealed at low temperature, it is possible to produce states in which a) the single domain character of the magnetic structure is clearly revealed, b) the process of magnetization takes place mainly as a result of rotation of vectors of spontaneous magnetization intensity and c) the magnitude of H_c is small. However, an increase in the magnetic anisotropy due to externally applied stresses brings about a sharp increase in H_c. It can, therefore, be postulated that low values of H_c of specimens, annealed at low temperatures and possessing a magnetic structure approaching the single domain structure, are associated with a low degree of total magnetic anisotropy. There are 3 figures and 3 Soviet-bloc references.

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Fig. 1:

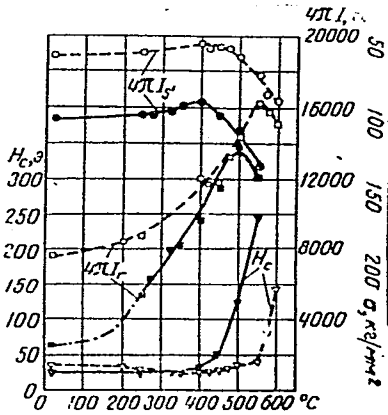
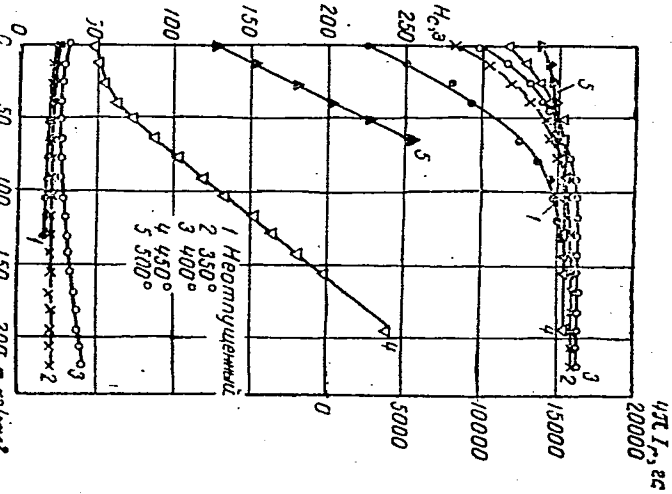


Fig.2



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