SOV/126-8-2-1/26

On the Elastic Moduli of a Solid Mixture

elastic continuum approximation. The results obtained are in qualitative agreement with the experimental data reported by Koster and Rauscher (Ref 4) for Ag-Cu, Cd-Zn, Al-Sn and Pb-Sn.
There are 4 references, 3 of which are Soviet and 1 German.

ASSOCIATION: Institut metallofiziki AN UkrSSR (Institute of Metal Physics, Ac. Sc. of the Ukrainian SSR)

SUBMITTED: July 17, 1958

Card 2/2

67683

18.9100

SOV/126-8-4-4/22

AUTHOR: Krivoglaz, M.A.

TITLE: Effect of Geometrical Defects on the Background Intensity Distribution in X-ray and Neutron Diffraction Patterns

PERIODICAL: Fizika metallov i metallovedeniye, Vol 8, Nr 4, 1959, pp 514-530 (USSR)

ABSTRACT: The present paper is concerned with the study of the background intensity distribution in the case of the scattering of monochromatic radiation by a monocrystal. Particular attention is paid to those properties of the background which are associated with the presence in the expression for the intensity of a term which tends to infinity in the neighbourhood of the reciprocal lattice sites. The analysis is based on the formulae for the intensity of diffuse scattering of monochromatic radiation by a monocrystal I$_\Phi$ which were obtained by the author in Ref 3. As in Ref 3, only scattering on irregularities due to differences in scattering factors and atomic radii is taken into account. General formulae are derived which may be used to determine the intensity as a function of the direction of the scattered ray. They may also be used, with the aid of

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SOV/126-8-4-4/22

Effect of Geometrical Defects on the Background Intensity Distribution in X-ray and Neutron Diffraction Patterns

purely geometrical constructions, to determine the intensity distribution in the Laue pattern under various possible conditions. A detailed discussion is given of the scattering of monochromatic radiation by a monocrystal whose position is slightly displaced relative to the position giving purely Bragg reflection. In this case, although the Bragg reflection is absent, the Ewald construction shows that near the direct reflection there should be intense diffuse scattering maxima. Formulae are derived giving the intensity distribution at such points as a function of the scattering angle. It is suggested that it would be useful to have experimental data on the background intensity distribution, especially near critical points and phase transition points of the second kind, since the present theory gives expressions for the anomalously large scattering which takes place near a critical point.

There are 6 figures and 9 references, of which 3 are English and 6 are Soviet.

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67683

SOV/126-8-4-4/22

Effect of Geometrical Defects on the Background Intensity Distribution in X-ray and Neutron Diffraction Patterns

ASSOCIATION: Institut metallofiziki AN USSR (Institute of Physics of Metals, Academy of Sciences of the Ukrainian SSR)

SUBMITTED: January 7, 1959

Card 3/3

18.8100

67750

SOV/126-8-5-2/29

AUTHOR: Krivoglaz, M.A.

TITLE: On the Effect of Fluctuations in Correlation Parameters on the Scattering of X-rays and Thermal Neutrons by Solid Solutions

PERIODICAL: Fizika metallov i metallovedeniye, Vol 8, 1959, Nr 5, pp 648-666 (USSR)

ABSTRACT: A detailed discussion is given of the scattering of X-rays and thermal neutrons by solid substitutional solutions, which is due to differences in atomic scattering functions and geometrical defects. Irregularities in both the composition and the correlation parameters are taken into account. The paper is divided into the following sections: 1) Introduction; 2) Determination of the Fourier components of the atomic displacements; 3) Diffuse scattering by ideal solutions; 4) Diffuse scattering associated with fluctuations in the correlation parameters in the region of the phase transition point of the second kind; and 5) Determination of the reduction in the intensity of regular reflections. If fluctuations in the composition and the correlation

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67750

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On the Effect of Fluctuations in Correlation Parameters on the Scattering of X-rays and Thermal Neutrons by Solid Solutions

of parameters are taken into account, one finds that the correlation parameter fluctuations lead to a change in the coefficient which connects lattice defects with fluctuations in the composition and to the appearance of additional scattering. Isodiffusion curves for the scattering by correlation parameter fluctuations do not have a lemniscate-like form but a form close to an oval. Effects associated with correlation parameter fluctuations play a relatively greater role if the lattice constant is very dependent on the correlation parameters and deviations from Wegard's rule are large. In ideal solutions the scattering by correlation parameter fluctuations is proportional to $c^2(1-c)^2$ and becomes negligible at small concentrations. In non-ideal solutions the role of these fluctuations may become enhanced. In particular, near the phase transition point of the second kind, they may lead to the appearance of a strong diffuse scattering in the neighbourhoods of structural reflections whose intensity tends to infinity for $T \to T_0$.

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On the Effect of Fluctuations in Correlation Parameters on the Scattering of X-rays and Thermal Neutrons by Solid Solutions

There are 1 figure and 11 references, of which 2 are English, 1 is Ukranian, 1 is a Russian translation from English and 7 are Soviet.

ASSOCIATION: Institut metallofiziki AN USSR (Institute of Metal Physics of the Academy of Sciences of the Ukranian SSR)

SUBMITTED: January 8, 1959

Card 3/3

24(7) SOV/48-23-5-21/31

AUTHORS: Geychenko, V. V., Danilenko, V. M., Krivoglaz, M. A., Matysina, Z. A., Smirnov, A. A.

TITLE: On the Theory of the Diffused Dispersion of an X-Ray and Slow Neutrons in Multicomponent Alloys (K teorii diffuznogo rasseyaniya rentgenovykh luchey i medlennykh neytronov mnogokomponentnymi splavami)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1959, Vol 23, Nr 5, pp 637-639 (USSR)

ABSTRACT: The study of the diffused dispersion of various types of waves in the crystal lattice of alloys offers the possibility of investigating the arrangement of the various atoms in the crystal lattice and the influence exerted by microinhomogeneities upon alloy properties. A formula must be developed and expanded , permitting the computation of dispersion for the cases of X-rays and slow neutrons by the application of "factors of atomic dispersion". Such a formula (1) is written down in the form of a finite sum and the factors for the computation of the dispersion of an X-ray and of slow neutrons are described. This finite sum may be decomposed into two partial sums which consist of the diagonal or non-diagonal

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SOV/48-23-5-21/31

On the Theory of the Diffused Dispersion of an X-Ray and Slow Neutrons in Multicomponent Alloys

members, respectively. These two partial sums are then computed, namely, for the disordered state in the Brave type lattice. For an exemplification, these two formulas are written down for a binary alloy with the hexagon systems AB and AB_3. Finally, a wide space is devoted to the correlation parameters characterizing the state of the crystal. There are 4 references, 3 of which are Soviet.

ASSOCIATION: Institut metallofiziki Akademii nauk USSR (Institute of Metal Physics of the Academy of Sciences, UkrSSR)

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24 (7)

AUTHORS: Krivoglaz, M. A., Tikhonova, Ye. A. SOV/48-23-5-27/31

TITLE: The Theory of Dispersion of X-rays and Thermal Neutrons in Fluctuating Inhomogeneities of Solid Solutions (Teoriya rasseyaniya rentgenovykh luchey i teplovykh neytronov na fluktuatsionnykh neodnorodnostyakh tverdykh rastvorov)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1959, Vol 23, Nr 5, pp 652 - 654 (USSR)

ABSTRACT: The considerations made in the present paper lie within the framework of the kinematic theory. The inhomogeneity of the material is caused by the various factors of dispersion of different atoms and by the geometrical tensions, caused by the different atom radii. Similar papers are then referred to (Refs 1 and 2) and for inhomogeneous binary solutions a formula (1) is given for the intensity of the diffused dispersion of X-rays. This formula is verified for the case of the ideal solution. Non-ideal inhomogeneous solutions are considered next and the intensity expressed in formula (1) is developed from the thermodynamic point of view. The result is formula (3) which is examined in the final part of the present paper.

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The Theory of Dispersion of X-rays and Thermal Neutrons in Fluctuating Inhomogeneities of Solid Solutions SOV/48-23-5-27/31

The influences exerted by the quantities occurring in the formula are studied in this connection. The parameters of order and correlation, the superlattice reflection and the intensity of regular reflection are also taken into account. There are 4 references, 2 of which are Soviet.

ASSOCIATION: Institut metallofiziki Akademii nauk USSR (Institute of Metal Physics of the Academy of Sciences, UkrSSR)

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81639

S/181/60/002/06/27/050
B006/B056

24.7600

AUTHOR: Krivoglaz, M. A.

TITLE: The Theory of Phononic Thermal Conductivity of Non-perfect Crystals Near the Critical Point on the Curve of the Decay or Phase Transition of the Second Type

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 6, pp. 1200-1210

TEXT: It was the aim of the present paper to investigate the phononic thermal conductivity of non-perfect crystals in which the defects are not statistically distributed, the defect concentration is not low, and the distortion extends to all cells of the crystal; such crystals are, e.g., concentrated solid solutions or seignettoelectrics. The author here theoretically investigates the low-temperature phononic thermal conductivity of solid solutions which are cooled from the critical point on the decay curve. At low temperatures which are considerably below the Debye temperature the thermal conductivity of such a solution is lower than that of a perfect solution, and with a temperature drop it decreases proportionally to the latter. In the case

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The Theory of Phononic Thermal Conductivity of Non-perfect Crystals Near the Critical Point on the Curve of the Decay or Phase Transition of the Second Type

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of a solution which is cooled from the range of the critical point, the low-temperature thermal conductivity decreases with decreasing temperature, passes through a minimum, after which it again rises. If the solution approaches the critical state, the minimum is shifted toward lower temperatures, and the minimum value of thermal conductivity decreases. An analogous effect may be observed also at the critical point, where the curve of phase transitions of the second type goes over into the decay curve (cf. the phase diagram on p. 1206). For solutions of stoichiometric composition, transition from the unordered to a nearly completely ordered solution must lead to a sudden increase of thermal conductivity. In the last part of the paper, the processes occurring near the critical point on the curve of phase transitions of the second type are finally investigated for the case of one-component crystals. The anomalies of low-temperature thermal conductivity occurring within the range of the critical point (in which the curves of phase transitions of the second type go over into those of the first type) are investigated for crystals having a symmetry center and whose critical

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point is in the low-temperature range. A. F. Ioffe and Ye. D. Devyatkova are mentioned. There are 1 figure and 10 references: 7 Soviet, 1 German, 1 British, and 1 Dutch.

ASSOCIATION: Institut metallofiziki AN USSR, Kiyev (Institute of Metal Physics of the AS UkrSSR, Kiyev)

SUBMITTED: June 26, 1959

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24.7200

78095
SOV/70-5-1-4/30

AUTHOR: Krivoglaz, M. A.

TITLE: Concerning the X-Ray Scattering by Strongly Distorted Uniform Solid Solutions

PERIODICAL: Kristallografiya, 1960, Vol 5, Nr 1, pp 24-31 (USSR)

ABSTRACT: Continuing his studies on the diffuse scattering of X-rays and thermal neutrons (Zh. eksperim. i teor. fiz., 34, 204, 1958; et al.), the author found that the scattering intensity distribution in strongly distorted solid solutions is asymmetric; as its determination requires the greater number of terms of the expanded expression of scattering intensity, the higher is the degree of distortions and the larger are the indices of reflections. In a binary solid solution, whose scattering intensity is a function of the scattering power of the constituent atoms A and B, and of structure distortions, the heterogeneity that causes scattering can be defined

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Concerning the X-Ray Scattering by Strongly Distorted Uniform Solid Solutions

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by assumption that the content c_s of A atom at s-th node equals 1 or 0 when the node is occupied by A or B, and the vector of static displacements δR_s is a given value. Then, the Fourier series of the values are

$$c_s - c = \sum_k c_k e^{-ikR_s}; \quad \delta R_s = i\sum_k R_k e^{-ikR_s}; \quad c_k = \frac{1}{N}\sum_s (c_s - c) e^{ikR_s}. \quad (1)$$

where c denotes the content of A atom; c_k is Fourier component of c; R_s is radius vector in an ideal structure; N is number of atoms in the crystal; $c_k^* = c_{-k}$; $R_k^* = -R_{-k}$; R_k is fluctuations in the correlation of parameters; summation over k is carried out in terms of wave vector $k/2\pi$ in the first cell of the reciprocal lattice. For an ideal solid solution, whose lattice constant is proportional to the content of components, the scattering intensity is expressed by

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$$I = \left|\sum_s [c_s f_A + (1 - c_s) f_B] e^{[illegible]}\right|^2 = I_0 + I^{[illegible]} + [illegible] + I_3^{(2)}. \quad (2)$$

where f_A and f_B denote scattering powers of A and B atoms; $q = q_1 - 2\pi K_n$; q_1 is difference between incident and scattered wave vectors; K_n is a vector to the reciprocal lattice point nearest to the end of $q_1/2\pi$; I_0 is intensity of diffraction lines; $I^{(1)}$ is background intensity; $I_1^{(2)}$, $I_2^{(2)}$, $I_3^{(2)}$ is scattering intensities due to geometrical distortions, variations in the scattering power of atoms, and the difference between the scattering powers of atoms respectively. In nonideal solid solutions, $I_1^{(2)}$ increases appreciably, but if R_k is small

$$I \approx \frac{1}{2} \bar{f}^2 N^2 \sum_k \overline{|c_k|^2} \, \overline{|c_{k-q}|^2} (q_1 A_k)^2 (q_1 A_{k-q})^2$$

holds, where $\bar{f} = cf'_A + (1 - c) f'_B$; A_k is a vector parallel to k and defined by

$$A_k = a \frac{k}{k^3}; \quad a = \frac{1+\sigma}{3(1-\sigma)} \frac{1}{\Delta} \frac{\partial \Delta}{\partial c}. \qquad (9)$$

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σ is Poisson factor; Δ is atomic volume. The mean square of the Fourier component c is

$$\overline{|c_k|^2} = \frac{\kappa T}{V(\varphi_{cc} + \beta k^2)},$$

where κ is Boltzman constant; V is volume; $\phi_{cc} = \frac{\partial^2 \phi}{\partial c^{(2)}}$;

ϕ is thermodynamic potential of a unit volume;
β = κ T/d. Both the low and higher order terms of
the expansions of above series, variations of the
terma depending on the values of various factors in
special cases, the effect of term variations on the
scattering intensity of ideal and nonideal solid
solutions are analyzed by means of over 20 more equations,
partially derived and explained in the author's pre-
ceding papers. The scattering intensity distribution
in the vicinity of reciprocal lattice points and the iso-
diffusion curves for nonideal solid solutions are found
to deviate from a lemniscate form to which they are
close in the case of ideal solid solutions. For instance,
the background intensity and the relative effect of

Concerning the X-Ray Scattering by Strongly Distorted Uniform Solid Solutions 78095 SOV/70-5-1-4/30

higher order terms increase appreciably with grouping of impurities and with the atomic displacements due to a bombardment by high-speed particles. There are 8 references, 5 Soviet, 2 U.S. 1 U.K. The U.S. and U.K. are: C. W. Tucker, P. Senio, Phys. Rev., 99, 1777, 1955; H. Kanzaki, J. Phys. Chem. Solids, 2, 107, 1957; K. Huang, Proc. Roy. Soc. A, 190, 102, 1947.

ASSOCIATION: Institute of Metalphysics of the Academy of Sciences of the Ukrainian SSR (Institut metallofiziki AN Uk. SSR)

SUBMITTED: May 27, 1959

Card 5/5

DANILENKO, V.M. [Danylenko, V.M.]; KRIVOGLAZ, M.O. [Kryvohlaz, M.O.]
LARIKOV, L.N.; SMIRNOV, A.A.

Ukrainian Republic Conference on the Theory of Metals and Alloys.
Ukr. fiz. zhur. 5 no.1:130-135 Ja-F '60. (MIRA 14:6)
(Metals—Congresses)
(Alloys—Congresses)

25569
S/185/60/005/002/004/022
D274/D304

24.7100 3309, 1160, 1153

AUTHORS: Kryvoglaz, M.O. and Tykhonova, O.O.

TITLE: Theory of X-ray scattering by multi-component ordered solutions

PERIODICAL: Ukrayins'kyy fizychnyy zhurnal, v. 5, no. 2, 1960, 158-171

TEXT: X-ray scattering by partially-ordered multicomponent solid solutions is considered; the solutions have unit cells of arbitrary type, but only the case of each atom being the center of symmetry of the crystal is considered. Formulas are derived for the intensity of diffuse scattering. Solutions with lattice of β-brass type are considered in more detail, as well as solutions in which one sublattice is occupied by similar atoms and the other sublattice contains atoms of two different types. First, the formula for the intensity of the Bragg reflection is derived. Further, the formula for the intensity of diffuse scattering is derived:

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$$I_F = -N_0^2 \sum_{\substack{\alpha,\alpha'=1 \\ (\alpha<\alpha')}}^{n} \sum_{\gamma,\gamma'=1}^{\nu} \overline{c_{q\gamma\alpha} c^*_{q\gamma'\alpha'}} \; B_{q\alpha\alpha'\gamma} B_{q\alpha\alpha'\gamma'} \qquad (9)$$

$$B_{q\alpha\alpha'\gamma} = \sum_{\gamma'} e^{2\pi i K_l h_{\gamma'}} \left[\bar{f}_{\gamma'} q_{1'} (A_{q\gamma'\gamma\alpha} - A_{q\gamma'\gamma\alpha'}) - \delta_{\gamma\gamma'}(f\alpha - f\alpha')\right] \qquad (10)$$

The Fourier coefficients $\overline{c_{q\gamma\alpha} \cdot c^*_{q\gamma'\alpha'}}$ can be expressed in terms of the concentration c of components at various types of lattice points and in terms of the correlation parameters. B_q is expressed in terms of the difference between atomic-scattering factors and in terms of the factor of proportionality between the q-th Fourier coefficients of concentration-fluctuations and of displacements. (q characterises the distance to the reciprocal lattice points). For a binary solution A-B, and ignoring the correlation, the formula for the intensity reduces to

$$I_F = N_0 \sum_{\gamma=1}^{\nu} c_{\gamma A} c_{\gamma B} B^2_{qAB\gamma} \, . \qquad (13)$$

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The expression for the intensity becomes very simple for solutions in which the lattice points of all the sublattices, except one, are occupied by a single type of atoms. In the neighborhood of reciprocal lattice points, the intensity can be expressed in terms of the second derivative of the thermodynamic potential with respect to the concentration c. Formulas are derived by means of which B_q can be expressed in terms of the interatomic coupling constants. If the interaction between nearest neighbors only is considered, these constants can be expressed in terms of the derivative of the lattice parameters with respect to concentration, and in terms of the modulus of elasticity. In the case of certain actual crystal structures, simpler formulas were obtained; (this for hexagonal, rhombic, tetragonal, and cubic crystals by the authors in (Ref. 2: UZhF, 3, 297, 1958). In the proximity of the reciprocal lattice points which correspond to lattice, as well as superlattice reflection, the intensity of diffuse scattering varies in inverse proportion with the square of the distance from the lattice point; in that case the factor of proportionality contains the square of a structure factor which, for superlattice reflection, becomes zero

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Theory of X-ray scattering...

in case of a disordered solution. The obtained formulas permit calculating the intensity by means of independent experimental data on thermodynamic activity of components, elasticity modulus, and concentration. On solutions with crystalline lattice of β-brass type, formulas are derived (in the nearest neighbor approximation) which express the intensity of scattering at any point of the reciprocal lattice in terms of the concentration at different lattice-points and of the correlation parameters; these formulas make it possible (in several cases) to determine the correlation parameters experimentally. Using a statistical theory of ordering, the correlation parameters can be determined as functions of temperature and energy of ordering. By means of the thermodynamic theory of fluctuations, the intensity can be expressed directly in terms of energy of ordering. A formula is derived which makes it possible (in principle) to determine experimentally the energy of ordering. On solutions with two sublattices, the second sublattice having atoms of two different types, the results obtained can be used for studying vacancies in lattices of type NaCl and CsCl. A formula is obtained which permits determining (by numerical integration) the quantity

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L which characterizes the weakening in intensity of scattering. The two sublattices have different L; in crystals of type NaCl and CsCl, L_1 exceeds L_2 by a factor of 1½ approximately. There are 5 references: 3 Soviet-bloc and 2 non-Soviet-bloc. The reference to the English-language publication reads as follows: K. Huang, Proc. Roy. Soc., 190, 102, 1947.

ASSOCIATION: Instytut metalofizyky AN USSR (Institute of Metal-physics, AS UkrSSR)

SUBMITTED: July 11, 1959

Card 5/5

KRYVOGLAZ, M.A.

25570
S/185/60/005/002/005/022
D274/D304

24 7100 3309, 1160, 1153

AUTHORS: Kryvoglaz, M.O. and Tykhonova, O.O.

TITLE: Theory of X-ray scattering by interstitial solid solutions

PERIODICAL: Ukrayins'kyy fizychnyy zhurnal, v. 5, no. 2, 1960, 174-188

TEXT: General formulas are derived for the intensity of diffuse scattering for both ideal and non-ideal solutions. (Ideal solutions are those with correlation parameters equal to zero). Solutions in which the interstitial atoms are in the octahedral interstices of face-centered and body-centered cubic lattices were considered in more detail, as well as martensite-type crystals. The general formulas obtained by the authors in the preceding article (of the same issue) can be also used for interstitial solid solutions, provided the interstices are considered as sublattices filled by interstitial atoms with zero scattering factor). The problem is treated from a macroscopic viewpoint, hence the intensity-distribution in the

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Theory of X-ray scattering...

neighborhood of the lattice points of the reciprocal lattice can be considered in detail irrespective of the atomic-interaction forces. Formulas are derived in the nearest-neighbor approximation, which permit determining the intensity distribution in the entire reciprocal-lattice space for any crystals to which this approximation applies. Further simplifying assumptions are made. For small q (q characterizes the distance to the reciprocal lattice points), the correlation parameters (which are frequently unknown) can be ignored, and the intensity I_F expressed in terms of the second derivative of the thermodynamic potential with respect to the concentration of the interstitial atoms; the quantity A_q (which is a proportionality factor between the q-th Fourier coefficient of atomic displacement from the lattice points and the q-th Fourier coefficient of the concentration of interstitial atoms) for hexagonal, rhombic, tetragonal and cubic crystals, can be expressed in terms of the modulus of elasticity and the derivative of the lattice parameters with respect to concentration. For an ideal solution, the intensity of diffuse scattering is $I_F = Nf^2c\,(1 - c)(ql, A_q)^2$ (5)

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Theory of X-ray scattering...

N is the number of interstices; c - the concentration of atoms in these interstices, f - an atomic-scattering factor of the pure metal, multiplied by a factor due to lattice defects; (q and A_q were already defined). As the interstitial atoms can be found in various types of interstices, the intensity of diffuse scattering in ideal solutions can be obtained as the sum of the terms corresponding to the various types of interstices. On interstitial solid solutions with face-centered lattices, the interstitial atoms are found in the center of the cubic lattices and in the middle of their faces, the interstices having cubic symmetry. Just as in the case of substantial solid solutions, the intensity of diffuse scattering is inversely proportional to q^2 in the neighborhood of the reciprocal lattice point. For small q, the isodiffusive surfaces are in the form of two spheres which touch at the reciprocal lattice point, (in case of elastic isotropy). For large q, the isodiffusive curves greatly differ from a bispherical shape. On martensite-type interstitial solutions, the formulas for A_q are derived. The isodiffusive surfaces have a shape far from spherical; this is especially the case for strongly anisotropic crystals. The intensity of diffuse scatter-

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ing in the neighborhood of the two lattice points (h00) and (00h) differs greatly. On interstitial solid solutions with body-centered cubic lattices, the interstitial atoms can be found with same probability in any octahedral interstice (belonging to certain types). The intensity can be found by the same formulas as for the Martensite type. The interstices have tetragonal, and not cubic symmetry. The isodiffusive surfaces do not pass through the reciprocal lattice point. As the type of isodiffusive surface varies according to the type of solid solution, the study of diffuse scattering can be used as yet another method of investigating the structure of solid solutions. Thus it can be determined whether an interstitial atom is to be found at the lattice point or in the interstice of a body-centered lattice, or whether such an atom is found in the octahedral or tetrahedral interstice of a face-centered lattice. The formulas obtained for A_q can be used not only for studying the intensity of diffuse scattering, but also for ascertaining the displacements about the interstitial atom, and for calculating the intensity reduction factor in the Bragg reflection. An example is given, where the displacements of Fe-atoms about the interstitial carbon-atom in

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Theory of X-ray scattering...

α-Fe are calculated. The obtained displacements are more accurate than those of J.C. Fisher, (Acta Metal., 6, 13, 1958). It is noted that the obtained distribution of defects about the interstitial atom can be used for many other problems, e.g. for determining the energy of interaction of carbon atoms in a Fe-solution, for studying the ordering of carbon-atoms in martensite, for determining the influence of interstitial atoms on the electrical conductivity of Fe, etc. The mean square displacement of atoms in the solid solutions is found from formulas given. Experimental and calculated values were compared, and it was found that though there is qualitative agreement, considerable quantitative discrepancies occur, especially for displacements alongthe x-axis. These could be narrowed by taking into account additional factors. There are 4 figures, 2 tables and 12 references: 6 Soviet-bloc and 6 non-Soviet-bloc. The references to the 4 most recent English language publications read as follows: W. Cochran, G. Kartha, Acta Cryst., 9, 944, 1956; H. Kanzaki, J. Phys. Chem. Solids, 2, 107, 1957; J.C. Fisher, Acta Metal., 6, 13, 1958; D.D. Betts, A.B. Bhatia, G.K. Horton, Phys. Rev., 104, 43, 1956.

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S/185/60/005/002/005/022
D274/D304

Theory of X-ray scattering...

ASSOCIATION: Instytut metalofizyky AN USSR (Institute of Metal-physics AS UkrSSR)

SUBMITTED: July 2, 1959

Card 6/6

80124

S/126/60/009/05/001/025
E032/E514

24.7200

AUTHOR: Krivoglaz, M.A.

TITLE: The Theory of Scattering of X-rays by Distorted Nonuniform Solid Solutions

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol 9, No 5, pp 641-656 (USSR)

ABSTRACT: In previous papers (Refs 1-3) a development was given of the theory of scattering by uniform solutions, the scattering being due to differences in the atomic scattering factors and the atomic radii of the components. The nonuniformities in the electron density are due to thermodynamic fluctuations in the composition and the order parameters. Such fluctuations can be calculated without the use of simplified models so that the theory can be used to study the qualitative properties of the intensity distribution pattern, to determine the numerical values of the intensities and to carry out a quantitative comparison between theory and experiment. Nonuniform solid solutions, i.e. solutions in which there are small

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S/126/60/009/05/001/025
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The Theory of Scattering of X-rays by Distorted Nonuniform Solid Solutions

segregations of particles of a new phase, which differs from the parent phase in composition and/or structure frequently have a high mechanical strength. In this case, however, the study of the intensity distribution is considerably complicated, since usually the structure of the segregations, their form, the time dependence of their dimensions and other characteristics cannot be determined by independent experiments and cannot be calculated with the aid of present theories of solid solutions. Hence, in distinction to the uniform solutions, it is not possible to predict the intensity distribution for any given solution subjected to a given heat treatment. It is, however, possible to calculate the intensity distribution for a number of simplified models of the segregations. These intensity distributions can then be used in a qualitative comparison with experiment and the best model will then provide an

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The Theory of Scattering of X-rays by Distorted Nonuniform Solid Solutions

estimate of the dimensions and properties of the segregations. Such intensity calculations for a number of models of the segregations have been carried out by Yelistratov (Ref 4) and Bagaryatskiy (Ref 5) who did not, however, take into account crystal distortions. Some authors have obtained intensity distributions with distortions taken into account with the aid of one-dimensional models. However, the distributions in one and three-dimensional cases are considerably different. The results obtained for one-dimensional crystals cannot in general be generalized to three-dimensional crystals. The present paper gives a calculation of the scattering of monochromatic X-rays by a monocrystal containing segregations. The effect of the segregations on extinction is not taken into account, although there are cases in which this is important. It is assumed that the segregations are

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E032/E514

The Theory of Scattering of X-rays by Distorted Nonuniform Solid Solutions

spherical in form and that scattering by dislocations and other defects can be neglected. The distortions are estimated on the elastic isotropic continuum approximation and the difference between the elastic constants of the segregations and the parent continuum is neglected. The concentration of the segregations and the volume occupied by them are assumed to be small and the overlapping of segregations is neglected. It is further assumed that the segregations are randomly distributed. The concentration and order distribution along the radius of a segregation can be very complicated. Since these distributions are unknown at present, certain simplifying assumptions have to be made. Three models are considered. In model A a segregation which is uniform in structure and composition occupies a sphere of radius r_2 inside a solid solution with constant concentration. Such segregation could appear in the case

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of allotropic phase transformations taking place without changes in concentration and also in transformations in which concentration does change but the effective diffusion length exceeds the distance between the segregations. The dependence of v (the "effective atomic volume" which is equal to the mean atomic volume of the atoms of the phase under consideration multiplied by the ratio of the number of atoms of this phase to the number of atoms in an equal volume of the parent phase before the deformation of the lattice) on the radius for segregations of type A is shown in Fig 1a. If the atomic volumes v_1 and v_3 of the segregation (phase I) and the parent phase (phase III) are different, distortions will appear in the crystal. If during a phase transformation the concentration does not remain constant, then in the initial stage of the process the segregation should be surrounded by a region impoverished in one of the

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The Theory of Scattering of X-rays by Distorted Nonuniform Solid Solutions

components. In order to take this effect into account the model B (Fig 1b) can be used or the model C (Fig 1c). These models are used to calculate the scattering of X-rays by crystals. In the first section a general formula is derived for the scattering intensity on the basis of the kinematic theory. This is then specialized to weakly distorted crystals (Section 2) and strongly distorted crystals (Section 3). It is shown that distortions lead to much stronger attenuation in the intensity of direct reflections than in the case of uniform solutions and to the appearance of certain characteristic features in the distribution of diffusely scattered X-rays.

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There are 2 figures and 12 references, 6 of which are Soviet, 1 Czechoslovak and 5 English.

ASSOCIATION: Institut metallofiziki AN UkrSSR (Institute of Metal Physics, Ac. Sc., UkrSSR)

SUBMITTED: November 30, 1959

S/126/60/010/002/021/028/XX
E201/E491

AUTHOR: Krivoglaz, M.A.

TITLE: Static Distortions and Weakening of Line Intensities in X-Ray or Neutron Diffraction Patterns of Solid Solutions With Face-Centred Cubic Lattices

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol.10, No.2, pp.169-182

TEXT: Static displacements of crystal atoms around an impurity affect quite strongly many properties of crystals. These displacements govern weakening of intensities of "correct" reflections (lines or spots) in X-ray or neutron diffraction patterns and they cause diffuse scattering. Knowledge of such displacements is essential in theories of the electrical resistance of solutions and of their other properties. In the present paper displacements of atoms at various distances from an impurity and root-mean-square displacements in substitutional and interstitial solid solutions with face-centred cubic lattices are calculated with allowance for crystal structure. The displacements are found in terms of a derivative of the atomic volume with respect to impurity concentration and Young's modulus. A quantity L^{o}

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Static Distortions and Weakening of Line Intensities in X-Ray or Neutron Diffraction Patterns of Solid Solutions With Face-Centred Cubic Lattices

is found it occurs in the exponent of an exponential function in the attenuation factor which describes weakening of intensities of "correct" reflections produced by static displacements. The numerical values of L^{o} and atomic displacements are calculated for alloys based on Ag, Al, Au, Cu, Ni, Pb (Tables 1 and 4). Allowing for anisotropy, the displacements are found also at large distances from an impurity. The effect of establishment of short-range order on L^{o} is studied and shown to be considerable in some cases. The paper is entirely theoretical. There are 5 tables and 19 references: 7 Soviet, 8 English, 1 German and 3 International.

ASSOCIATION: Institut metallofiziki AN USSR
(Institute of Physics of Metals AS UkrSSR)

SUBMITTED: February 29, 1960

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85035

18 8200 2308, 1146, 1045 only

S/126/60/010/004/001/023
E032/E314

AUTHOR: Krivoglaz, M.A.

TITLE: Theory of Damping of Elastic Waves in Two-phase Mixtures

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol. 10, No. 4, pp. 497 - 512

TEXT: The author discusses elastic waves in a two-phase mixture in thermodynamic equilibrium. Changes in the elastic stress (pressure) and temperature which are associated with the waves upset the conditions of phase equilibrium and produce phase transformations. In addition to elastic deformations other types of deformation will appear, for example, volume changes associated with differences in the molecular volumes of the two phases, so that the velocity of propagation of the wave is not a function of the elastic moduli only, and may differ very considerably from the velocity in a single-phase system. At large frequencies transformations do not succeed in taking place and the velocity is determined by the elastic moduli only. It follows that the velocity of propagation depends on the frequency and the phase-transformation relaxation

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Theory of Damping of Elastic Waves in Two-phase Mixtures

time. Expressions are derived in the present paper for the velocity and absorption coefficient as functions of frequency for various relaxation times, temperatures and relative concentrations of the two phases. Single-component two-phase systems and two-phase mixtures of solid solutions are discussed. There are 10 references: 6 Soviet, 2 English and 2 international.

ASSOCIATION: Institut metallofiziki AN UkrSSR (Institute of Metal Physics of the AS Ukrainian SSR)

SUBMITTED: May 23, 1960

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19(0), 24(0)

S/053/60/0
B006/B017

AUTHORS: Danilenko, V. M., Krivoglaz, M. A., Larikov, L. N., Smirnov, A. A.

TITLE: Congress of the Ukrainian Republic on the Theory of Metals and Alloys

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol 70, Nr 1, pp 191-198 (USSR)

ABSTRACT: This Conference which took place from 1 - 5 June, 1959 in Kiyev was attended by scientists from the Ukraine and from other Republics of the Union; 70 lectures were delivered and discussed in 2 plenary meetings in 2 sections (electron theory and molecular-kinetic theory of metals and alloys). The problems and prospects of metal theory in the light of the fulfillment of the Seven-year Plan and the phenomenological theory of ferromagnetism were summarized in 2 lectures by I. M. Lifshits and S. V. Vonsovskiy. The following lecture were also delivered: V. P. Silin on the investigation of the influence of the interaction between the conduction electr on the metal properties by the aid of the theory by L. D.

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Congress of the Ukrainian Republic on the Theory of Metals and Alloys

S/053/60/070/01/006/007
B006/B017

dau; I. M. Lifshits and V. G. Peschanskiy on the galvanomagnetic characteristics of metals with open Fermi surfaces in strong magnetic fields; in this connection a paper by Lifshits, M. Ya. Asbel', and M. I. Kaganov on the relations between the asymptotic behavior of these characteristics and the topology of the Fermi surface were analyzed, the resistance change in the magnetic field was (depending on the direction) found to increase quadratically or to approach a saturation value; according to the law by P. L. Kapitsa, however, the increase should be linear. M. Ya. Asbel' reported on results of the quantum theory of the electric high-frequency resistance which he set up; M. Ya. Asbel' and E. A. Kaner investigated the cyclotron resonance in metals in the region of the anomalous skin effect in magnetic fields by the aid of the aforementioned theory; M. I. Kaganov investigated the case of a non-quadratic dependence of the electron energy on the impulse; Yu. A. Bychkov, L. E. Gurevich, and G. M. Nedlin reported on the thermomagnetic effect in strong magnetic fields; A. A. Smirnov and M. A. Krivoglaz on a determination of the shape of the Fermi surface in metals via a determination of the total

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momenta of the photon pairs which are formed in the annihilation of positrons and conduction electrons; A. M. Kosevich on a theory of the influence exercised by elastic deformation on the energy spectrum of the electrons in the metal and on the oscillation of magnetic susceptibility; B. I. Berkin and I. M. Dmitrenko on the results of an experimental investigation of the influence of a compression from all sides on the anisotropy and the de Haas-Van Alfen effect in crystals of weakly magnetic metals; V. L. Gurevich on sound absorption in the magnetic field in the case of an arbitrary law of dispersion; G. L. Kotkin on sound absorption in metals for arbitrary Fermi surfaces; A. A. Galkin and A. P. Korolyuk on the experimental determination of fluctuations of the ultrasonic absorption coefficient in the magnetic field for tin and zinc; M. A. Krivoglaz and Ye. A. Tikhonova on the theory of X-ray- and slow neutron scattering in solid solutions; V. I. Iveronova and A.A. Katsnel'son on the theory of the intensity distribution of diffused scattering; M. A. Krivoglaz on the scattering of X-rays and of thermal neutrons; A. A. Smirnov and Ye. A. Tikhonova on the concentration dependence of the intensity of regular

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reflection and of the background of scattered X-rays; V. M. Danilenko on dislocations in ordered alloys; A. N. Men' and A. N. Orlov on the computation of the maximum oscillation frequency of the atoms of a binary solid solution with cubic body-centered lattice; A. P. Zvyagina and V. I. Iveronova on the dependence of the characteristic Debye temperature of an alloy on the form of the spectrum of the thermal vibrations of the atoms; K. B. Vlasov on the rotation of the polarization plane of elastic transversal waves which propagate in a metal along the direction of the magnetic field; A. A. Berdyshev and B. V. Karpenko on the interaction of the inner electrons by means of conduction electrons; B. V. Karpenko and A. A. Berdyshev on the interaction of conduction electrons and spin waves in an antiferromagnetic; L. M. Petrova and Yu. P. Irkhin on the computation of Hall's constant of a ferromagnetic metal within the framework of the s-d exchange model by Vonsovskiy; P. S. Zyryanov, T. G. Izyumova, and G. V. Skrotskiy on the electric resistance of ferromagnetic metals in the radiofrequency range near the ferromagnetic resonance; Yu. A. Izyumov and

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G. V. Skrotskiy on the magnetic spin resonance of conduction electrons; A. I. Gubanov on ferromagnetism in amorphous ferromagnetics; M. Ya. Azbel', V. I. Gerasimenko, and I. M. Lifshits on paramagnetic resonance in metals if the skin depth is very small compared to the sample dimensions; V. P. Silin on a macroscopic theory of the optical effects in metals in the range of the normal and of the anomalous skin effect. S. V. Konstantinov and V. I. Perel' on the conductivity and the magnetic susceptibility of a metal in the variable electromagnetic field in taking into account three-dimensional dispersion; B. A. Grinberg and A. N. Orlov on the resistance change in the magnetic field and the Hall effect in a pure metal; A. A. Smirnov and A. I. Nosar' on a theory of the electric resistance of alloys with distorted lattice within the framework of the many-electron model of metal; G. V. Samsonov and V. S. Neshpor on the conductivity of Mo_3Si and $MoSi_2$; G. V. Samsonov and Yu. B. Paderno on the investigations of the physical properties and the electron configuration of rare earth hexaborides; V. Ye. Mikryukov on the experimental results

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concerning the Wiedemann-Franz law in metals and alloys; G. Ye. Pikus and V. B. Fiks on the electrotechnical effects in liquid metals; I. B. Borovskiy and K. P. Gurov on the influence of impurities on the physical properties of transition metals; M. I. Korsunskiy and G. P. Borovikova on the influence of impurities on the X-ray spectra of solids; I. M. Lifshits on a new type of phase transitions in metals at high pressures; I. M. Lifshits and G. I. Stepanova on a method of describing solutions by the introduction of correlation functions for the atom groups; B. N. Finkel'shteyn on the thermodynamics of a three-component solid solution; Z. A. Matysina and A. A. Smirnov on the theory of the ordering of alloys with hexagonal closely packed lattice; I. A. Gindin, B. G. Lazarev, Ya. D. Starodubov, and V. I. Khotkevich on the existence of low-temperature isomorphic transformations of a series of metals (alkali, Bi, Be); I. M. Lifshits and V. V. Slezov on the coagulation of particles in the late stage of decay; R. I. Garber on the kinetics of pore formation in rock salt crystals; V. I. Vladimirov on the theory of coagulation of

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surplus vacancies in a solid; B. Ya. Lyubov and A. L. Roytburd on the theory of the growth of martensite crystals; L. N. Larikov on the kinetics of the recrystallization in deformed metals and alloys; I. V. Salli on the problem of the lines of the metastable equilibrium in the diagrams of binary systems; M. I. Zakharova and I. N. Stetsenko on phase transformations in iron-vanadium alloys; K. P. Gurov on the relation between the activation energy of self-diffusion with the characteristic temperature of pure metals; I. M. Fedorchenko and A. I. Raychenko on the volume increase in heating mixed powders; Ye. A. Tikhonova on the diffusion theory of interstitial atoms in alloys of the CuAu type; V. E. Fiks on the mobility mechanism of the impurity ions in metals in an electric field; P. P. Kuz'menko and Ye. I. Khar'kov on experimental investigations of charge transfer in pure metals by means of tracer atoms; I. N. Frantsevich, D. F. Kalinovich, I. I. Kovenskiy, M. D. Smolin, and M. D. Glinchuk on investigations of the mutual charge transfer of both components in binary solid

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solutions of C, Cr, Mo, and tungsten in iron by means of radioactive isotopes; I. A. Oding and V. N. Geminov on the destruction of metals in creeping at increased temperatures; I. A. Oding and L. K. Gordiyenko on the variation of the mechanical properties of the metals with preceding creeping test; B. Ya. Pines on characteristics of the diffusion mechanism in creeping; N. S. Zhurkov and A. V. Savitskiy on the experimental verification of the diffusion theory in the mechanical destruction in pure silver and in an Ag + 5% Al alloy; N. S. Fastov on the thermodynamics of irreversible processes in the deformation of metals; V. I. Khotkevich obtained the same results in this respect; A. I. Gindin communicated data on the increase of the plasticity of armco iron at low temperatures by preceding plastic deformation at higher temperatures. Yu. M. Plishkin reported on the stable configurations of atomic layers in expanding cylindrical crystals into the direction of the axis. K. P. Rodionov reported on the anomalous change of physical properties of a solid in a temperature range which, in general, does not coincide with the melting temperature.

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S/053/60/070/01/006/007
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N. I. Barich on the rules governing the periodic change of the interatomic binding forces as depending on the position of the elements in the periodic system by D. I. Mendeleyev. G. M. Vorob'yev on the measurement of the intensity of X-ray interferences in the case of texturated samples. A. S. Viglin also spoke about problems of texture.

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24.7100(1160, 1136, 1142)

23121

S/181/61/003/005/026/042
B108/B209

AUTHORS: Kashcheyev, V. N. and Krivoglaz, M. A.

TITLE: Effect of anharmonism upon the energy distribution of inelastically scattered neutrons. I. The case of a weak bond

PERIODICAL: Fizika tverdogo tela, v. 3, no. 5, 1961, 1528-1540

TEXT: In studying the scattering of slow monochromatic neutrons, the authors confine themselves to single-phonon scattering from a perfect crystal. Neutron absorption and magnetic scattering are neglected. The expression for the differential scattering cross section of the above neutrons is divided into two portions, corresponding to coherent and incoherent scattering:

$$\sigma_c(\mathbf{q}_1, \omega) = CN\frac{k_2}{k_1}\sum_{jj'}\frac{Q_{j\mathbf{q}_1}Q^*_{j'\mathbf{q}_1}}{\sqrt{\omega_{\mathbf{q}j}\omega_{\mathbf{q}j'}}}[\varphi'_{\mathbf{q}j\mathbf{q}j'}(\omega) + \varphi''_{\mathbf{q}j\mathbf{q}j'}(\omega)], \quad (5)$$

$$\sigma_i(\mathbf{q}_1, \omega) = C\frac{k_2}{k_1}\sum_{jj'}\sum_{\mathbf{k}}\frac{S_{jj'}(\mathbf{k})}{\sqrt{\omega_{\mathbf{k}j}\omega_{\mathbf{k}j'}}}[\varphi'_{\mathbf{k}j\mathbf{k}j'}(\omega) + \varphi''_{\mathbf{k}j\mathbf{k}j'}(\omega)]. \quad (6),$$

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Effect of anharmonism upon the ...

where

$$C = \frac{m^2}{8\pi^2\hbar^4 pv};$$
$$Q_{jq_1} = \sum_\gamma \bar{A}_\gamma (q_1 e_{q j\gamma}) e^{2\pi i K_n R_{s\gamma}}$$
$$S_{jq_1}(k) = \sum_\gamma |q_1 e_{kj\gamma}|^2 \left[\overline{(A_{s\gamma} - \bar{A}_\gamma)^2} + \overline{B^2_{s\gamma}}\right]. \quad (7);$$

$\bar{A}_\gamma$ and $A_{s\gamma} - \bar{A}_\gamma$ are the mean and the varying portions of the constant $A_{s\gamma}$ which characterizes the lattice nodes of kind γ. $A_{s\gamma}$ and $B_{s\gamma}$ are the constants in the expression for the interaction energy of slow neutrons with a nucleus at the lattice node $s\gamma$ (s indicates the number of the respective lattice cell). $\vec{q}_1 = \vec{k}_2 - \vec{k}_1$; $\vec{q} = \vec{q}_1 - 2\pi\vec{K}_n$; $\vec{K}_n$ is the vector of the reciprocal lattice; $\vec{R}_{s\gamma}$ is the radius vector of the respective nodes and $\vec{e}_{kj\gamma}$ is the polarization vector. The quantities φ' and φ'' entering Eqs. (5)

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and (6) are then determined from the relations

$$\left.\begin{aligned}\varphi'_{k_j k_{j'}}(\omega) &= \frac{1}{2\pi}\int_{-\infty}^{\infty} dt\, e^{-i\omega t}\,\mathrm{Sp}\left(a_{k_j}(t)\, a^{+}_{k_{j'}}(0)\, e^{-\lambda H}\right)\left(\mathrm{Sp}\, e^{-\lambda H}\right)^{-1},\\ \varphi''_{k_j k_{j'}}(\omega) &= \frac{1}{2\pi}\int_{-\infty}^{\infty} dt\, e^{-i\omega t}\,\mathrm{Sp}\left(a^{+}_{k_j}(t)\, a_{k_{j'}}(0)\, e^{-\lambda H}\right)\left(\mathrm{Sp}\, e^{-\lambda H}\right)^{-1}.\end{aligned}\right| \quad (8).$$

Since these quantities are chiefly determined by the dynamical properties of the system, they are calculated from the Hamiltonian as expressed by the creation and annihilation operators. With the help of Green's function according to Ref. 8 (N. N. Bogolyubov, S. V. Tyablikov. DAN SSSR, 126, 53, 1959; D. N. Zubarev. UFN, 71, 71, 1960), the authors obtained

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$$\left.\begin{aligned}\varphi'_{kj\,kj}(\omega) &= \frac{1}{\pi}\,\frac{\Gamma_{kj}(\omega)\,n(\omega)}{[\omega-\omega_{kj}-P_{kj}(\omega)]^2+\Gamma^2_{kj}(\omega)},\\ \varphi'_{kj\,kj}(-\omega) &= \frac{1}{\pi}\,\frac{\Gamma_{kj}(\omega)\,[n(\omega)+1]}{[\omega-\omega_{kj}-P_{kj}(\omega)]^2+\Gamma^2_{kj}(\omega)},\end{aligned}\right\} \quad (12)$$

$$\left.\begin{aligned}\varphi''_{kj'kj}(\omega) &= \frac{P_{kjj'}(\omega)\,\varphi''_{kj'kj'}(\omega)}{\omega-\omega_{kj}}+\frac{1}{\pi}\,\frac{\Gamma_{kjj'}(\omega)\,n(\omega)}{\omega-\omega_{kj}}\times\\ &\times\frac{\omega-\omega_{kj'}-P_{kj'}(\omega)}{[\omega-\omega_{kj'}-P_{kj'}(\omega)]^2+\Gamma^2_{kj'}(\omega)},\\ \varphi'_{kj'kj}(-\omega) &= \frac{P_{kjj'}(\omega)\,\varphi'_{kj'kj'}(-\omega)}{\omega-\omega_{kj}}+\frac{1}{\pi}\,\frac{\Gamma_{kjj'}(\omega)\,[n(\omega)+1]}{\omega-\omega_{kj}}\times\\ &\times\frac{\omega-\omega_{kj'}-P_{kj'}(\omega)}{[\omega-\omega_{kj'}-P_{kj'}(\omega)]^2+\Gamma^2_{kj'}(\omega)}\ (\text{при }\omega\simeq\omega_{kj'}).\end{aligned}\right\} \quad (13),$$

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where

$$\left.\begin{aligned} \Gamma_{\mathbf{k}jj'}(\omega) = \frac{\pi}{2\hbar^2}\sum_{\mathbf{k}_1j_1,\mathbf{k}_2j_2} V_{-\mathbf{k}j,\mathbf{k}_1j_1,\mathbf{k}_2j_2}V^*_{-\mathbf{k}j',\mathbf{k}_1j_1,\mathbf{k}_2j_2}\{(1+n_{\mathbf{k}_1j_1}+n_{\mathbf{k}_2j_2})\times \\ \times[\delta(\omega-\omega_{\mathbf{k}_1j_1}-\omega_{\mathbf{k}_2j_2})-\delta(\omega+\omega_{\mathbf{k}_1j_1}+\omega_{\mathbf{k}_2j_2})]+ \\ +2(n_{\mathbf{k}_1j_1}-n_{\mathbf{k}_2j_2})\delta(\omega+\omega_{\mathbf{k}_1j_1}-\omega_{\mathbf{k}_2j_2})\}, \\ \Gamma_{\mathbf{k}j}(\omega)\equiv\Gamma_{\mathbf{k}jj}(\omega), \end{aligned}\right\} \quad (14)$$

and

$$\left.\begin{aligned} P_{\mathbf{k}jj'}(\omega) = \frac{\pi}{2\hbar^2}P\sum_{\mathbf{k}_1j_1,\mathbf{k}_2j_2} V_{-\mathbf{k}j,\mathbf{k}_1j_1,\mathbf{k}_2j_2}V^*_{-\mathbf{k}j',\mathbf{k}_1j_1,\mathbf{k}_2j_2}\left(\frac{1+n_{\mathbf{k}_1j_1}+n_{\mathbf{k}_2j_2}}{\omega-\omega_{\mathbf{k}_1j_1}-\omega_{\mathbf{k}_2j_2}}-\right. \\ \left.-\frac{1+n_{\mathbf{k}_1j_1}+n_{\mathbf{k}_2j_2}}{\omega+\omega_{\mathbf{k}_1j_1}+\omega_{\mathbf{k}_2j_2}}+2\frac{n_{\mathbf{k}_1j_1}-n_{\mathbf{k}_2j_2}}{\omega+\omega_{\mathbf{k}_1j_1}-\omega_{\mathbf{k}_2j_2}}\right), \\ P_{\mathbf{k}j}(\omega)\equiv P_{\mathbf{k}jj}(\omega), \\ n(\omega)=(e^{\lambda\hbar\omega}-1)^{-1};\quad n_{\mathbf{k}j}=n(\omega_{\mathbf{k}j}). \end{aligned}\right\} \quad (15)$$

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S/181/61/003/005/026/042
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Effect of anharmonism upon the ...

The coefficients at the third-order term in the expansion of the potential energy of the crystal according to the displacement of the atoms, $V^{ikl}_{s\gamma s'\gamma' s''\gamma''}$, enter these relations through the expression

$$V_{kj k'j' k''j''} = \left(\frac{\hbar}{2\rho N v}\right)^{3/2} \sum_{s\gamma s'\gamma' s''\gamma''} \sum_{ikl} \frac{V^{ikl}_{s\gamma s'\gamma' s''\gamma''} e^{i}_{kj\gamma} e^{k}_{k'j'\gamma'} e^{l}_{k''j''\gamma''}}{\sqrt{\omega_{kj}\omega_{k'j'}\omega_{k''j''}}} \times \exp\left[i\left(\mathbf{k}\mathbf{R}_{s\gamma} + \mathbf{k}'\mathbf{R}_{s'\gamma'} + \mathbf{k}''\mathbf{R}_{s''\gamma''}\right)\right], \qquad (10).$$

The widening of the peaks in the energy distribution of the scattered neutrons, $\Gamma_{\vec{k}j}(\omega)$, is found to be proportional to kT^4 at low temperatures ($\varkappa T \ll h\omega_m$), and to kT at high temperatures, both in second approximation. ω_m is the maximum frequency of acoustic phonons. Eqs. (14) and (15) show

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that for j = j' for short-wave acoustic and optical phonons, the frequency shift of the phonon vibrations, $P_{\vec{k}j}(\omega)$, is approximately equal to the widening of the scattering peaks. Thus, in rough estimation, $P_{\vec{k}j}(\omega) \propto 0.1\omega_m$ for low temperatures and $P_{\vec{k}j}(\omega) \propto 0.1 \frac{\varkappa T}{\hbar}$ for high temperatures. There are 16 references: 10 Soviet-bloc and 6 non-Soviet-bloc. The two references to English-language publications read as follows: G. Placzek, L. van Hove. Phys. Rev., 93, 1207, 1954; M. Cohen, R. P. Feynman. Phys. Rev., 107, 13, 1957.

ASSOCIATION: Institut fiziki AN LSSR (Institute of Physics, AS Latviyskaya SSR), Institut metallofiziki AN USSR Kiyev (Institute of Physics of Metals, AS UkrSSR, Kiyev)

SUBMITTED: November 19, 1960

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APPROVED FOR RELEASE: 06/14/2000 CIA-RDP86-00513R000826520020-6"

23122
S/181/61/003/005/027/042
B108/B209

24,7900 (1144, 1158, 1163)

AUTHORS: Kashcheyev, V. N. and Krivoglaz, M. A.

TITLE: Effect of spin-spin and spin-phonon interaction in a ferromagnetic on the energy distribution of scattered neutrons.

PERIODICAL: Fizika tverdogo tela, v. 3, no. 5, 1961, 1541-1552

TEXT: The authors studied the effect of elementary excitations on the energy distribution of neutrons scattered from a ferromagnetic at temperatures far below the Curie point. The differential scattering cross section of unpolarized neutrons may be written in two components, one of which accounts for magnetic single-magnon (spin-wave) scattering (σ_1), the other for magnetic single-phonon scattering (σ_2):

$$\sigma(\mathbf{q}_1, \omega) = \sigma_1(\mathbf{q}_1, \omega) + \sigma_2(\mathbf{q}_1, \omega), \tag{3}$$

$$\sigma_1(\mathbf{q}_1, \omega) = CN\frac{k_2}{k_1}\left(1 + \frac{q_{1z}^2}{q_1^2}\right)[\varphi_q'(\omega) + \varphi_q''(\omega)] \tag{4}$$

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S/181/61/003/005/027/042
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Effect of spin-spin and ...

$$\left.\begin{aligned} \varphi'_q(\omega) &= \frac{1}{2\pi}\int\limits_{-\infty}^{\infty} dt e^{-i\omega t}\,\mathrm{Sp}\,\{b_q(t)\,b_q^+(0)\,e^{-\lambda H}\}\,(\mathrm{Sp}\,e^{-\lambda H})^{-1},\\ \varphi''_q(\omega) &= \frac{1}{2\pi}\int\limits_{-\infty}^{\infty} dt e^{-i\omega t}\,\mathrm{Sp}\,\{b_q^+(t)\,b_q\,(0)\,e^{-\lambda H}\}\,(\mathrm{Sp}\,e^{-\lambda H})^{-1}. \end{aligned}\right\} \quad (5).$$

In these expressions, $\vec{q} = \vec{q}_1 - 2\pi\vec{K}_n$; $\vec{q}_1 = \vec{k}_2 - \vec{k}_1$; $\vec{K}_n$ - vectors of the nodes of the reciprocal lattice. Expressing φ' and φ'' by Green's function one obtains

$$\left.\begin{aligned} \sigma'_1(q_1, \omega) &= \frac{C'N}{\pi}\frac{k_2}{k_1}\left(1+\frac{q_{1z}^2}{q_1^2}\right)\frac{\Gamma_q(\omega)\,N(\omega)}{[\omega-\omega_q-P_q(\omega)]^2+\Gamma_q^2(\omega)},\\ \sigma''_1(q_1, -\omega) &= \frac{C'N}{\pi}\frac{k_2}{k_1}\left(1+\frac{q_{1z}^2}{q_1^2}\right)\frac{\Gamma_q(\omega)\,[N(\omega)+1]}{[\omega-\omega_q-P_q(\omega)]^2+\Gamma_q^2(\omega)}, \end{aligned}\right\} \quad (10)$$

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for the cross sections of single-magnon scattering (Ref. 2: V. N. Kashcheyev, M. A. Krivoglaz, FTT, v. 3, no. 5, 1961), where σ_1' corresponds to the absorption and σ_1'' to the emission of a magnon by a neutron. The attenuation of a phonon, $\Gamma_{\vec{q}}(\omega)$, its frequency shift $P_{\vec{q}}(\omega)$, and $N(\omega)$ are given by the following expressions:

$$N(\omega) = (e^{\lambda\hbar\omega} - 1)^{-1}; \quad \Gamma_{x}(\omega) = \Gamma_{x3}(\omega) + \Gamma_{x4}(\omega) + \Gamma_{xsl}(\omega),$$

$$\Gamma_{x3}(\omega) = \frac{\pi}{\hbar^2} \sum_{x'} \Big\{ |V_{xx'x+x'}|^2 (N_{x'} - N_{x+x'}) \delta(\omega + \omega_{x'} - \omega_{x+x'}) + \frac{1}{2} |V_{x'x-x'x}|^2 (1 + N_{x'} + N_{x-x'}) \delta(\omega - \omega_{x'} - \omega_{x-x'}) \Big\}, \qquad (11)$$

$$\Gamma_{n4}(\omega)=\frac{2\pi}{\hbar^2}\sum_{n'n''}|V_{nn'+n''-nn'n''}|^2\,[N_{n'+n''-n}(1+N_{n'}+N_{n''})-N_{n'}N_{n''}]\times$$

$$\times\,\delta(\omega+\omega_{n'+n''-n}-\omega_{n'}-\omega_{n''})+\frac{6\pi}{\hbar^2}\sum_{n'n''}\{|V'_{nn-n'-n''n'n''}|^2[(1+N_{n-n'-n''})\times$$

$$\times(1+N_{n'}+N_{n''})+N_{n'}N_{n''}]\,\delta(\omega-\omega_{n-n'-n''}-\omega_{n'}-\omega_{n''})+3\,|V'_{n+n'+n''nn'n''}|^2\times$$

$$\times[N_{n'}N_{n''}-N_{n+n'+n''}(1+N_{n'}+N_{n''})]\,\delta(\omega+\omega_{n'}+\omega_{n''}-\omega_{n+n'+n''})\}, \quad (12)$$

$$\Gamma_{nel}(\omega)=\frac{\pi}{\hbar^2}\sum_{kj}\{|V_{nn-kkj}|^2(1+n_{kj}+N_{n-k})\,\delta(\omega-\omega_{n-k}-\omega_{kj})+$$

$$+|V_{n+knkj}|^2(n_{kj}-N_{k+n})\,\delta(\omega-\omega_{k+n}+\omega_{kj})+$$

$$+|V'_{nk-nkj}|^2(N_{k-n}-n_{kj})\,\delta(\omega-\omega_{kj}+\omega_{k-n})\}. \quad (13).$$

$$P_n(\omega)=P_{n3}(\omega)+P_{n4}(\omega)+P_{nel}(\omega).$$

In the following, the authors study the dependence of Γ and P on tempera-

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ture and on the wave vector. The attenuation due to spin-spin interaction in cubic crystals is found to be

$$\left.\begin{array}{c} \Gamma_{\varkappa}(\omega_{\varkappa}) = \frac{\zeta(5/2)}{32\pi^3\sqrt{2\pi}}\left(\frac{g\hbar}{\mu}\right)^2 v^3\omega_2\varkappa^3\left(\frac{\varkappa_B T}{\hbar\omega_2}\right)^{5/2} \simeq \frac{0.1}{S^2}\frac{\varkappa_B T_c}{\hbar}\left(\frac{\varkappa}{\varkappa_m}\right)^3\left(\frac{T}{T_c}\right)^{5/2}, \\ \hbar\omega_{\varkappa} \gg \varkappa_B T, \\ \Gamma_{\varkappa}(\omega_{\varkappa}) - \frac{1}{48\pi^3}\left(\frac{g\hbar}{\mu}\right)^2 v^2\omega_2\varkappa^4\left(\frac{\varkappa_B T}{\hbar\omega_2}\right)^2 \ln^2\frac{\hbar\omega_2\varkappa^2}{\xi\varkappa_B T} \simeq \\ \simeq \frac{1}{S^2}\frac{\varkappa_B T_c}{\hbar}\left(\frac{\varkappa}{\varkappa_m}\right)^4\left(\frac{T}{T_c}\right)^2 \ln^2\frac{\varkappa T_c}{\varkappa_m T}. \\ \hbar\omega_{\varkappa} \ll \varkappa_B T. \end{array}\right\} (16),$$

where $\zeta(5/2) = 1.341$ (Riemannian zeta function), $\xi \simeq 1$, T_c - Curie temperature, $g = g_0\mu_0\hbar^{-1}$; g_0 - gyromagnetic factor, μ_0 - Bohr's magneton, μ - magnetic moment of the atom, $\varkappa_Б$ - Boltzmann's constant, v - atomic

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volume. The temperature dependence of P is given by

$$P_{\kappa} = -\frac{\zeta(^5/_2)}{128\pi\sqrt{2\pi}}\frac{1}{S}\left(\frac{\varkappa_B T}{IS}\right)^{5/2}\omega_{\kappa} \simeq -\frac{0.04}{S}\left(\frac{T}{T_c}\right)^{5/2}\omega_{\kappa}. \quad (18)$$

where I indicates the volume integral. In the case of spin-phonon interaction,

$$\left.\begin{aligned} \Gamma_{\kappa\parallel}(\omega_{\kappa}) &= \frac{2}{3\pi}\frac{a^4(\varkappa_B T_c)^2}{\hbar^2\rho c_1^2\omega_2}(\beta_1^2+\beta_1\beta_2+\beta_2^2)\varkappa_B T\kappa^3, \\ \Gamma_{\kappa\perp}(\omega_{\kappa}) &= \frac{a^4(\varkappa_B T_c)^2\beta_1^2}{\pi\hbar^2\rho\omega_2^3}\varkappa_B T\kappa^3. \end{aligned}\right\} \quad (24)$$

holds for high temperatures (T higher than the Debye temperature) and great

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$\varkappa \gg \varkappa_\pi$ ($\varkappa_{\pi\parallel} = \frac{c_1}{\omega_2}$; $\varkappa_{\pi\perp} = \frac{c_2}{\omega_2}$; c_1 and c_2 are the velocities of longitudinal and transverse phonons, respectively). For non-zero temperatures, this expression goes over into

$$\left.\begin{aligned} \Gamma_{\varkappa\parallel}(\omega_\varkappa) &= \frac{16a^4\varkappa_B T_c c_1^3}{3\pi\rho\omega_2^4}(\beta_1+\beta_2)^2 n_{\varkappa j}(n_{\varkappa j}+1)\,|\varkappa^4|_{\varkappa=2\frac{c_1}{\omega_2}} \\ \Gamma_{\varkappa\perp}(\omega_\varkappa) &= \frac{8a^4\varkappa_B T_c c_2^3\beta_1^2}{3\pi\rho\omega_2^4} n_{\varkappa j}(n_{\varkappa j}+1)\,|\varkappa^4|_{\varkappa=2\frac{c_2}{\omega_2}}. \end{aligned}\right\} \quad (25)$$

when $\varkappa \ll \varkappa_\pi$ and $\hbar\omega_\varkappa \ll \varkappa_B T$; β_1 and β_2 are dimensionless constants of the order of unity. For the same case, the frequency shift has the form

$$P_{\varkappa\parallel}(\omega_\varkappa) = -\frac{\sqrt{2}\,\zeta(5/2)}{\pi^{5/2}}\frac{a^4(\varkappa_B T_c)^2(\beta_1+\beta_2)^2}{\rho c_1^2 \hbar}\varkappa^2\left(\frac{\varkappa_B T}{\hbar\omega_2}\right)^{5/2}, \quad T \ll 0.1\frac{T_A^2}{T_c}, \quad (27)$$

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$$P_{n\parallel}(\omega_n) = -\frac{4\pi^2}{45}\frac{a^4(\varkappa_B T_c)^2(\beta_1+\beta_2)^2}{\rho c_1 \hbar \omega_2}\varkappa^2\left(\frac{\varkappa_B T}{\hbar c_1}\right)^4, \quad 0.1\frac{T_\lambda^2}{T_c} \ll T \ll T_\lambda, \qquad (28)$$

$$P_{n\parallel}(\omega_n) = -\frac{4}{9\pi^2}\frac{a^4(\varkappa_B T_c)^2(\beta_1+\beta_2)^2\varkappa_m^2}{\rho \hbar \omega_2 c_1}\varkappa^2\frac{\varkappa_B T}{\hbar c_1}, \quad T > T_\lambda, \; 0.1\, T_\lambda \gg T_c. \qquad (29)$$

the corresponding expressions for transverse phonons are obtained from Eq.(27) by the substitutions $(\beta_1 + \beta_2)^2 \longrightarrow \frac{1}{2}\beta_1^2$ and $c_1 \longrightarrow c_2$. There are 15 references: 8 Soviet-bloc and 7 non-Soviet-bloc. The reference to an English-language publication reads as follows: R. J. Elliott, R. D. Lowde. Proc. Roy. Soc., 230, 46, 1955.

ASSOCIATION: Institut fiziki AN LSSR (Institute of Physics, AS Latviyskaya SSR), Institut metallofiziki AN USSR Kiyev (Institute of Metal Physics, AS UkrSSR, Kiyev)

SUBMITTED: November 19, 1960

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KRIVOGLAZ, M.A.

Effect of conduction electrons on neutron scattering by crystals. Fiz. tver. tela 3 no.9:2761-2773 S '61. (MIRA 14:9)

1. Institut metallofiziki AN USSR, Kiyev.
(Electrons) (Neutrons—Scattering)

KASHCHEYEV, V.N.; KRIVOGLAZ, M.A.

Theory of inelastic neutron scattering on impurity centers in crystals. Fiz.tver.tela 3 no.10:2167-2180 O '61. (MIRA 14:10)

1. Institut fiziki AN Latviyskoy SSR, Riga i Institut metallofiziki AN USSR, Kiyev.
(Neutrons--Scattering) (Crystal lattices)

32073

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B104/B102

24 7500

AUTHOR: Krivoglaz, M. A.

TITLE: Extension of singularities of the frequency dependences of the damping of elementary excitations in crystals

PERIODICAL: Fizika tverdogo tela, v. 3, no. 12, 1961, 3678 - 3681

TEXT: The author studies the frequency dependence of the damping of elementary excitations near spectral singularities such as minima, maxima or saddle points. The author also studies the frequency dependence of damping near the threshold points of the elementary excitation with emission of a long-wave phonon. Referring to L. P. Pitayevskiy (ZhETF, 36, 1168, 1959) and to a previous paper by himself the author studies the extension of singularities for the case where the damping of phonons is due to their scattering from static inhomogenities of a solid solution. The Hamiltonian then has the form $H = \sum_{kj} \hbar\omega_{kj} a^+_{kj} a_{kj} + \sum_{kjk'j'} V_{kjk'j'} a^+_{kj} a_{k'j'} -$ (1)

$$-\frac{1}{2}\sum_{kjk'j'} (V'_{kjk'j'} a^+_{kj} a^+_{k'j'} + \text{s. c.}),$$

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where $a^{+}_{\vec{k}j}$ and $a_{\vec{k}j}$ are the phonon production and annihilation operators. Using relation

$$\langle\langle a_{kj}; a^{+}_{kj}\rangle\rangle = \frac{1}{2\pi}\frac{1}{\omega - \omega_{kj} - R_{kj}(\omega) - Q_{kj}(\omega)} \qquad (2)$$

where

$$R_{kj}(\omega) = \sum_{k'j'}\left[\frac{|V_{kj,k'j'}|^2}{\omega - \omega_{k'j'} - R'_{k'j'}(\omega)} - \frac{|V'_{kj,k'j'}|^2}{\omega + \omega_{k'j'} + R'_{k'j'}(-\omega)}\right]. \qquad (3)$$

for the Green functions, correlation functions between $a^{+}_{\vec{k}j}$ and $a_{\vec{k}j}$ for damping and level shift are found. A successive approximation is made of the inverse Green function with respect to the phonon interaction parameter V which is of higher order than that made in the mentioned previous papers. If this higher approximation is taken into the singularities of the frequency dependence of damping are extended. For T→0 the extension interval decreases as T^2. At T = 0 the singularity does not seem extended. The author thanks L. P. Pitayevskiy for discussions. There are 5 references: 4 Soviet and 1 non-Soviet. The reference to the English-language

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B104/B102

Extension of singularities ...

publication reads as follows: L. Van Hove. Phys. Rev., 89, 1189, 1953.

ASSOCIATION: Institut metallofiziki AN USSR Kiyev (Institute of Physics of Metals of the AS UkrSSR, Kiyev)

SUBMITTED: July 10, 1961

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S/181/61/003/012/019/028
B104/B102

24.7200 (1153,1160)

AUTHOR: Krivoglaz, M. A.

TITLE: Theory of diffuse scattering of X-rays, neutron, and electron beams in ion crystals containing charged defects or impurities

PERIODICAL: Fizika tverdogo tela, v. 3, no. 12, 1961, 3682 - 3690

TEXT: In the first part the author studies the elastic scattering of X-rays and neutron beams from charged defects in non-piezo-electric ion crystals such as NaCl or CaCl, in which positive and negative defects of equal concentration are assumed to exist. The deformations and polarizations of the lattice around these defects and the Debye shielding of the defect fields are taken into account.

$$I_{\Phi} = \frac{1}{2} cN(f_{s.s.} - q_1 A'_q f_{s.s.})^2 + + \frac{1}{2} cN(f_{s.p.} - q_1 A''_q f_{s.s.} - q_1 B''_q f_{s.p.})^2 \frac{r^2 q^2}{1 + r^2 q^2}. \quad (13)$$

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is obtained for the intensity of the diffuse scattering of X-rays. c is the concentration of the defects, N is the number of cells, f'_{nc}, f'_{np}, f_{nc} and f_{np} are scattering factors, $\vec{q}_1$ is the difference between the wave vectors of scattered and incident waves, q stands for the distance to the lattice points, $A_{\vec{q}}$ and $B_{\vec{q}}$ are determined experimentally. The singularities of I, due to Coulomb shielding, are studied. In piezoelectrics, essential effects occur due to the fact that the atomic displacement is inversely proportional to the first power of the distance from the defect. In analogy to (13),

$$I_{\varphi} = \frac{1}{2} c N f^2_{nc} \left[\frac{|a_q|^2 (q_1 e'_q)^2}{q^2} + \frac{|a_q|^2 (q_1 e''_q)^2}{q^4} \frac{r^2 q^2}{1 + r^2 q^2} \right]. \qquad (17)$$

is obtained for the piezoelectrics. Here $\vec{e}'_q$ and $\vec{e}''_q$ are unit vectors. It is shown, that for the diffuse electron scattering from charged defects, on the condition $rq \gg 1$, and if the Coulomb shielding is unimportant, the

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differential elastic electron scattering cross section is proportional to q^{-4}. For $rq \ll 1$ it is proportional to q^{-2}. r is the shielding radius. There are 6 references: 3 Soviet and 3 non-Soviet. The reference to the English-language publication reads as follows: K. Huang. Proc. Roy. Soc., 190, 102, 1947.

ASSOCIATION: Institut metallofiziki AN USSR Kiyev (Institute of Physics of Metals of the UkrSSR, Kiyev)

SUBMITTED: July 10, 1961

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KRIVOGLAZ, M.A.; TIKHONOVA, Ye.A.

Effect of anharmonicity on the Debye factor of the weakening of line intensities in X-ray photographs. Kristallografiia 6 no.4:496-502 Jl-Ag '61. (MIRA 14:8)

1. Institut metallofiziki AN USSR.
(X-ray crystallography)

KRIVOGLAZ, M.A.

Theory of the damping of elastic vibrations in systems containing soluble particles or microcavities. Fiz. met. i metalloved. 12 no.3:338-349 S '61. (MIRA 14:9)

1. Institut metallofiziki AN USSR.
(Vibrations)

KRIVOGLAZ, M.A.

Theory of X ray scattering by crystals containing defects. Fiz. met. i metalloved. 12 no.4:465-475 O '61. (MIRA 14:11)

1. Institut metallofiziki AN USSR. (Crystals—Defects) (X rays—Scattering)

S/126/61/012/006/002/023
E032/E114

AUTHORS: Krivoglaz, M.A., and Tikhonova, Ye.A.

TITLE: The influence of thermal vibrations in solid solutions on the intensities of normal X-ray and neutron reflections and the intensity of the Mossbauer lines

PERIODICAL: Fizika metallov i metallovedeniye, v.12, no.6, 1961, 801-813

TEXT: After a brief introduction the authors give a derivation of a general formula for the Debye attenuation factor. Perturbation theory is used to derive this formula and the formula is accurate to within linear terms in the difference between the force constants and quadratic terms in the mass difference between the member atoms. Fluctuation non-uniformities in the concentration are explicitly taken into account and it is shown that they play an appreciable part. The analysis is then specialised to ideal solutions in which the atoms are distributed randomly over the lattice sites, ordered solutions in which the effect of short-range order on the Debye attenuation factor is investigated, and non-ideal unordered solutions. The intensity
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of the Mossbauer lines is investigated as a function of temperature. A more detailed discussion is given of the case of small concentration of radiating atoms. The paper is entirely theoretical. No numerical computations are reported.
There are 15 references: 11 Soviet-bloc and 4 non-Soviet-bloc.
The English language references read as follows:

Ref.3: D. B. Bowen, Acta met., v.2, 1954, 373.
Ref.10: J. Schwinger, Phys.Rev., v.82, 664, 1951.
Ref.12: G.L. Squires, Phys.Rev., v.103, 1956, 304.

ASSOCIATION: Institut metallofiziki AN USSR
(Institute of Metal Physics, AS Ukr.SSR)

SUBMITTED: April 11, 1961

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KRIVOGLAZ, M.A.

Theory of X-ray scattering by heterogenous solid solutions. **Pt.2: Case of nonspherical particles of a new phase.** Sbor. nauch. rab. Inst. metallofiz. AN URSR no.13:17-34 '61. (MIRA 14:12)

(X rays--Scattering) (Metal crystals)

KRIVOGLAZ, M.A.

Calculating the X-ray Debye temperature of crystals with a cubic face-centered lattice. Sbor. nauch. rab. Inst. metallofiz. AN URSR no.13:35-43 '61. (MIRA 14:12)
(Metal crystals—Thermal properties)
(Crystal lattices)

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S/056/61/040/002/030/047
B102/B201

AUTHOR: Krivoglaz, M. A.

TITLE: Theory of inelastic neutron scattering by imperfect crystals

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 2, 1961, 567-584

TEXT: While neutron scattering by ideal crystals has been studied a number of times, the lack is still felt of a comprehensive representation of the theory of inelastic neutron scattering in real crystals (or solid solutions) exhibiting lattice defects or distortions. A study of the neutron energy spectrum under different angles is of value in that one may therefrom infer the energy spectrum of the lattice vibrations; from the shape and width of this spectrum, in turn, one may infer the interaction of phonons with one another and with the inhomogeneities of the crystal, the photon relaxation time, the arrangement of atoms, etc. Apart from a peak broadening (due to coherent single-phonon scattering) the lattice imperfections should also give rise to a blurredness of the

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B102/B201

Theory of inelastic neutron scattering ...

coherent inelastic scattering. Formulas are given for ideal solutions, for nonideal solutions, and for solutions near the critical point on the decomposition curve as well as near the point of phase transition of second kind. The incoherent inelastic scattering is examined in chapter 3. Here again, some formulas are given for the scattering cross sections - all of which is for the case where no local vibrations occur. Chapter 4 deals with a study of neutron scattering by local vibrations; it is presupposed here that the impurity atoms (or other defects) have a strong effect upon the crystal vibrations, so that local levels appear; the defect concentration, however, is presupposed to be low. It is found in this case that the distribution width is dependent on temperature (at high temperatures it is proportional to T). The following results have been obtained: phonon scattering by static inhomogeneities of crystals leads to a broadening of the peaks in the energy spectrum of coherently scattered neutrons; this broadening is considerably dependent upon the order in the arrangement of the solution atoms and becomes anomalously large near the critical points on the decomposition curve and phase transition points. Taking account of distortions and correlations in the solution leads to the appearance

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of an angular dependence of the incoherent-scattering intensity; coherent scattering sharply increases near the critical point on the decomposition curve. I. M. Lifshits and L. D. Landau are mentioned. There are 21 references: 15 Soviet-bloc and 6 non-Soviet-bloc. The three most recent references to English-language publications read as follows: P. C. Martin, I. Schwinger, Bull. Am. Phys. Soc. 3, 202, 1958; Phys. Rev. 115, 1342, 1959; I. Toyozawa, Progr. Theor. Phys. 20, 53, 1958.

ASSOCIATION: Institut metallofiziki Akademii nauk Ukrainskoy SSR (Institute of Metal Physics, Academy of Sciences, Ukrainskaya SSR)

SUBMITTED: August 6, 1960

KRIVOGLAZ, M.A.; TIKHONOVA, Ye.A.

Effect of thermal vibrations in solid solutions on the intensity of regular reflections of X rays and neutrons and the intensity of Mossbauer's lines. Fiz. met. i metalloved. 12 no.6:801-813 D '61. (MIRA 16:11)

1. Institut metallofiziki AN UkrSSR.

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S/056/61/040/006/022/031
B108/B209

24.7500 (1144, 1160, 1499)

AUTHOR: Krivoglaz, M. A.

TITLE: Effect of diffusion on the scattering of neutrons and photons by crystal imperfections and on the Mössbauer effect

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 6, 1961, 1812 - 1824

TEXT: The diffusion jumps of atoms are considered for the case where the probability W of these jumps is considerably less than the effective frequency of atomic vibrations, ω_0. The energy change of neutrons on scattering is denoted by $E = \hbar\omega$. As will be shown here diffusion leads to a blurred energy spectrum of elastic scattering in the range $\omega \lesssim W$. In this case, atomic vibrations may be taken into consideration by introducing the Debye factor e^{-M_s} into the scattering amplitude; $M_s = \frac{1}{2}\overline{(\vec{q}_1\vec{u}_s)^2}$; $\vec{q}_1$ is the difference between the wave vectors of the scattered and the incident wave, and $\vec{u}_s$ the thermal displacement of the s-th atom. The point defects

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in the different positions $1, 2, \ldots, \nu, \ldots, n$ in a low concentration c are assumed to be distributed irregularly. The differential distribution of the defects may be characterized by the quantity $c_{r\nu}(t)$ which is equal to unity or zero, depending on whether or not an imperfection of the ν-th type is present in the point r at the instant t. The scattering amplitude of monochromatic neutrons from a single crystal at the time t is

$$a(t) = \sum_{r\nu} c_{r\nu}(t) \exp(iq_1 R_{r\nu}) \Big\{\varphi_\nu + \sum_s{}' [A_s - \bar{A}_s + b_s(sS_s)] \times \exp(iq_1 \delta R_{sr\nu}) \exp(iq_1, R_s - R_{r\nu})\Big\} + \sum_s{}' [A_s - \bar{A}_s + b_s(sS_s)] \exp(iq_1, R_s + \delta R_s), \quad (1)$$

$$\varphi_\nu = \sum_s \bar{A}_s \exp(iq_1 \delta R_{sr\nu}) \exp(iq_1, R_s - R_{r\nu}).$$

Effect of diffusion on the ...

The primed sum extends over the atoms moving with the center of the imperfection, $\dot{r}\nu$; the double-primed sum goes over the rest of the atoms; A_s and b_s are constants in the expression for the energy of interaction of the neutron with the nucleus s. The change in the scattering cross section due to imperfections is found to be

$$\sigma(\mathbf{q}_1, \omega) = \frac{m^2}{8\pi^3\hbar^5}\frac{k_2}{k_1}\sum_{r\nu r'\nu'}\int_{-\infty}^{\infty} dt e^{-i\omega t}\langle c_{r\nu}(t)\, c_{r'\nu'}(0)\rangle \times$$
$$\times \{F_{\nu\nu'}\exp(i\mathbf{q}_1, \mathbf{R}_{r\nu} - \mathbf{R}_{r'\nu'}) + \Phi_{\nu\nu'}(\mathbf{R}_{r\nu} - \mathbf{R}_{r'\nu'})\}. \quad (2)$$

where

$$F_{\nu\nu'} = \varphi_\nu\varphi^*_{\nu'} + \sum_s{}' \overline{[(A_s - \overline{A}_s)^2 + \overline{B}_s^2]}\exp(i\mathbf{q}_1, \delta\mathbf{R}_{sr\nu} - \delta\mathbf{R}_{sr'\nu'}), \quad (3)$$

$$\Phi_{\nu\nu'}(\mathbf{R}_{r\nu} - \mathbf{R}_{r'\nu'}) = \sum_s{}'' \overline{[(A_s - \overline{A}_s)^2 + \overline{B}_s^2]}\,\{\langle\langle \exp(i\mathbf{q}_1\mathbf{R}_s(r\nu r'\nu')) \times$$
$$\times \exp(i\mathbf{q}_1, \delta\mathbf{R}_{sr\nu} - \delta\mathbf{R}_{sr'\nu'})\rangle\rangle - 1\}, \qquad B_s^2 = b_s^2 S_s(S_s + 1)/4. \quad (4)$$

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Introducing the Fourier components of the quantities $c_{r\nu}$ into Eq. (2), the author obtains the following expression for the differential cross section of inelastic scattering ($\omega \neq 0$):

$$\sigma(q_1, \omega) = N_g \frac{m^2}{4\pi^2\hbar^3} \frac{k_2}{k_1} \Big\{ \sum_{\nu\nu'} [F_{\nu\nu'} \exp(2\pi i K_n R_{\nu\nu'}) f_{\nu\nu'}(q, \omega) + \sum_k \Phi_{\nu\nu'k} f_{\nu\nu'}(k, \omega)] \Big\}. \quad (6)$$

$$f_{\nu\nu'}(q, \omega) = \frac{N^2}{N_g} \frac{1}{2\pi} \int_{-\infty}^{\infty} \langle c_{q\nu}(t)\, c^*_{q\nu'}(0) \rangle e^{-i\omega t} dt,$$

$$\Phi_{\nu\nu'}(R_{r\nu} - R_{r'\nu'}) = \sum_k \Phi_{\nu\nu'k} \exp(ik, R_{r\nu} - R_{r'\nu'}), \quad (7)$$

where $\vec{q} = \vec{q}_1 - 2\pi\vec{K}_n$; $\vec{K}_n$ is the vector of the reciprocal lattice adjoining the end of the vector $\vec{q}_1/2\pi$; N_g is the number of defects in the crystal; $\vec{R}_{\nu\nu'} = \vec{R}_{r\nu} - \vec{R}_{r\nu'}$. In this way, the problem of determining the energy

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distribution of neutrons scattered from imperfections is reduced to finding the correlation functions $f_{\nu\nu'}(\vec{q},\omega)$, for which the formula

$$f_{\nu\nu'}(q,\omega) = \frac{1}{\pi}\,\mathrm{Re}\left(\frac{a(q)}{x} + \frac{i\omega}{x}\right)^{-1}_{\nu\nu'} = \sum_{i=1}^{n} \frac{A_i(q)}{\alpha_{qi}^2 + \omega^2}, \qquad (16)$$

is determined; $a(\vec{q})/x$ is a matrix with the elements $a_{\nu\nu'}(\vec{q})/x_\nu$; the matrix $1/x$ has the elements $\delta_{\nu\nu'}/x_\nu$. The "inverse relaxation time" $\alpha_{\vec{q}i}$ is the root y_i of the equation $|a_{\nu\nu'} - \delta_{\nu\nu'} y| = 0$ (17). The constants $a_{\nu\nu'}(\vec{k})$ originate from the system of equations for the Fourier components:

$$dc_{k\nu}(t)/dt = -\sum_{\nu'=1}^{n} a_{\nu\nu'}(k)\, c_{k\nu'}(t), \qquad \nu = 1, 2, \ldots, n, \qquad (15)$$

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B108/B209

Effect ... the...

The re... ... for every diffusion mechanism of any imperfections, the ... the energy distribution of scattered neutrons depend ... the way on the magnitude and orientation of the vector ... diffusion of imperfections must also lead to such a wide... distribution of scattered monochromatic photons. Using the ...

$$I(q, \omega) = N_g \sum_{\nu\nu'} \varphi_\nu^* \varphi_{\nu'} \exp(2\pi i K_g R_{\nu\nu'}) f_{\nu\nu'}(q, \omega). \quad (22)$$

for the intensity of diffusion scattering of photons from imperfections, one may ... analogous calculations as with formula (6) in the case of neutrons, using the same function $f(\vec{q},\omega)$. A similar widening is expected for the absorption or emission spectra in the Mössbauer effect at high temperatures. Mention is made of G. N. Belozerskiy and Yu. A. Nemilov. There are 11 references: 4 Soviet-bloc and 7 non-Soviet-bloc. The two references to English-language publications read as follows: G. H. Vineyard. Phys. Rev. 110, 999, 1958; P. Schonfield. Phys. Rev. Lett., 4, 239, 1960.

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Effect of diffusion on the...

ASSOCIATION: Institut metallofiziki Akademii nauk Ukrainskoy SSR (Institute of Physics of Metals of the Academy of Sciences UkrSSR)

SUBMITTED: January 11, 1961

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KRIVOGLAZ, M.A.

Width and shape of Mössbauer lines in solid solutions. Zhur. eksp.i teor.fiz. 41 no.3:765-772 S '61. (MIRA 14:10)

1. Institut metallofiziki AN USSR.
(Solutions, Solid—Spectra)

S/126/62/013/004/001/022
E032/E514

AUTHOR: Krivoglaz, M.A.

TITLE: The theory of thermal diffuse scattering of X-rays by solid solutions

PERIODICAL: Fizika metallov i metallovedeniye, v.13, no.4, 1962, 481-492

TEXT: It is pointed out that in the case of thermal scattering of X-rays by solid solutions or other non-ideal crystals the normal lattice vibrations cannot be regarded as corresponding to plane waves, and in order to establish the possibility of studying thermal vibrations with the aid of X-ray scattering, it is necessary to consider in detail thermal diffuse scattering by these solutions. In the first section of this paper the author gives a classical calculation of the scattered intensity in the case of binary substitutional solutions with lattices having one atom per unit cell. It follows from this calculation that the intensity due to scattering by thermal vibrations depends on the correlation parameters in the solution and this complicates the temperature dependence of the intensity. It is stressed that

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The theory of thermal diffuse ... S/126/62/013/004/001/022
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this must be borne in mind in experimental determinations of the correlation parameters with the aid of the Fourier transformation of the scattered intensity. The calculations are confined to the case where statistical defects can be neglected. In the more general case it is necessary to use the author's results reported in Ref.7 (ZhETF, 1958, 34, 204). In the present paper a formula is obtained for the scattered intensity in the case where the expansion of the latter in powers of the statistical displacements includes terms up to and including the second order only. The second section is concerned with the quantum mechanical calculation of the scattered intensity. In the classical case discussed in the first section, the masses of the atoms do not enter into the formulae for the scattered intensity and only the difference between the interaction constants is important. However, at low temperatures, when the classical approximation cannot be used, the mass differences are just as important as the force-constant differences. The quantum mechanical calculations are confined to the case where the relative mass difference is much greater than the difference between the interaction constants. Moreover, it is assumed that the interaction constants

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$V^{\alpha\alpha'}_{ss'}$, do not depend on the types of atoms α, α'. The Hamiltonian for the vibrations of the solid solution on the second quantization representation is the same as that used by the author in a previous paper (Ref.8: ZhETF, 1961, 40, 567). It is used to derive a formula for the scattered intensity. The intensity distribution in the neighbourhood of the reciprocal-lattice sites is discussed in detail. The anomalous increase in the thermal scattering intensity in the neighbourhood of these sites is discussed for solutions quenched from the neighbourhood of the critical point.

ASSOCIATION: Institut metallofiziki AN UkrSSR
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KRIVOGLAZ, M.A.

Blurring of frequency-sensitive characteristics of the damping of elementary excitations in crystals. Sbor. nauch. rab. Inst. metallofiz. AN URSR no.15:100-116 '62. (MIRA 15:12)
(Metal crystals) (Oscillations)

KRIVOGLAZ, M.A.

Theory of inelastic one-phonon scattering of neutrons by multicomponent disordered solid solutions. Sbor. nauch. rab. Inst. metallofiz. AN URSR no.14:126-132 '62. (MIRA 15:6)
(Neutrons—Scattering) (Crystal lattices)

GERTSRIKEN, S.D.[deceased]; DEKHTYAR, I.Ya.; KRIVOGLAZ, M.A.; LARIKOV, L.N.; LYSAK, L.I.; NESTERENKO, Ye.G.; NOVIKOV, N.N.; SOSNINA, Ye.I.; SLYUSAR, B.F.; TIKHONOV, L.V.; TREFILOV, V.I.; CHUISTOV, K.V.; BERLIN, Ye.N., red.izd-va; DOLUZHINSKAYA, L.V., tekhn.red.

[Physical principles of the strength and plasticity of metals] Fizicheskie osnovy prochnosti i plastichnosti metallov. [By] S.D.Gertsriken i dr. Moskva, Metallurgizdat, 1963. 321 p. (MIRA 16:12)

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X-ray scattering by crystals composed of blocks and containing dislocations. Sbor. nauch. rab. Inst. metallofiz. AN URSR no. 17:25-31 '63. (MIRA 17:3)

KRIVOGLAZ, M.A.

Effect of long-range forces on wave fluctuations and scattering in crystals. Fiz. tver. tela 5 no.12:3439-3452 D '63. (MIRA 17:2)

1. Institut metallofiziki AN UkrSSR, Kiyev.