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UKRAINIAN REPUBLIC CONFERENCE ON THE THEORY OF METALS AND ALLOYS

- USSR -

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UKRAINIAN REPUBLIC CONFERENCE ON THE THEORY OF METALS AND ALLOYS

/ Following is a translation of an article written by V. M. Danilenko, M. A. Krivoglaz, L. N. Larikov, and A. A. Smirnov in Uspekhi Fizicheskikh Nauk (Achievements of Physical Sciences), Vol LXX, No 1, Moscow, 1960, pages 191-198. /

The Ukrainian Republic Conference on the Theory of Metals and Alloys took place in Kiev from 1 June to 5 June 1959. This was the first conference to consider a broad range of topics of the theory of metals and alloys rather than narrow individual problems of metallophysics, as was heretofore the custom. The conference summed up the results of accomplished work and set the course for future investigations of those basic questions of theoretical metallophysics that play an important role in the technical progress of the country.

Scientists of the Ukraine and a great number of scientific coworkers from other Republics participated in the work of the Conference.

The Conference heard and discussed 70 papers and communications, which were presented in two plenary sessions and in two sections: the electron theory of metals and the molecular-kinetic theory of metals and alloys.

During the plenary sessions, interesting review reports were presented by I. M. Lifshits and S. V. Vonsovskiy.

I. M. Lifshits read a report: "Basic problems and prospects of the development of metal theory in the light of the task of accomplishing the Seven Year Plan." The report of S. V. Vonsonskiy was dedicated to the phenomenological theory of ferromagnetism. Both papers marked out the most essential questions of theories of metals and pointed out lines for further investigations.

A report by V. P. Silin was dedicated to the important question of the conductivity effect of the mutual interaction between electrons on the properties of metals. The interaction was considered with the help of the fermi-liquid theory offered by L. D. Landau, which was generalized with a consideration of an electromagnetic interaction between electrons acting at a distance. Interelectron interaction leads to a qualitative change of the energy spectrum of an electron system. Side by side with the branch of Fermi-excitation characteristic for an electronic gas, there appear in an electronic liquid branches of Bose-excitations, which correspond to "zero sound," and also to longitudinal and lateral plasma oscillations. As a result, the interelectron interaction leads to additional losses of energy by the fast electrons passing through thin films of metal, related to excitation of the zero sound and the plasma oscilations, and also to a change of dielectric susceptibility in the infra-red region.

A great number of reports were dedicated to an investigation of various phenomenon in metals, the study of which presents an opportunity to reinstate the shape of the Fermi plane of electron conductivity.

In works of I. M. Lifshits and V. G. Peschanskiy, the galvanomagnetic characteristics of metals with open Fermi planes in strong magnetic fields were reviewed. There was analyzed the substantial relationship between the asymptotic of these characteristics and the topology of the Fermi-plane established in works of I. M. Lifshits, M. Ya. Azbel' and M. I. Kaganov. In particular, in the presence of open trajectories of electrons on the Fermi plane, the resistance for one direction of the magnetic field moves toward saturation and quadratically increases for other directions. This way it was possible to explain the rule of lineal increase of resistance in a magnetic field as a result of some neutralization established by P. L. Kapitsa. The assumed character of the Fermi plane for gold and copper was actually discovered by Pippard.

A report by M. Ya. Azbel' presented the results of the quantum theory of the high frequency electroresistance established by him. It was demonstrated that, depending on the surface resistance of the field, quantum oscillations must be observed. The amplitude of these oscillations sharply increases if the frequency of the electromagnetic field coincides with the frequency of the cyclotron, while the resonance increase of the amplitude must be present not only in the field parallel to the metal surface (as in the case of classical cyclotron resonance) but also in the inclined field. Investigations of the effect at various directions of the magnetic field presents a chance to reestablish the shape of the Fermi surface and determine electrons velocities on that surface. Analysis of the shape of the Fermi surface may be simplified by using thin films when the various groups of electrons are separated.

A report of M. Ya. Azbel' and E. A. Kaner was dedicated to the theory of the cyclotron resonance in metals predicted by the authors, which takes place in the area of an abnormal skin effect in the magnetic field. Investigation of this effect presents an opportunity to determine electron velocities in the Fermi surface and its topology. There were analysed the latest investigations of cyclotron resonance in Sn, Cu, Bi, In, and Pb. It was noted that one of the methods of determining maximum diameter of the Fermi surface appears to be investigation of cyclotron resonance in the thin films. If the diameter of the Larmorov orbit of the electron is equal to the thickness of the film, a break must be observed on the curve depicting the relation between the surface impedance and the intensity of the field.

As M. I. Kaganov noted in the case of a quadratic relationship between the electron energy and the impulse, the period of rotation of electrons in a magnetic field, and therefore the resonance frequency, is a function of the applied field. This effect can be utilized for analysis of the shape of the isoenergetic surfaces in a semiconductor.

In a report submitted by Ya. A. Bychkov, L. E. Gurevich, and G. M. Nedlin, the thermomagnetic effects in strong magnetic fields was examined. These effects also substantially depend on the shape of the Fermi surface, and, in particular, qualitatively differ from closed and open surfaces. In the presence of a temperature gradient, the appearing stream of photons absorbs electrons and results in the appearance of a new mechanism of thermomagnetic effects. This mechanism appears if the ratio

$\left(\frac{T}{\theta}\right)^2\frac{\xi}{k\theta}$ (T - temperature, θ - Debye temperature, ξ - chemical potential of electrons)

is very small and this should take place at not too low temperatures. At the same time, the thermomagnetic effects do not depend on the temperature and the direction of the field.

A different type method of determining the shape of the Fermi surface of electrons in metals was examined in a report of A. A. Smirnov and M. A. Krivoglaz. This method is based on the study of the summary pulse of a pair of photons, forming upon annihilation of a positron with the conductivity electron in a metal. The connection of this pulse with the pulse of the electrons makes it possible -- by conducting investigations of the angular distribution of γ-quanta at various orientations of the monocrystal -- to determine the region in the space of pulses filled with electrons. Despite the existence of various reasons for decay of the γ-quanta distribution picture, this method may be utilized for determining the general character of the anisotropic Fermi surface not only in pure metals but also in some alloys.

A report of A. M. Kosevich presents a theory of the effect of elastic deformation on the energy spectrum of electrons in metal and on the oscillations of the magnetic susceptibility in the outer field. If the metal contains electron groups with a small number of electrons, then small deformations may change the periods of oscillations by tens of percent. In a constant magnetic field, the change in the outer pressure must lead to oscillations of the thermodynamic magnitudes of the metal. The de Gaas-van Alfen effect was also calculated for the case of the pulsed magnetic field.

A communication of B. I. Verkin and I. M. Dmitrenko contained results of experimental investigations of the effect of manifold pressure to 1730 kG/cm^2 on crystals of weakly magnetic metals (Zn, Bi, Be, Sn) with reference to the magnitude of the magnetic anisotropy and the de Gaas-van Alfen effect. It was demonstrated that the magnetic anisotropy and the period of magnetic oscillations of susceptability depend on the outer pressure in a complicated periodic manner.

Three reports were dedicated to the question of absorption ultra-sound in a magnetic field. The location of maximums on the curve depicting relationship of the absorption coefficient to the intensity of the field correspond to a definite relation between the length of the sound wave and the diameter of the Larmorov orbit and in a substantial manner depend on the form of the Fermi surface. In connection with this -- as indicated in the report by V. L. Gurevich, who examined a case of arbitrary dispersion -- the examination of absorption of sound in a magnetic field also presents a possibility of recreation of the shape of the Fermi surface. Side by side with the ordinary deformation mechanism of sound absorption, V. L. Gurevich offered a new mechanism named by him the "induction mechanism" which is related to the Joule heat effect of the induction currents, originating in the movement of the regions of metal in the magnetic field deformed by waves. There are regions of portions of the field in which induction absorption appears to be essential. Peculiarities of absorption in a region where the diameter of the Larmorov orbit is substantially smaller than the length of the sound wave, and the relations between the coefficients of absorption and the reversed field are not periodic, were examined.

In work by G. L. Kotkin the absorption of sound in metals with an isotope Fermi surface was investigated. The conditions obtained for maximum coefficient of absorption differed from analogous conditions of Pippard.

A. A. Galkin and A. P. Korolyuk presented a communication concerning experimental disclosure of oscillations of the ultrasonic absorption coefficient in a magnetic field for tin and zinc. The pulse projections of electrons for various crystallographic directions was determined according to the periods of oscillation. In strong magnetic fields, a sharp anisotropy of ultrasonic absorption was observed which allowed judging the shape of the Fermi surface.

Considerable attention was given at the conference to the theory of dispersion of Roentgen rays and slow neutrons by solid solutions, In a report of M. A. Krivoglaz and Ye. A. Tikhonova dedicated to this question, there was presented a general theory of dispersion by means of solutions of arbitrary composition with arbitrary parameters of distant and close order. The peculiarities of the intensity distribution in the neighborhood of kinks of a reversed lattice were investigated and it was demonstrated that the study of the character of peculiarities can serve as a method for determining the location of the admixed atoms in the lattice. It was demonstrated that the index of the exponential in the Debye factor of weakening intensity does not depend quadratically on the length of the wave and that it is related in a non-additive manner with the statistical and dynamical displacements. The distribution of the intensity of the diffisuion dispersion calculated on the basis of this theory by means of a Debye diagram was examined in a work by V. I. Iveronova and A. A. Katsnel'son. The experimental investigation of the alloy Ni_3Pt conducted by them demonstrated that the calculated and the measured distribution of intensity are in complete agreement. A report of M. A. Krivoglaz examined the dispersion of Roentgen rays and thermal neutrons in the area of the point of the phase transition of the second type. It was demonstrated that with consideration of lattice distortion, the distribution of intensity may change substantially. In particular, in crystals not having a center of symmetry, and in crystals located near the critical point, abnormally large dispersion occurs not only in the neighborhood of superstructural images but also in the neighborhood of the structural images. The authors also examined the analogous effects of abnormal dispersion near the critical point on the curve of the dissociation and near the Curie ferromagnetic or antiferromagnetic temperature.

A report by A. A. Smirnov and Ye. A. Tikhonova presented an examination of the concentration dependence of the intensity of the normal images and the background of dispersed Roentgen rays from non-regulated substitution alloys in which the non-uniformities of the lattice are connected with the difference of atomic factors and atomic radii of various compounds. The obtained formulas also permit finding the intensity dispersion of slow neutrons.

A V. M. Danilenko report presented results of calculations of intensity of Roentgen ray dispersion in different blast-furnace type structures (errors of superposition of tightly-packed atom layers, antiphase blast-furnace regulations and others). A well-developed general theory investigated the effect of a blast-furnace structure of different types on the character and the magnitude of the erosion of normal images.

K. P. Ryaboshapka and V. M. Danilenko demonstrated that the presence of dislocations in normal alloys leads to various spreadings of the maximum intensity corresponding to structural and superstructural images. It was explained in what manner the intensity of normal images and the intensity of the diffused dispersal change upon the formation of a telkor atmosphere around the dislocations.

A report by A. N. Men' and A. N. Orlov submitted calculations of maximum frequency of ω_m oscillations with a volume-centered cubical lattice. It was demonstrated that upon normalizing ω_m grows and therefor the characteristic temperature of the alloy increases.

A report by A. P. Zvyagina and V. I. Iveronova noted that the Debey characteristic temperature of alloy, determined from Roentgen data, substantially depends on the appearance of the spectrum of the thermal oscillations of atoms. Calculations indicated that a normalizing solid solution increases the mean quadratic thermal displacement of atoms and decreases θ in the case of unchanged magnitude of interatomic forces of interaction (and increasing maximum frequency of atomic oscillation).

A series of reports were dedicated to magnetic properties of substances. K. B. Vlasov examined the effect of turning the plane of the polarized elastic transverse waves spreading in metals along the direction of the magnetic field. This effect is closely connected with the change of sound absorption in a magnetic field and can rach an appreciable magnitude in field $\sim 10^3$, with a frequency of elastic waves of $\sim 10^7$ gc.

A report by A. A. Berdyshev and B. V. Karpenko was dedicated to the calculation of the indirect interaction between the inner electrons by means of electron conductivity. Indirect interaction always favors ferromagnetism which may take place in the complete absence of a direct connection and even with a negative exchange integral. Indirect interaction exchange is perhaps responsible for ferromagnetism in the diluted alloys, alloys of Geissler and the rare-earth metals. B. V. Karpenko and A. A. Berdyshev noted that the interaction of the conductivity electrons with spin waves in an anti-ferromagnetic resists the correlation of electrons near the Fermi surface and by the same token to the transition of metal into a superconductive state.

A report of L. M. Petrova and Yu. P. Irkhin contained a calculation of an ordinary constant of Hall for ferromagnetic metal in the framework of the s-d Vonsovsky exchange model in the presence of a double-zone structure of the conductivity band. It was shown that the calculation resulted in the decrease of R with the decrease of temperature, as was observed with nickel and alloys of nickel with copper.

Works of P. S. Zyryanov, T. G. Izyumova and G. B. Skrotskiy reviewed electroresistance of ferromagnetic alloys in the area of radiofrequency near ferromagnetic resonance. Near the resonance frequency, the amplitude of the spin waves -- appearing under the action of the outer electromagnetic field -- sharply rises. At the same time the electroresistance -- related to the energy of dissociation of the interaction of the forced frequencies with the conductivity electrons -- also sharply rises. Without considering the damping the spin waves, the electroresistance appears to be inversely proportional to a square of the difference between the electromagnetic field frequence and the resonance.

Yu. A. Izyumov and G. B. Skrotskiy examined the spin magnetic resonance on conductivity electrons. The cases of ferromagnetic and non-ferromagnetic metals were examined.

A. I. Gubanov, with the help of a quasi-chemical approach, examined the phenomenon of ferromagnetism in amorphous ferromagnetics. The author noted that a distant order of atomic location does not appear to be necessary for the existence of ferromagnetism. The expression obtained by him for Curie temperature indicates that a function of the distribution of neighboring atoms according to distance plays an important role.

In work of M. Ya. Azbel', V. I. Gerasimenko, and I. M. Lifshits the paramagnetic resonance in metals was examined in cases when the depth of the skin-layer is slightly smaller than the measurements of the sample. As a result of diffusion of the conductivity electrons with spin reversed at the resonance absorption, the area of the sample demagnetation may be substantially greater than the area of skin-layer. As a result, at resonance frequency, the coefficient of the electromagnetic emission passing through the thin film sharply increases. An important result of this work appears to be the noted possibility of obtaining oriented nuclei during paramagnetic resonance in a layer greater in thickness than a skin layer.

A report by V. P. Silin offered a microscopic theory of optical effects in metals, suitable for the area of normal as well as abnormal skin-effect. It is taken into consideration that the substitution of the electron beyond the period of oscillation is small in comparison with the depth of the skin-layer, though the length of the free run may be great. The developed theory gives an opportunity to investigate the optical properties of small conductors and to investigate the case of an inclined spot of light on the surface of large samples.

In work of S. B. Constantinov and V. I. Perel', an expression was developed for the conductivity and magnetic susceptability of metal in an alternate electromagnetic field with consideration of the space dispersion. The obtained results were applied to the metal electrons in a strong magnetic field. It was demonstrated that in metals with a small number of electron conductivities at frequencies smaller than the cyclotron frequency - the passing of an electromagnetic wave spreading along the magnetic field through the metal is possible.

In a report of V. A. Grinberg and A. N. Orlov, a change in resistance in a magnetic field and the Hall effect in a pure metal with parallel lines of dislocation were considered.

In a report of A. A. Smirnov and A. I. Nosar', the theory of electroresistance of alloys with a distorted crystalline lattice developed in the framework of a multi-electronic metal model -- was presented. It was shown that a relationship between the residual alloy electro-resistance and the composition and the parameters order may be obtained by utilizing a very small number of model presentations. Consideration of distortions of the crystal lattice, caused by various sizes of atoms, leads to additional resistance, the dependence of which from the alloy composition appears to be related to the character of the concentric function function of its volume.

A report of G. V. Samsonov and V. S. Neshpor presented a consideration of the nature of conductivities of Mo_3Si and $MoSi_2$. It was demonstrated that the conductivity has a metallic character and that at the same time Mo_3Si appears to contain electrons and $MoSi_2$ holes.

G. V. Samsonov and Yu. B. Paderno communicated their investigations of physical properties and electronic structure of hexaborides of rare metals with a CaB_6 structure and having a low magnetude of electron output.

A report of V. Ye. Mikryukov contained an analysis of wide experimental material concerning performance of the Videman-Frantz law in metals and alloys.

In work of G. Ye. Pikus and V. B. Fiks, electromagnetic effects in liquid metals were examined. During the passing of current through such a metal, -- because of impacts of electrons against the walls -- the electrons transmit the impulse to the wall, and the liquid receives an impulse in the reverse direction. As a result, during the passing of current a drop in pressure occurs proportional to the difference in potentials and depending on the type of the character of dispersion of electrons by the walls. The reverse effect is related to the appearance of the difference in potentials and also depends on the character of the electron dispersion by the walls. This potential difference is caused by the retardation of the stream of electrons (because of their collision with the walls) from the stream of ions. A $\sim 1\ kg/cm^2$ drop in pressure in mercury will cause a $\sim 10^{-6}$ difference in potentials.

A report of I. B. Borovskiy and K. P. Gurov contained a communication concerning an investigation of the influence of small admixtures on the physical properties of transitional metals (diffusion, coefficient of liniar expansion, modulus of elasticity, coefficient of internal friction, specific elasticity and so forth). The non-uniform change in properties with concentration of admixture was explained by the influence of the excessive charge of the added atom on the electrical structure of the crystal area near these atoms.

A report of M. I. Korsunskiy and G. P. Borovikova discussed the question of the influence of small admixtures on the Roentgen spectra of solid bodies. It was demonstrated that an admixture of a quantity 0.01-0,001 at.% markedly changes the location of Roentgen levels in germanium.

A large group of reports was dedicated to the question of the theory of the phase conversions in metals and alloys.

A report of I. M. Lifshits examined the new type phase transitions in metals at great pressures. Such transitions are connected with peculiarities of a function of the distribution of conductivity electrons at absolute zero temperature. In connection with these peculiarities, at a definite magnitude pressure p_k, at the time of a changing topology of the Fermi surface -- the relation between the thermodynamic potential and the pressure also presents peculiarities. Inasmuch as the change of compression near the point of transition is proportional to $(p-p_k)^{1/2}$, the author considers it would be proper to name these transitions "2.5-type transitions." Strictly speaking, a phase transition of this kind in pure metal (concerning the thermodynamic potential) may occur only at absolute zero. At limited temperatures (or concentrations of admixtures) the peculiarity vanishes. Near the period of transition there takes place a complicated relationship between the paramagnetic susceptability of electrons and the pressure. According to the produced estimate, a phase transition of this kind should take place at pressures of $\sim 10^4 - 10^5$ atm. or at relatively small percentages of admixture.

A work of I. M. Lifshits and G. I. Stepanova presents a method for describing solutions in which the configuration of atoms does not correspond to the state of thermodynamic equilibrium for the examined temperature. The method is based on the introduction of a function of correlation for a group of atoms. A method for determining these functions of correlations and the free energy of unbalanced solid solutions is offered. This method is particularly convenient for small admixture concentrations. In particular, the obtained results can be used for thermodynamic characteristics of solutions with a constant change of velocity of the correlation of parameters or with an unknown value of parameter correlation to the corresponding determinations of the hardening temperature s.

B. N. Finkel'shteyn examined the thermodynamics of a tri-component solid solution. The calculation of the free energy was accomplished in the framework of a model of twin interaction of solution atoms with the help of a quasi-chemical approach. A case was investigated when the concentration of a two-component solution was small. The temperature relationship of parameters of a near order was determined as well as the thermodynamic activities of the components.

A report of Z. A. Matysina and A. A. Smirnov was dedicated to the development of a theory of normalizing alloys with hexagonally tightly-packed crystalline lattices. The calculation was accomplished in the framework of a statistical theory of normalizing both without accounting for correlation but with accounting for a quasi-chemical approach. The temperature of normalization, the dependence of the degree of the distant order on temperature and composition and the parameters of correlation in the alloy were discussed.

I. A. Gindin, B. G. Lazarev, Ya. D. Starodubov and V. I. Khotkevich communicated information relative to the presence of low-temperature polymorphous conversions for a series of metals (the alkali metals bismuth, beryllium). The conversion occurs after plastic deformation of metals, at which time the low temperature has a lattice with tightly-packed atoms.

In work of I. M. Lifshits and V. V. Slezov, the process of coagulation of parts was examined in the late stage of decomposition when the spherical particles are sufficiently large and the solution saturation is small. A strict solution of the difficult mathematical problem was given, namely a solution of a temporary equation for functions of the particle distribution according to size. An assymptotic solution of the problem at high temperatures t was found. In particular, the critical radius of the nucleus at high t is directly proportional to $t^{1/3}$. The obtained results can be applied in particular, to a phenomenon of caking and formation of pores in crystals supersaturated with holes. Pores disappear at first from the layer on the metal surface and the thickness of the layer should be proportional to $t^{1/3}$. As was noted in a presentation of P. I. Garber, the investigation of the kinetics of the formation of pores in crystals of rock salt substantiated this conclusion.

V. I. Vladimirov examined the theory of coagulation of excess vacancies in a solid body. The impossibility of large structural defects by way of coagulation of uniformly distributed vacancies at constant temperature was demonstrated. The coagulation processes occur dúring body cooling. In an infinitely extended body, there exists a temperature Tcr. and the process of coagulation is impossible above it. Kinetics of formation of nuclear coagulation below Tcr. depends on the velocity of sample cooling. There was offered an estimate of critical sizes of samples at which the process of coagulation is destroyed at the expense of departure of vacancies on the body surface, and also an estimation of maximum and minimum measurements of horizontal defects of the prismatic dislocation type, appearing as a result of coagulation vacancies.

A report of B. Ya. Lyubov and A. L. Roytburd was dedicated to the theory of growth of martensite crystals. Consideration of the atomic interaction conducted by means of a single-measurement model allowed the authors to find the critical value of the moving force f_{cr} below which the growth of the new phase occurs as a result of thermal fluctuations, on condition that there be sufficiently high intensity of the thermal movement. At $f > f_{cr}$ the growth occurs as a result of a directed transition of atoms through the potential barrier and at the same time the transition of single atoms conditions and ensures the transition of the following atoms. The authors of this report estimated the temperature at the front of the transition at stable conditions of the growth and calculated the field of intensity and the elastic energy of the matrix for the concrete model, depending on the parameter of the transition and the actior of the outer loads.

A report of L. N. Larikov was devoted to the crystallization kinetics of deformed metals and alloys. The author demonstrated that the fluctuation formation of undistorted small crystals may occur with marked speed only in the most disorganized areas of the deformed metals. The obtained formulas for the velocity growth of the centers of crystallization satisfactorily agree with the experimental data for pure metals. The author examined the action mechanism of soluble and insoluble admixtures on the linial velocity of the central growth.

A report of I. V. Salli considers the question of the lineal metastable equilibrium of diagrams of a binary system. On the basis of molecular-kinetics and the thermodynamic theory of crystallization, a critical analysis of the works was made in which an extrapolation of the equation lines into subcritical area was utilized. The author considers that the metastable phases appearing at high velocities of cooling, as a rule, are stable in other conditions of crystallization and are present on the diagram at higher concentrations than that of the crystalline liquid. As corroboration, the author submitted data obtained by study of the hardening of some alloys at cooling velocities up to 100,000° in sec.

M. I. Zakharova and I. N. Stetsenko devoted their report to phase-transitions in alloys of iron-vanadium. As a result of investigations of magnetic properties and structure at polymorphous transitions in these alloys, th presence of a new ferromagnetic phase β was established. This phase was observed in a wide area of concentration at temperatures exceeding the temperature of the phase transition $\sigma \to \alpha$. In the 1050 - 1150° area of temperatures, there were noted abnormally small velocities of phase conversion.

A group of reports was dedicated to the mobility of atoms and ions in metallic systems.

A report of K. P. Gurov -- using a Brenig formulation -- considers the question of the relation of the activating energy of self-diffusion to the characteristic temperature of pure metals. This relation appears to be a first approximation of a more general relationship, including the unbalanced characteristics of the process. In conclusion, the authors compared the calculated activating energies with the experimental.

The report of I. M. Fedorchenko and A. I. Raychenko -- with a consideration of the Kirkendall effect -- examined the growth of volume as a result of burning mixed powder bodies. A face-centered cubical lattice made of metal cubes in a metal matrix served as a model. Calculations were made for a non-porous body and with an allowance for the independence of the diffusion coefficient of metal B from concentration and time. The calculated maximum effects were compared with the experimentally observed effects in a Cu-Ni system.

Ye. A. Tikhonova presented a theory of diffusion of implanted atoms in A-B type alloys of CuAu, in which -- at normalizing -- atoms A and B are distributed according to alternating planes parallel to one of the sides of the cube. It was demonstrated that at normalizing, the diffusion coefficient of the alloy and the energy of activation change intermittently. In normalized alloy strong anisotropy of the diffusion coefficient must be observed. The diffusion coefficient along the layers is ordinarily greater than the coefficient perpendicular to the directions of layers.

A report by V. B. Fiks was devoted to the mechanism of the mobility of the admixed ions in metals under the action of an electric field with a consideration of the effect of increasing ions by electrons. It was demonstrated that the effective mobility of the admixed ion in a metal is determined not only by its charge but also by the cross-section of the electron dispersion. The movement of neutral admixed atoms was fully determined by their absorption by electrons. This theory led him to arrive at "the rule of electroconductivity" established by Scoupi and the limits of its application. Calculations indicate that the addition of the effect of "carrying away" ions by electrons into thermodiffusion may present a considerable difference from the effects obtained experimentally.

P. P. Kuz'menko and Ye. I. Khar'kov submitted interesting data obtained through study of electro-migration in pure metals by means of marked atoms.

I. N. Frantsevich, D. F. Kalinovich, I. I. Kovenskiy, M. D. Smolin, and M. D. Glinchuk submitted the results of a study -- by means of radioactive isotopes -- of mutual electro-migration of both compounds of binary solid solutions of carbon, chrome, molybdenum and tungsten in iron, and also of the electro-migration of tungsten in nickel. It was established that the ions of carbon, chrome, and tungsten in the noted solutions migrate -- in a constant electric field -- toward the cathode. In a solid solution of molybdenum in iron, the atoms of molybdenum migrate to the anode. The atoms of iron in these solutions migrate in a direction opposite to migration of the dissolved element.

A group of reports was dedicated to the mechanism of creeping and distortion of metals at high temperatures.

A report by I. A. Oding and V. N. Geminov contained a discussion of metal destruction mechanism at creeping in conditions of increased temperature. The destruction in such cases was explained by a process of gradual accumulation in the metal of intragranular and intergranular faults connected with the dislocation-hole mechanism.

A report by I. A. Oding and L. K. Gordiyenko presented the results of investigations (by the method of microscopic analysis) of the changing mechanical properties of metals previously subjected to creepage test. They established the rules of the plasticity change, characteristics of flow, and the conditional limit of strength for the technical iron and nickel-chrome alloy in various stages of service under conditions of creepage. The change in mechanical properties was compared with the microstructure of the sample.

A report by B. Ya. Pines was dedicated to peculiarities of a creepage diffusion mechanism. The author offered data indicating that the criterion of one or another creepage mechanism appears to be the influence of cold working and annealing on the velocity process. Diffusion creepage increases after cold working and decreases after annealing. The reverse influence is observed in the case of a dislocation mechanism of the creepage. The observed diffusion creepage in crystalline bodies, however, differs from the viscous flow of amorphous bodies by the presence of unbalanced conditions, distorting the simple rules of viscous flow. The author illustrated this thought by submitting a large amount of experimental material, obtained through investigation of processes of restoration and aftereffect in metallo-ceramic bodies.

N. S. Zhurkova and A. V. Savitskiy presented results of experimental verification of the diffusion theory of a mechanical destruction process in pure silver and in the alloy of silver with 5 at.% of aluminum. The non-coincidence of a temperature effect of the destruction and self-diffusion processes as well as the different effect on them of a small addition of alloying elements indicates, as was pointed out by the reporters, the different nature of the processes and sheds doubt as to the soundness of the crack-growth diffusion mechanism.

A report by N. S. Fastov was dedicated to the thermodynamics of irreversible processes of strengthening and weakening of metals. A process of accumulating energy in plastically-deformed crystals was examined. At a small magnitude of deformation, practically all of the work expended on deformation is accumulated toward the energy of strengthening. In step with the degree of increased deformation, the ratio of the energy of strengthening to the work expended on deformation decreases. An estimate was made as to the location and width of the velocity maximum of the ouput of strengthening energy at a constant speed of heating. The obtained results are in qualitative agreement with experimental data obtained by V. I. Khotkevich for cadmium.

In a discussion related to this group of reports, it was stated that though the comparison of mechanisms of various processes only on the basis of the temperature effect on the velocity flow does not appear sufficiently hopeful, nevertheless there are at the present time serious reasons for reexamining some of the simplified views relative to the mechanism of creepage and metal destruction at high temperatures. Communications from A. I. Gindin and Yu. M. Plishkin were closely related to the above reports.

A short communication from A. I. Gindin contained interesting data relative to the increase of plasticity of armco-iron at low temperatures by way of preliminary plastic deformation at a considerably greater temperature.

A report by Yu. M. Plishkin investigated the question of stable configurations of atomic layers in relation to the stretching of a cylinder in the direction of its axis. By means of some simplified allowances, the shape of the crack corresponding to the minimum potential energy was obtained.

K. P. Rodionov -- on the basis of obtained experimental data -- expressed a hypothesis of the existence of a temperature area, in general not coinciding with the melting temperature, in which there may occur an abnormal change in the physical properties of a solid body under pressure and temperature. A thermodynamic analysis was given concerning true compression coefficients, thermal expansion, thermal capacity, and parameters in relation to pressure and temperature in the area of abnormality. The report expressed some qualitative considerations relative to the nature of this phenomenon.

A report by N. I. Varich was devoted to a discussion of the rules of periodic change in interatomic forces depending on the location of elements in the periodic system of D. I. Mendeleyev.

In his communication, G. M. Vorob'yev examined the possibility of authentic measurements of the intensity of Roentgen interferences with the presence of structure in samples.

A communication from A. S. Viglin was devoted to the question of textures. In it there was a discussion of the quantitative measure of structure in polycrystalline materials.

In the closing plenary session, the conference adopted a resolution in which the most important questions of metals and alloys were recorded and which also indicated directions of further investigations. Organizational measures directed toward the improvement of work in the area of the theory of metals were also recommended.

END